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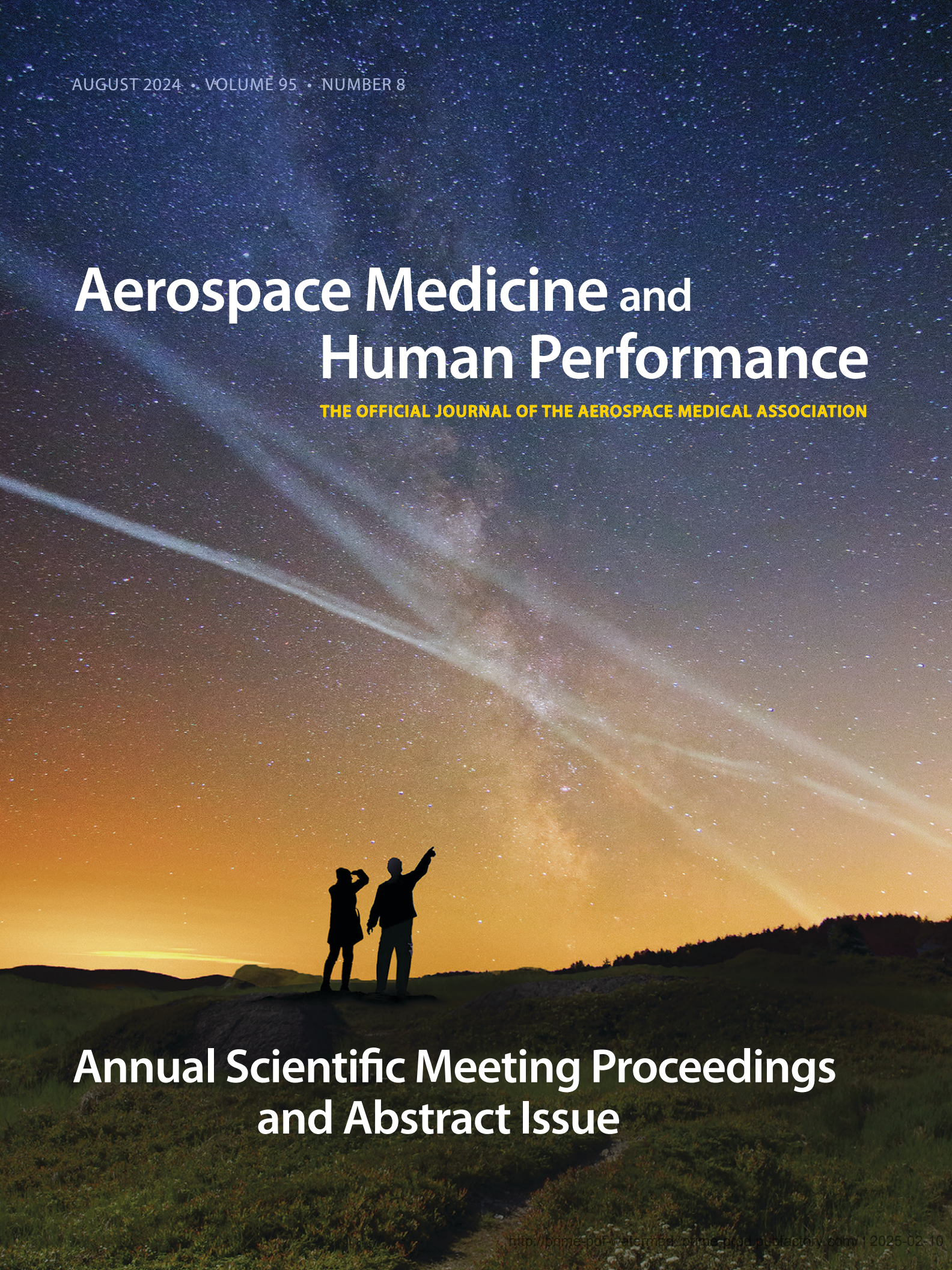
Aerospace Medicine and Human Performance

THE OFFICIAL JOURNAL OF THE AEROSPACE MEDICAL ASSOCIATION



Annual Scientific Meeting Proceedings and Abstract Issue

Aerospace Medicine and Human Performance

AUGUST 2024 VOLUME 95 NUMBER 8 [ISSN 2375-6314 (print); ISSN 2375-6322 (online)]

This journal, representing the members of the Aerospace Medical Association, is published for those interested in aerospace medicine and human performance. It is devoted to serving and supporting all who explore, travel, work, or live in hazardous environments ranging from beneath the sea to the outermost reaches of space.

AEROSPACE MEDICAL ASSOCIATION is an organization devoted to charitable, educational, and scientific purposes. The Association was founded when the rapid expansion of aviation made evident the need for physicians with specialized knowledge of the flight environment. Since then, physicians have been joined in this Association by professionals from many fields and from many countries, all linked by a common interest in the health and safety of those who venture into challenging environments.

AEROSPACE MEDICINE AND HUMAN PERFORMANCE, formerly *Aviation, Space, and Environmental Medicine*, is published monthly by the Aerospace Medical Association, a non-profit charitable, educational, and scientific organization of physicians, physiologists, psychologists, nurses, human factors and human performance specialists, engineers, and others working to solve the problems of human existence in threatening environments on or beneath the Earth or the sea, in the air, or in outer space. The original scientific articles in this journal provide the latest available information on investigations into such areas as changes in ambient pressure, motion sickness, increased or decreased gravitational forces, thermal stresses, vision, fatigue, circadian rhythms, psychological stress, artificial environments, predictors of success, health maintenance, human factors engineering, clinical care, and others. This journal also publishes notes on scientific news and technical items of interest to the general reader, and provides teaching material and reviews for health care professionals.

MEMBERSHIP—The Aerospace Medical Association welcomes members interested in aerospace medicine and human performance. Membership applications may be obtained online at www.asma.org or from the Aerospace Medical Association's headquarters at 320 S. Henry Street, Alexandria, VA 22314, or phone the Membership Department at (703) 739-2240; skildall@asma.org.

SUBSCRIPTIONS—*Aerospace Medicine and Human Performance* is provided to all members of the Aerospace Medical Association (online; a print subscription may be purchased separately). Subscriptions and changes of address should be sent to the Subscription Department, *Aerospace Medicine and Human Performance*, 320 S. Henry Street, Alexandria, VA 22314, at least 90 days in advance of change. Institutional Subscription Rates (Online): U.S.-$348, Canada-$348, Other countries-$348 (includes air delivery); Agent Disc.-$20. Individual Subscription Rates (Online): U.S.-$268, Canada-$268, Other countries-$268 (includes air delivery). Single copies and back issues: $30+P/H ($7.50 U.S./$25 International Air). NOTE TO INTERNATIONAL SUBSCRIBERS: Please add $50 for bank handling charges on checks not drawn on U.S. banks.

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Aerospace Medicine and Human Performance

AUGUST 2024 VOLUME 95 NUMBER 8

AsMA 94th Annual Scientific Meeting Proceedings Hyatt Regency Chicago Hotel, Chicago, IL, United States May 5–10, 2024

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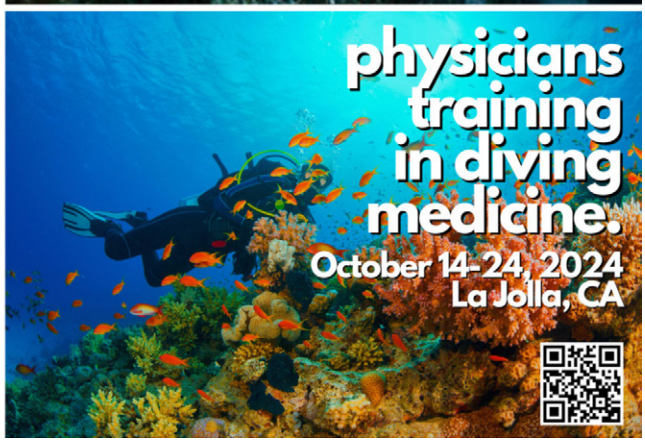

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For United States Federal Income Tax purposes, you can deduct as a charitable contribution the price of the membership renewal less the estimated cost of your ***Aerospace Medicine and Human Performance*** journal subscription. We estimate the cost to produce the journal to be $100 per year. Any membership contribution in excess of $100 per year is tax deductible.
For Non-U.S. members, the entire membership fee is related to the activities of the Aerospace Medical Association to improve the professional knowledge and practice of its members. This includes subscription to the Association's professional journal, itself part of the education effort of the Association.

Specialties: Please select from the following list of specialties all that apply to you.

- ☐ Administrative Medicine – physicians
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- ☐ Aviation Medical Examiner
- ☐ Biochemistry
- ☐ Bioengineering
- ☐ Biomedical Engineering
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- ☐ ENT
- ☐ Environmental Sciences
- ☐ Epidemiology
- ☐ Family Practice
- ☐ Forensic Medicine
- ☐ Gastroenterology
- ☐ General Practice
- ☐ General Surgery
- ☐ Geriatrics
- ☐ Hand Surgery
- ☐ Human Performance
- ☐ Human Systems Integration
- ☐ Hyperbaric Medicine
- ☐ Industrial or Occupational Medicine
- ☐ Industrial or Traumatic Surgery
- ☐ Internal Medicine
- ☐ Legal Medicine
- ☐ Life Insurance Medicine
- ☐ Life Science
- ☐ Maxillofacial Surgery
- ☐ Medical Anthropology
- ☐ Military Command
- ☐ Neurological Surgery
- ☐ Neurology
- ☐ Nuclear Medicine
- ☐ Nursing/Patient Transport
- ☐ Obstetrics and Gynecology
- ☐ Occupational Diseases
- ☐ Ophthalmology
- ☐ Optometry
- ☐ Orthopedic Surgery
- ☐ Otolaryngology and Otology
- ☐ Pathology
- ☐ Pediatrics
- ☐ Pharmacology
- ☐ Physical Medicine & Rehabilitation
- ☐ Physiology
- ☐ Plastic Surgery
- ☐ Preventive Medicine – General
- ☐ Proctology
- ☐ Psychiatry
- ☐ Psychology
- ☐ Public Health
- ☐ Pulmonary Disease
- ☐ Radiology & Roentgenology
- ☐ Research and Research Scientist
- ☐ Rheumatology
- ☐ Space Medicine
- ☐ Sports Medicine
- ☐ Surgery
- ☐ Thoracic Surgery
- ☐ Toxicology
- ☐ Tropical Medicine
- ☐ Urology

Please consider joining one or more of the following Constituent Organizations https://www.asma.org/about-asma/constituents:

- ☐ Aerospace Human Factors Association
- ☐ Aerospace Medicine Student and Resident Organization
- ☐ Aerospace Nursing and Allied Health Professionals Society
- ☐ Aerospace Physiology Society
- ☐ Airlines Medical Directors Association
- ☐ American Society of Aerospace Medicine Specialists
- ☐ International Association of Military Flight Surgeon Pilots
- ☐ Life Sciences & Biomedical Engineering Branch
- ☐ Society of NASA Flight Surgeons
- ☐ Society of U.S. Air Force Flight Surgeons
- ☐ Society of U.S. Army Flight Surgeons
- ☐ Society of U.S. Naval Flight Surgeons
- ☐ Space Medicine Association

95th AsMA Annual Scientific Meeting: "Innovation: Journey to the Future"

Hyatt Regency Atlanta, Atlanta, GA, United States

June 1–6, 2025

Call for Abstracts Deadline: Nov. 1, 2024; ***NO Exceptions!***

The Aerospace Medical Association's 2025 Annual Scientific Meeting will be held in Atlanta, GA, USA. The theme for this year's Annual Scientific Meeting is **"Innovation: Journey to the Future."** With emerging technology and new entrants into the aviation and space environment, it is now more important than ever to encourage the next generation of young people to consider entering career fields like aerospace medicine, engineering, aviation, maintenance, air traffic control, and remotely piloted vehicle operations, to name a few. To quote a staff member, "if a young person can't see it, they can't be it." Many of our youth have no awareness of the career opportunities in aerospace medicine. We need to be out in our schools and youth organizations telling our story. In addition, AsMA members will need to maintain a full awareness, and in many cases, a working knowledge of the innovations so we can better respond to needs of the aviation and space communities. The future will require us to think differently as the airspace system changes.

The Annual Scientific Meeting is the premier international forum to learn and discuss evolving trends and multidisciplinary best practices in research, clinical applications, human performance, and flight safety. The 95th Annual Scientific Meeting welcomes abstracts in the many areas related to Aerospace Medicine. For a complete list, see the box on p. 2 of this form.

AsMA ABSTRACT SUBMISSION PROCESS

LIMIT: 350 words/2500 characters including spaces; NO Tables or Figures or References should be included in the abstract. All abstracts must be submitted via the electronic submission system link on the association's website: *https://www.asma.org/scientific-meetings/asma-annual-scientific-meeting/call-for-papers*.

ATTENTION: You MUST use personal email addresses when entering your abstracts and those of your co-authors.

ABSTRACT PRESENTATION TYPES

The Annual Scientific Meeting highlights four types of presentation formats.

1. Poster: Individual Digital Poster presentations are integrated into a Poster session, grouped by topic. The presentation must be submitted as a PowerPoint with up to a maximum of 10 slides. Video and audio clips can be embedded. They will be displayed digitally. Posters are on display for two full days, each in an assigned space. Authors will be asked to present their poster for a single designated 90-min period on one of these days.

2. Slide: Standalone 15-minute slide presentation with questions/discussion that will be integrated into an oral slide session, grouped by topic. PowerPoint presentations will be organized by topic area and presented during 90-minute blocks of time, 6 periods of 15 minutes each. Individual PowerPoint Oral presentations are limited to 15 minutes, including 3–5 minutes for questions and discussion.

3. Panel: Invited Presentation that will link to support a Panel Overview containing five (non-case study) or six (case study) abstracts presented as a cohesive whole. Panels also have 90 minutes, ideally 5 presentations of 15 minutes each followed by a 15-minute discussion period.

4. Workshop: Invited Presentation that will link to and support a Workshop Overview. Overview abstracts should reflect the material to be presented in this long format for up to 8 hours of CME credit.

PRESENTATION CATEGORIES

There are two presentation categories based on the topic. (Templates and examples are provided for each type and will be available on the abstract submission website). Authors will be required to enter abstract text under the headings as described below.

1. Original Research: Material that is original in nature and has not been previously presented. Original analysis of a hypothesis involving data collection and analysis. Headings include Introduction, Methods, Results, and Discussion.

2. Education: Typically, a discussion of information that is already available.

a. Program/Process Review: Description of a program or process that is used to solve a problem or accomplish a task. Headings include Background, Description, and Discussion.

b. Tutorial/Review: An educational session intended as a review of established material. Headings include Introduction, Topic, and Application.

c. Case Study: A single clinical or human performance event. Headings include Introduction, Case Description, and Discussion.

PANEL GUIDANCE

Panels must be composed of a coordinated sequence of 4–5 abstracts that flow logically from one to another supporting the central theme. Panels must contain abstracts that allow 15 minutes of structured discussion at the end of the session.

Case Study Panels: Case Study Panels can have 6 abstracts and are intended to highlight a particular institution, community, or aeromedical issue, usually presented from the same institution or aeromedical community.

It is the responsibility of the Panel Chairperson to enter all supporting abstracts and to ensure that all supporting abstracts clearly describe how each supports the Panel theme. If the Panel theme is not clearly identified and/or the abstracts do not support a central theme, the Scientific Program Committee may decline the proposed Panel in total. Unrelated abstracts from a laboratory or organization do not constitute a Panel (unless they are Case Studies).

Panel Chairs are also responsible for preparing questions and discussion points to facilitate a moderated discussion with the audience during the sixth period. Each Panel speaker should cite or link directly to the Panel theme, and at the end of their talk should provide a logical segue to the next abstract.

WORKSHOP GUIDANCE

Rules for workshops and the review process are similar to those for Panels (above). Individual abstracts must be entered for each invited presenter and all necessary information must be entered in the same manner as all other abstracts, including financial disclosure statements. Course materials should be made available for registrants.

A separate registration fee is charged for Workshops registration. For additional information contact Jeff Sventek, Executive Director, at jsventek@asma.org.

AsMA ABSTRACT SUBMISSION PROCESS

All abstracts must be submitted via the electronic submission system linked to on the association's website: *https://www.asma.org/scientific-meetings/asma-annual-scientific-meeting/call-for-papers*. Click on the link to the abstract submission site--available on the

AsMA home page and Meetings page on or about September 1, 2024. Authors with questions regarding the abstract submission process should contact AsMA directly at (703) 739-2240, x101 (Ms. Rachel Trigg); or email rtrigg@asma.org.

The following information is required during the submission process: Abstract title, presenting author information (including complete mailing and email addresses and telephone numbers), topic area (from list provided on back of form), contributing authors names, emails and institutions, abstract content **(LIMIT: 350 words/2500 characters including spaces), at least 2 Learning Objectives** (the Accreditation Council for Continuing Medical Education requires this for all presentations). In addition, three (3) multiple choice or True/False questions and answers are required for each Poster, Slide, and Panel presentation for enduring materials for CME credit. Read instructions online for additional details. ***Poster presenters are required to upload their poster as a PowerPoint in advance of the meeting.***

PLEASE NOTE: All Presenters (including panelists) are required to register for the meeting. *There is a discounted fee for non-member presenters. Registration limited to the day of presentation will be available on site.*

Financial Disclosure/Conflict of Interest/Ethics

Abstracts will not be accepted without a financial disclosure form. The form is included as part of the website abstract submission process. The presenting author must agree to comply. Scientific presentations at AsMA-sponsored events will adhere to the highest standards of scientific ethics, including appropriate acknowledgment or reference to scientific and/or financial sources. Presenters must avoid the endorsement of commercial products in their abstracts and during their presentations. There must be no advertisements on Posters, slides, or handout materials.

Presentation Retention Policy

AsMA will use live capture technology to record all oral presentations during the meeting. Recorded presentations will be made available to registrants after the meeting. Authors are required to provide permission for live capture and a nonexclusive license to repurpose the content. PDF copies of Poster presentations must be uploaded to the designated submission site.

Permissions and Clearances

It is the author's responsibility to obtain all necessary permissions and clearances prior to submission of the abstract. AsMA assumes no liability or responsibility for the publication of any submitted material.

Acceptance Process

Abstracts will be reviewed by a minimum of three members of the AsMA Scientific Program Committee. Acceptance will be based on the abstract's originality, relevance, scientific quality, and adherence to the guidelines provided. Criteria for non-acceptance include, but are not limited to: insufficient, inconsistent, or ambiguous data; commercialism; or reviews of previously published literature. Abstracts must be 100% complete upon submission, including all final data and results. How well authors abide by submission and format guidelines will also be one of the criteria used to determine acceptance of abstracts.

Presenters are limited to one Slide OR Poster AND one Panel presentation unless given specific prior permission by the Scientific Program Committee Chair, Amanda Lippert, at sciprog@asma.org. Following review by the Scientific Program Committee in November, all contributors will receive a notification of acceptance or non-acceptance by email. Accepted abstracts will be published in *Aerospace Medicine and Human Performance*.

While the Scientific Program Committee strives to honor the presenter's desired presentation format, for reasons such as space limitations or dissimilar content, an abstract may be changed to an alternative presentation format. Assignment of an abstract to either a poster or a slide presentation will be recommended by the Scientific Program Committee, but the final decision will be made by the Program Committee Chair.

Abstract Withdrawal

Withdrawing abstracts is strongly discouraged. However, if necessary, a request to withdraw an abstract should be sent to Amanda Lippert, the Scientific Program Chair, at sciprog@asma.org and Rachel Trigg at rtrigg@asma.org. The request for withdrawal must include the abstract title, authors, ID number, and reason for withdrawal. Abstract withdrawal decisions must be sent to the Scientific Program Chair as soon as possible.

Mentorship

Optional review / feedback for student and resident presenters at AsMA 2025

AsMA is continuing its mentorship initiative for student and resident authors for the 2025 Scientific Meeting. You have the option to submit a draft of your abstract to a group of senior AsMA members for review and feedback. If you have questions about this opportunity, please e-mail sciprog@asma.org. E-mail your abstract to sciprog@asma.org no later than October 1, 2024. The Program Mentor Group will review provide feedback via e-mail by October 20, 2024. The abstract will still need to be finalized in the submission system.

TOPIC AREAS: (These will be listed on a drop-down menu on the submission site. They are used to organize the abstracts into sessions.)

1: Human Performance
- 1.1 Personnel Selection
- 1.2 Training
- 1.3 Hypobaric & Hyperbaric Physiology
- 1.4 Thermal Physiology
- 1.5 Acceleration / Vibration/ Impact
- 1.6 Fatigue
- 1.7 Neurophysiology & Sensory (inc. Vision, Auditory, Vestibular, Spatial Disorientation)
- 1.8 Aerospace Human Factors & Psychology
- 1.9 Aerospace Human Systems Integration

2: Clinical Medicine
- 2.1 Aviation Medicine
- 2.2 Health Promotion and Wellness Programs
- 2.3 Medical Standards / Aircrew Health
- 2.4 Occupational / Environmental Medicine
- 2.5 Operational Medicine
- 2.6 Hyperbaric Medicine

3: Travel and Transport Medicine
- 3.1 Travel Medicine
- 3.2 Aeromedical Transport / Air Evacuation
- 3.3 Air Transport Medicine
- 3.4 Commercial
- 3.5 Pandemic Preparedness

4: Space Medicine
- 4.1 Space Medicine
- 4.2 Space Operations

5: Safety and Survivability
- 5.1 Escape / Survival
- 5.2 Flight Safety / Accident Investigation

6: Other
- 6.1 History of Aerospace Medicine
- 6.2 Ethics

Follow the link to the abstract submission site on our website:
https://www.asma.org/scientific-meetings/asma-annual-scientific-meeting/call-for-papers
Deadline is November 1, 2024 (NO EXCEPTIONS!!!!!!!)

Empowering Excellence and Member Engagement—How Associations Influence Policy, Practice, and Personal Growth

Robert Orford, M.D., CM, MS, MPH, FACP, FRCPC, FRSM, FAsMA

Professional associations are important. Their collective strength and the services they provide benefit both individual members, the populations they serve, and the broader community.

The American Medical Association (AMA) is the largest and most influential association of physicians in the country. Its mission is to promote the art and science of medicine while improving public health. The main policy making body of the AMA is the House of Delegates (HOD), which meets twice annually. All major medical specialties, including the Aerospace Medical Association, are represented, as are all State Medical Associations. To maintain representation, it is important for physicians to maintain their membership in the AMA. Within the AMA there are 15–20 Section Councils, which encourage and facilitate cooperation among participating organizations, partners, and individuals. Councils may also sponsor or co-sponsor policy resolutions in the AMA HOD.

AsMA is a member of the Section Council on Preventive Medicine (SCPM), which includes AMA Delegates from AsMA and from our close cousins, the American College of Occupational and Environmental Medicine (ACOEM), the American College of Preventive Medicine, the American Association of Public Health Physicians, the American Academy of Insurance Medicine, the American College of Correctional Physicians, and the American Society of Addiction Medicine. AsMA's Delegate to the AMA, Dr. Joe "Bugs" Ortega, a Past President of AsMA, currently Chairs the SCPM. I serve as Alternate AsMA Delegate and served as ACOEM Delegate for many years before. AsMA also has a resident representative, Dr. Samantha King, who also represents AsMA at the AMA Resident & Fellow Section (RFS).

The American Osteopathic Association (AOA) is a physician organization with a mission, membership, and HOD like AMA's. Many AsMA members belong to AMA or AOA, and some belong to both. AsMA Past President Dr. Kris Belland, AOA HOD Delegate for Texas, represents AsMA's interests. Drs. Dan Berry and Jennifer Benincasa represent AOA at AsMA. AsMA is not solely an organization of physicians. We have nurses, nurse practitioners, physician assistants, physiologists, psychologists, Ph.D. researchers, and others with societies in their own professional areas, some of them, such as the American Nursing Association and the American Psychological Association, being quite large.

The many national associations connected with AsMA through common membership may influence national health care and prevention policies individually or collectively. Some, such as AsMA, with its extensive international membership,

Left to right: Robert Orford, AsMA President and AMA Delegate; Dr. Samantha King, UTMB Aerospace Medicine Resident, AMA Resident, and Fellow Section Delegate; and Dr. Joe Ortega, AsMA AMA Delegate at the AMA 2024 Annual Meeting.

The plaque on the front of the AsMA Home Office.

DOI: https://doi.org/10.3357/AMHP.958PP.2024

CONTACT DETAILS:
Email: President@asma.org • **Web site:** www.asma.org • **Facebook:** Aerospace Medical Association • **Twitter:** @Aero_Med

PRESIDENT'S PAGE, *continued*

and AMA (a member of the World Medical Association), have international influence as well. As we navigate the evolving landscape of aerospace medicine, preventive medicine, and clinical care in the United States and other countries, it is important to recognize the critical role that all these associations play in supporting physicians and other professionals.

Through advocacy, organizations represent their members and their profession with a unified voice, advocating for policies to enhance professional activities, reduce administrative burdens, and protect professional autonomy. They provide education, training, and lifelong learning. Their conferences and webinars also encourage networking, mentoring, and career advancement. Many, including AsMA, establish evidence-based guidelines, standards of care, and practice resources, which help professionals make informed decisions, improve clinical outcomes, and maintain professional excellence. Most Associations also play an important role by encouraging professional diversity and equity. Medical and other professional associations, whether national, specialty-focused, or state-based, play an indispensable role in society.

Which brings us to your role and opportunities in the Aerospace Medical Association. As the largest professional membership organization in aerospace medicine and human performance, AsMA provides valuable roles and opportunities to its members. Let's explore some of these:

Certification and Expertise: AsMA offers courses and workshops, including the annual FAA Aviation Medical Examiner (AME) Seminar, which covers aerospace physiology, human factors in aviation, the FAA regulatory framework, and the impact of clinical conditions on flight safety, and is a convenient way to maintain AME certification. AsMA also offers examinations for Aerospace Physiology Certification and for American Board of Preventive Medicine Maintenance of Certification.

Networking and Collaboration: AsMA facilitates connections among aeromedical professionals. Ask authors questions regarding their presentations or posters. Introduce yourself and engage with experts, researchers, practitioners, and AsMA leaders. Attend committee meetings and luncheons that interest you at the Annual Scientific Meeting and introduce yourself to your neighbors. In most cases you may attend a presentation at a luncheon as an observer in the gallery seats, even if you do not have a ticket for lunch. AsMA is a family, and your colleagues will be pleased to meet you.

Advocacy and Influence: AsMA actively advocates for health, safety, and performance enhancement in aviation and space. Members contribute to shaping regulatory policies and promoting scientific knowledge through the Resolutions process, through communication with senior medical staff of aeromedical certification regulatory bodies, and through contact with politicians and regulators concerning aviation and space medicine.

Research, Innovation, and the Annual Scientific Meeting: AsMA encourages research and innovation. By attending the AsMA Annual Scientific Meeting (ASM) you will stay informed about cutting-edge developments. Many years ago, an Air Force friend encouraged me to attend the AsMA Scientific Program Committee meeting in November, where the abstract review and planning are done for next year's meeting. I have attended most years since and encourage you to consider doing so also. You may also now review abstracts virtually.

Publications and Journals: AsMA publishes *Aerospace Medicine and Human Performance*, otherwise known as the "Blue Journal", monthly, providing you with access to the latest research, case studies, and best practices in aerospace medicine. AsMA members are entitled to the electronic version of the journal as a benefit of membership. An annual subscription to print copies of the journal is also available at a discounted rate.

Leadership Opportunities: AsMA offers many leadership roles. Look for opportunities to join one or more of our 18 Standing Committees, or our Constituent and Affiliated Organizations. Committees are listed in our Bylaws, Constituent and Affiliated Organizations in our Policies and Procedures. Both documents are available online. Through your participation, you will actively shape the association's initiatives and contribute to its mission.

In summary, AsMA is a comprehensive ecosystem for aerospace medicine professionals, offering education, networking, advocacy, and opportunities to make a meaningful impact on aviation health and safety. Thank you for your membership, and please encourage others to join us.

AsMA is a family. No one belongs here more than you!

AsMA 94th Annual Scientific Meeting Educational Information

The Aerospace Medical Association's 2024 Annual Scientific Meeting was held in Chicago, IL, USA. The theme for this year's Annual Scientific Meeting was "Honoring the Past ... Preparing for the Future." With emerging technology and new entrants into the aviation and space environment, it is now more important than ever to encourage the next generation of young people to consider entering career fields like aerospace medicine, engineering, aviation operations, maintenance, and air traffic control to name a few. To quote a staff member, "if a young person can't see it, they can't be it." Many of our youth have no awareness of the career opportunities in aerospace medicine. We need to be out in our schools and youth organizations telling our story. In addition, AsMA members will need to maintain a full awareness and, in many cases, a working knowledge of innovations so we can better respond to the needs of the aviation and space community. The future will require us to think differently as the airspace system changes.

EDUCATIONAL OBJECTIVES & BENEFIT

Based upon responses to a survey provided at the end of the 93rd Annual Scientific Meeting in New Orleans, LA, the top six categories our members indicated a need for more information in were: Aerospace Medicine; Space Medicine; Medical Standards; FAA Medicals; Human Performance; and Accident Investigation. The 94th Annual Scientific Meeting program was focused on these six major categories. Sessions covered the latest findings in aviation and space medicine, human performance, and related fields such as aerospace nursing, aerospace physiology, and human systems integration.

The scientific program was focused on meeting stated objectives. Participants learned: (1) principles of evidence-based medicine, operational risk management, and aeromedical decision-making in aircrew selection and clinical aerospace medicine practice; (2) evolving trends and best practices in aerospace medicine; (3) techniques for analyzing mechanical, human performance, and systems integration factors in aviation mishaps and safety programs; (4) mechanical, biological, social, cognitive, environmental stress, and systems factors that impact on optimal human performance and decision making in the full spectrum of aerospace operations; and (5) ethical principles to aerospace medicine decision-making and competencies in professionalism and systems-based practice in the application of aerospace medicine skills, teamwork, and interoperability in a multi-discipline professional environment.

KEY TOPICS

Key topics included: Space Medicine; three plenary lectures on aspects of aerospace medicine and aerospace operations; workplace stress and mental health; Aeromedical Grand Rounds and "RAM Bowl"; emerging technologies; hypoxia, acceleration, and high-altitude medical issues; spatial disorientation; patient safety and air transport medicine issues; in-flight medical events; human systems integration; human performance in aviation; aviation safety in civil and military settings; and aviation medicine case studies.

CREDIT HOURS FOR ATTENDANCE

The Undersea and Hyperbaric Medical Society designated this live activity for a maximum of 23.0 *AMA PRA Category 1 Credits™*. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Nursing CEUs: This nursing continuing professional development activity was approved by Montana Nurses Association, an accredited approver with distinction by the American Nurses Credentialing Center's Commission on Accreditation.

ABPM CONTINUING CERTIFICATION PROGRAM (CCP)

The ABPM's CCP was developed in compliance with the new Standards for Continuing Certification mandated by the American Board of Medical Specialties and in response to feedback from ABPM Diplomates, who wanted a simpler but more meaningful program, and who overwhelmingly preferred an innovative alternative to the traditional high-stakes, point-in-time Maintenance of Certification (MOC) exam. To ensure a smooth transition to the CCP, ABPM is introducing the new program in three separate and distinct phases.

Phase 1: 2023-2024

In Phase One of the transition, in effect for calendar years 2023 and 2024, Diplomates have only three annual requirements:

1. Maintain a current, valid, and unrestricted medical license in every U.S. state, U.S. territory, or Canadian province in which the Diplomate holds a license to practice medicine;
2. Pay the annual fee using the ABPM's Physician Portal;
3. Attest to earning 20 *AMA PRA Category 1 Credits™* (using the ABPM's Physician Portal)
    - Six of the credits must be relevant to Diplomates' ABPM Certification(s). Diplomates will choose for themselves which CME courses are relevant to the ABPM Specialties or Subspecialties in which they are Certified.

Phase 2: 2025-2029

Phase Two of the transition will begin in January 2025 and continue through December 2029, and will include an expansion of its LAP pilot for each ABPM Specialty and Subspecialty. The LAP will be an open-resource assessment that includes 30 questions annually, designed to be an innovative replacement for the traditional, high-stakes, point-in-time MOC exam.

Phase 3: 2030 and beyond

Finally, in January 2030, ABPM will launch Phase Three that will include both the annual CME and LAP requirements as well as an Improvement in Health and Healthcare component, the details of which are in development and will be shared once they have been finalized.

MEETING EVALUATIONS AND CME CREDIT

For CME credit, it is imperative that you reply to the post-meeting evaluation and answer all of the questions. Your evaluations are very important to us as they convey your educational needs and help us plan the academic program for the following year. In addition, this is an Accreditation Council for Continuing Medical Education (ACCME) requirement.

AsMA'S EDUCATIONAL MISSION

The Aerospace Medical Association's Annual Scientific Meeting is a forum in which the newest information on safe-guarding human life in flight environments is presented. During the rest of the year, the Association's monthly journal, Aerospace Medicine and Human Performance, fulfills this function.

Further information on the Aerospace Medical Association may be obtained by visiting our website at www.asma.org, by calling (703) 739-2240, or by writing to: Aerospace Medical Association, 320 S. Henry Street, Alexandria, VA 22314-3579.

Recording of sessions: The plenary lectures were videotaped and offered online following the meeting. All slides and panel sessions were live captured and made available to all paid registrants.

Accreditation Statement: This activity was planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of the Undersea and Hyperbaric Medical Society and the Aerospace Medical Association. The Undersea and Hyperbaric Medical Society is accredited by the ACCME to provide continuing medical education for physicians.
Full Disclosure Statement: All faculty members and planners participating in continuing medical education activities sponsored by the Aerospace Medical Association are expected to disclose to the participants any relevant financial relationships with ineligible companies. Full disclosure of all individuals in control of content and their relevant financial relationships was made at the activity.
UHMS Disclaimer: The information provided at this CME activity is for Continuing Medical Education purposes only. The lecture content, statements or opinions expressed however, do not necessarily represent those of the Undersea and Hyperbaric Medical Society (UHMS), its affiliates or its employees.

2024 Annual AsMA Plenary Lectures

69th Louis H. Bauer Lecture
Harrison Schmitt, M.Sc., Ph.D., astronaut and former Senator
"Human Space Adaptation—Apollo Experience—Honoring the Past … Preparing for the Future"

Joining NASA in its first astronaut class to include scientist-astronauts in June 1965, geologist Harrison H. "Jack" Schmitt was on the backup crew for Apollo 15. In August 1971, he was assigned as the Lunar Module Pilot for the last Apollo mission to the Moon, Apollo 17.

Dr. Schmitt received a Bachelor of Science degree in science from the California Institute of Technology in 1957; studied as a Fulbright Fellow at the University of Oslo in Norway from 1957 to 1958; and received a doctorate in geology from Harvard University in 1964, based on geological work in western Norway. In 1957, he began geological fieldwork on the west coast of Norway, returning there in 1960 to work in that region for the Norwegian Geological Survey. He also worked in the field for the U.S. Geological Survey in New Mexico, Arizona, and Montana. He was with the U.S. Geological Survey's Astrogeology Branch in Flagstaff, AZ, in 1964–1965, serving as Project Chief for Lunar Field Geological Methods on contract to NASA. He also was responsible for a lunar photographic and telescopic mapping project and for instructing NASA astronauts during their early geological training trips.

NASA Experience: Dr. Schmitt was selected in Astronaut Group 4 as a scientist-astronaut in June 1965. As a civilian, he completed jet and helicopter flight training at Williams AFB, AZ, and at the Pensacola Naval Air Station, FL. He logged more than 2100 hours flying time, including 1600 hours in jet aircraft (primarily the T-38 Talon) and 210 hours in helicopters (H-13). During the period of his general preparation for spaceflight, he assisted in the integration of operational and scientific activities into the Apollo lunar missions, as well as the planning for lunar orbit and surface operations for Apollo missions 8–13. These responsibilities included the design and oversight of an upgraded geological training program for Apollo missions 13–17. He was designated as the Mission Scientist in support of Apollo 11 and, in early 1970, he was assigned as the Backup Lunar Module Pilot for Apollo 15 that flew to the Moon in July 1971. In August 1971, Dr. Schmitt was assigned as Lunar Module Pilot for the Apollo 17 mission. Apollo 17 launched at 12:33 p.m. (EST), December 7, 1972, and splashed down in the Pacific on December 19, 1972, having completed 3 days of geological and geophysical exploration in the valley of Taurus-Littrow on the Moon. Schmitt is the first scientist and 12th and last person to step on the Moon. This last Apollo mission to the Moon broke several records set by previous flights, including longest manned lunar landing flight (301 hours, 51 minutes); longest total lunar surface extravehicular activities (22 hours, 4 minutes); longest distance traveled in the Lunar Roving Vehicle (35 km); largest lunar sample return [an estimated 115 Kg (249 lb)]; and the longest time in lunar orbit (147 hours, 48 minutes).

Post-Apollo 17 Career: In February 1973, Dr. Schmitt assumed additional duties for NASA as Chief of Scientist Astronauts, assisting in the definition of crew responsibilities for space operations during future Space Shuttle missions. He was appointed NASA Assistant Administrator for Energy Programs in January 1974, serving until late 1975 when he left NASA to run for election to the U.S. Senate from New Mexico. Elected to the Senate in 1976, he served for 6 years. After leaving the Senate in 1983, he served on President Reagan's Foreign Intelligence Advisory Board, President Bush 41's Commission on Ethics Law Reform, the Army Science Board, the Department of Interior's Strategic Minerals Advisory Board, and other federal advisory entities and delegations to international meetings and elections. He became a consultant to the Fusion Technology Institute at the University of Wisconsin-Madison in 1986, advising on the economic geology of lunar resources, eventually teaching in the course "Resources from Space" from 1996–2004. He remains an Associate Fellow of Engineering at the University of Wisconsin. During NASA's Constellation Program, he became chairman of the NASA Advisory Council in November 2005 and served until October 2008. From 2017–2022, he served as a member of the National Space Council's User Advisory Board. He is a prolific writer, having been published in many diverse venues, including *Science Magazine*, *Icarus*, the *Wall Street Journal*, and the *National Geographic Magazine*. In 2006, Springer published his book, "Return to the Moon," outlining a private sector approach to accessing lunar helium-3 for fusion power, medical diagnosis, and other applications. He also electronically published an annotated and illustrated version of the voice transcript from the Apollo 17 mission. Active in the private aerospace business sector, he was a Director of the Orbital ATK Corporation and its predecessor company, Orbital Sciences Corporation (1983–2018). In 1990, he joined the Board of Directors of the Draper Laboratory and, as a retired Director, he continues as an Emeritus Member of the Corporation that oversees the Laboratory. He continues to synthesize scientific data related to his exploration of Taurus-Littrow, including participation in NASA's "Apollo Next Generation Sample Analysis" (ANGSA) Program, as well as consulting with NASA and private entities on issues involved with NASA's Artemis Program to return to the Moon.

10th Reinartz Lecture
Panelists: Astronaut Joan Higgenbotham; Astronaut Robert Cabana; Astronaut (Dr.) Joe Kerwin; and Astronaut (Dr.) Serena Auñón-Chancellor
Panel: ***"Space Operations—Honoring the Past … Preparing for the Future"***

Joan Higginbotham is an electrical engineer, rocket scientist and retired astronaut, with dual master's degrees, and a 35-year career working with Fortune 500 companies in the aerospace, energy, and retail sectors.

During her 9-year tenure at NASA's Kennedy Space Center (KSC), Ms. Higginbotham participated in numerous space shuttle launches from the firing room, the "nerve center" for launches—an impressive accomplishment for anyone. However, when she returned to KSC for the launch of space shuttle Discovery on STS-116, she took "participation" to a whole new level: as astronaut Joan Higginbotham. On her nearly 13-day space mis-

sion, her primary task was to operate the International Space Station Remote Manipulator System (SSRMS), better known as the robotic arm, assisting with the installation of the P5 truss and supporting crewmembers during spacewalks to rewire the space station's power system and retract a solar panel. She is the third African American female astronaut to fly in space.

In 2022, she founded Joan Higginbotham, Ad Astra, LLC, an aerospace consulting firm. She consulted with Blue Origin, who was awarded a $3.4 billion contract by NASA to develop and fly a lunar lander.

Ms. Higginbotham has received numerous awards, including the World Who's Who of Women, Charlotte's (NC) 50 Most Influential Women, the NASA Exceptional Service Medal, *Savoy Magazine's* Top Influential Women in Corporate America, and she appeared in Alicia Key's Superwoman video. She was awarded an Honorary Doctorate in Aerospace Science from Southern Illinois University at Carbondale, her alma mater, and an Honorary Doctorate in Humanities from the University of New Orleans.

Robert D. Cabana is a former NASA astronaut, and recently retired as the agency's associate administrator, its third highest-ranking executive and highest-ranking civil servant. He was the senior advisor to NASA Administrator Bill Nelson and Deputy Administrator Pam Melroy. In that role, He led the agency's 10 center directors as well as the mission directorate associate administrators at headquarters. He acted as the agency's chief operating officer for more than 18,000 employees and an annual budget of more than $25 billion.

Before taking that position, Mr. Cabana was director of NASA's John F. Kennedy Space Center in Florida. In that role, Cabana managed all NASA facilities and activities at the spaceport, including the team of civil service and contractor employees who operate and support numerous space programs and projects.

Born in Minneapolis, MN, Mr. Cabana graduated from the U.S. Naval Academy in 1971 with a bachelor's degree in mathematics. He was commissioned a second lieutenant in the U.S. Marine Corps and completed Naval Flight Officer training in Pensacola, FL, in 1972. He then served as an A-6 bombardier/navigator with Marine Air Wings in Cherry Point, NC, and Iwakuni, Japan.

Returning to Pensacola in 1975, Mr. Cabana began pilot training and was designated a naval aviator in September 1976, earning the Daughters of the American Revolution award as the top Marine to complete flight training that year. He graduated with distinction from the U.S. Naval Test Pilot School in 1981 and served in the Flight Systems Branch at the Naval Air Test Center until 1984. During his career, Cabana has logged over 7000 hours in more than 50 different kinds of aircraft.

Mr. Cabana was selected as an astronaut candidate in June 1985 and completed his initial astronaut training in July 1986. He was assigned to the Lyndon B. Johnson Space Center Astronaut Office, serving in a number of leadership positions, including lead astronaut in the Shuttle Avionics Integration Laboratory; Mission Control Spacecraft Communicator, famously known as CAPCOM; and chief of NASA's Astronaut Office.

A veteran of four spaceflights, Mr. Cabana has logged 38 days in space, serving as the pilot on STS-41 and STS-53 and mission commander on STS-65 and STS-88. His fourth flight was the first assembly mission of the International Space Station in December 1998. Following his retirement as a colonel from the Marine Corps in September 2000, he was appointed a member of the Federal Senior Executive Service. He served in numerous challenging senior management positions at Johnson Space Center in Houston, ultimately becoming deputy director. In October 2007, he was appointed director of NASA's John C. Stennis Space Center in Mississippi. A year later he was reassigned as the 10th director of the John F. Kennedy Space Center.

Mr. Cabana's many achievements have been recognized with induction into the Astronaut Hall of Fame and being named an Associate Fellow in the American Institute of Aeronautics and Astronautics and a Fellow in the Society of Experimental Test Pilots. He has received numerous personal awards and decorations, including the Distinguished Flying Cross, the Presidential Distinguished Rank Award, and the National Space Club Florida Committee's Dr. Kurt H. Debus Award. He also is a recipient of the Rotary National Award for Space Achievement's National Space Trophy.

After graduating from Holy Cross in 1953, Joe Kerwin obtained an M.D. degree from Northwestern University, was drafted, and served as a U.S. Navy Flight Surgeon and Naval Aviator for 7 years before becoming a scientist-astronaut in 1965. He flew as Science Pilot on the first Skylab mission, spending a month in space in 1973. After Skylab he served in various NASA management positions, including NASA Representative in Australia (1982–1983) and Director of Space and Life Sciences at the Johnson Space Center (1984–1987.) He retired from the Navy, left NASA, and joined Lockheed in 1987.

At Lockheed Dr. Kerwin managed the Extravehicular Systems Project, providing hardware for Space Station Freedom from 1988–1990; with two other Lockheed employees he invented the Simplified Aid for EVA Rescue (SAFER), currently used by space-walking astronauts on the International Space Station (ISS). In 1994–1995, he led the Houston liaison group for Lockheed Martin's FGB contract, the procurement of the Russian "space tug" which has become the first element of the ISS.

Dr. Kerwin joined Systems Research Laboratories in June 1996 to serve as Program Manager of the team which bid to win the Medical Support and Integration Contract at the Johnson Space Center. He lost. The incumbent, KRUG Life Sciences, was selected. Then KRUG recruited him to replace its retiring President. He joined KRUG on April 1, 1997. In 1998, KRUG Life Sciences became the Life Sciences Special Business Unit of Wyle Laboratories of El Segundo, CA. Dr. Kerwin continued to lead the unit as Senior Vice President of Wyle. In 2003, Wyle was awarded the 10-year Bioastronautics contract by NASA to manage its future

medical work in support of human spaceflight. Dr. Kerwin managed that program until July 2004, when he retired.

In addition to his duties at Wyle, Dr. Kerwin served on the Board of Directors of the National Space Biomedical Research Institute (NSBRI) as an Industry representative until retirement. He now serves on its User Panel. He is also an Adjunct Professor of Space Medicine at the University of Texas Medical Branch (UTMB), and an Adjunct Professor of Physiology at the Texas A&M University College of Veterinary Medicine.

Dr. Serena M. Auñón-Chancellor was selected by NASA in 2009. Board certified in Internal and Aerospace Medicine, she recently served as Flight Engineer on the International Space Station for Expeditions 56 and 57. During her time on orbit, the crews contributed to hundreds of experiments in biology, biotechnology, physical science, and Earth science aboard the International Space Station. Investigations were led into new cancer treatment methods and algae growth in space. The crew also installed a new Life Sciences Glovebox, a sealed work area for life science and technology investigations that can accommodate two astronauts. During Dr. Auñón-Chancellor's first flight, she logged in 197 days in space. She currently covers medical issues and on-orbit support in the Astronaut Office.

Dr. Auñón-Chancellor graduated from Poudre High School, Fort Collins, CO, in 1993. She received a Bachelor of Science in Electrical Engineering from The George Washington University, Washington, DC, in 1997 and a Doctorate of Medicine from The University of Texas Health Science Center at Houston in 2001. She completed a 3-year residency in internal medicine at The University of Texas Medical Branch (UTMB) in Galveston, TX, in 2004, and then completed an additional year as Chief Resident in the Internal Medicine Department in 2005. She also completed an aerospace medicine residency at UTMB as well as a Master of Public Health in 2007. She is board-certified in Internal and Aerospace Medicine.

Dr. Aunon-Chancellor came to Johnson Space Center in August 2006, employed as a Flight Surgeon under the UTMB/Wyle Bioastronautics contract. She spent more than 9 months in Russia supporting medical operations for International Space Station crewmembers in Star City, including water survival training in the Ukraine. She served as the Deputy Crew Surgeon for STS-127 and also held the role of Deputy Lead for Orion Medical Operations.

58th Harry G. Armstrong Lecture
Lisa Kaltenegger, Ph.D., Director of the Carl Sagan Institute at Cornell University
"Searching for Alien Earths and Life in the Cosmos"

Prof. Lisa Kaltenegger is an award-winning astrophysicist and astrobiologist, the Founding Director of the Carl Sagan Institute at Cornell, Professor in Astronomy at Cornell University, and author of "Alien Earths: The Science for Planet Hunting in the Cosmos" (April 16, 2024). Asteroid 7734Kaltenegger is named after her.

Prof. Kaltenegger is a pioneer and world-leading expert in modeling habitable worlds and their light fingerprints and has spent the last decade finding new ways to spot life in the cosmos, working with NASA and ESA from Austria to the Netherlands, Harvard, Germany, and now Cornell. She is the author of more than 100 peer-reviewed publications.

Prof. Kaltenegger served on the National Science Foundation's Astronomy and Astrophysics Advisory Committee (AAAC), and on NASA senior review of operating missions, among others. She is a Science Team Member of NASA's Transiting Exoplanet Survey Satellite (TESS) Mission and the Near Infrared Imager and Slitless Spectrograph (NIRISS) instrument on the James Webb Space Telescope.

The Bauer Lecture was given on Monday, May 6, at 8:00 a.m. during Opening Ceremonies. Educational Support was provided by Wyle.

The Reinartz Lecture was given on Tuesday, May 7, at 8:30 a.m. Support was provided by the Eugen Reinartz Memorial Fund.

The Armstrong Lecture was given on Thursday, May 9, at 8:15 a.m. Eductional support was provided by Environmental Tectonics Corp.

2024 ABSTRACTS OF THE AsMA SCIENTIFIC SESSIONS

94th Annual Scientific Meeting **Hyatt Regency Hotel**
May 5 – 9, 2024 **Chicago, IL**

The following are the sessions and abstracts with rooms and presentation times for all presentations accepted after blind peer-review—in workshop, panel, slide, or poster sessions—for the 2023 Annual Scientific Meeting of the Aerospace Medical Association. The numbered abstracts are keyed to both the daily schedule and the author index. The Sessions numbers are listed as S-01 through S-89 (including workshops). Session chairs are included in the index to participants. The order of some sessions may have changed, so some abstracts may be out of numerical order. Abstracts withdrawn are listed as **WITHDRAWN**. Presenters are underlined in the text.

SLIDES & PANELS: Each slide presentation is scheduled for 15 minutes (10-min talk and 5-min Q&A). We strive to keep slide presentation on time. Panel presentations have more flexibility and may not keep to a strict 15 minutes per presenter format. There will be a discussion period of 15 minutes at the end of each panel.

POSTERS: Posters will be presented digitally this year. Poster authors must be present for the full session in which their poster is scheduled.

EXHIBITS: Exhibits will be open Sunday evening during the Welcome Reception, and 9:30 a.m. to 4:30 p.m. Monday and Tuesday. Please wear your badge and visit every exhibit.

CONFLICT OF INTEREST: All meeting planners and presenters completed financial disclosure forms for this live educational activity. All potential conflicts of interest were resolved before planners and presenters were approved to participate in the educational activity. Any conflicts of interest that could not be resolved resulted in disqualification from any role involved in planning, management, presentation, or evaluation of the educational activity.

TEMPLATES: All Abstracts were submitted according to a certain category and type using provided templates. Not all abstracts submitted fit the mold for Original Research abstracts. We therefore have created an Education category with three additional types: Case Report, Program/Process, and Tutorial. The templates for these are provided for your information.

ORIGINAL RESEARCH TEMPLATE:

This type of abstract describes the results and significance of new research undertaken to address gaps in the current knowledge of aerospace medicine or human performance. It is typically an original analysis of a hypothesis involving data collection and analysis.

INTRODUCTION: *<This section includes the background, including a statement of the problem and why it is important, the status of the current research, and the hypothesis to be tested.>*
METHODS: *<This section includes a brief description of how the study was conducted, the number, type, and gender of the subjects, and how they were selected and grouped. It should also include the metrics collected, how they were measured, and how frequently they were recorded. The types of scales or questionnaires administered should be identified. Environmental condition and administered medications should be described. In addition, a summary of the statistical methods should be provided. A statement concerning ethics approval for studies using human or animal subjects is also required.>*
RESULTS: *<This section includes a summary of the data and metrics of operational and/or statistical significance. "**Results will be discussed" is not acceptable.**>*
DISCUSSION: *<This section interprets the meaning of the results in terms of their application to the operational/clinical/scientific community and suggests areas for future research.>*

EDUCATION: CASE STUDY: CLINICAL OR HUMAN PERFORMANCE TEMPLATE:

This type of abstract describes the analysis of an individual clinical or operational case that is not a research study but provides pertinent information directly applicable to aeromedical practices, safety, or human performance.

INTRODUCTION: *<This section concisely summarizes the case.>*
BACKGROUND: *<This section describes the importance of the case and provides supporting evidence in the form of a literature review.>*
CASE PRESENTATION: *<This section describes the event.>*
DISCUSSION: *<This section explains the applicability and relevance to civilian and military operations.>*

EDUCATION: PROGRAM/PROCESS REVIEW TEMPLATE:

This type of abstract can describe a new Service thrust, e.g., identifying capability gaps, or reviews of critical areas, e.g., safety. It may be a description of a program or process that is used to solve a problem or accomplish a task.

BACKGROUND: *<This section describes why this is important to AsMA attendees and why this needs to be addressed now.>*
OVERVIEW: *<This section concisely describes the effort and how it applies to current or future gaps.>*
DISCUSSION: *<This section describes (1) the operational or clinical significance, (2) how it will this advance aeromedicine/human performance, and (3) address whether it supports cross Service/International/Military – Civilian spheres.>*

EDUCATION: TUTORIAL TEMPLATE:

This type of abstract describes new tools, models, techniques, methodologies pertinent to civilian and military aerospace medicine and human performance.

INTRODUCTION: *<This section summarizes what will be covered, e.g., list of topics or syllabus.>*
TOPIC: *<Description of new technology, procedure, methodology.>*
APPLICATION: *<This section details how the new material will be implemented and how broadly it applies to aerospace medicine and human performance.>*
RESOURCES: *<This is an optional section to provide citations where additional information can be found.>*

SUNDAY, MAY 05, 2024

Sunday, 05/05/2024 ***8:00 AM***
Michigan 1A, 1B

[S-01]: WORKSHOP: AVIATION MENTAL HEALTH: OUR HISTORY AND OUR FUTURE: WHERE WE ARE & WHERE WE ARE GOING?

Sponsored by AsMA Aviation Mental Health Work Group

Chair: Quay Snyder
Co-Chair: William Hoffman

WORKSHOP OVERVIEW: BACKGROUND: *Mental Wellness of all aviation professionals is critical to the safety of operations, optimization of performance and health of individuals. AsMA attendees are key educators and providers of mental wellness programs who need has been highlighted in several aviation mishaps and the aviation consequences of COVID worldwide.* ***OVERVIEW:*** *This workshop will evaluate the status of current global aviation mental health programs including Peer Support Programs (PSP), regulatory initiatives to reduce barriers to seeking help and industry proposals to improve fitness to fly. It will discuss future possibilities for personally assessing mental wellness, improving fitness and incorporation of programs into an Aviation Safety Management System (SMS). Breakout sessions will target aerospace medicine providers with specific interests. Active participant support will facilitate exchange of ideas to improve current gaps in wellness programs.* ***DISCUSSION:*** *The workshop will address international spheres across all aspects of aviation including airline, military, business, general and student training. Aerospace medicine initiatives in mental wellness training and support for the individual, providing templates for organizations and suggested guidance for regulators will improve safety and personal wellness. The workshop will initially present a historical review and current state of aviation mental wellness programs. A salutogenic approach rather than the current pathologic approach to medical certification is then discussed. Research initiatives for evidence-based recommendations is then discussed followed by a presentation on use of new technologies, including using AI and biomarkers in mental health. The above presentations trigger a discussion of ethical boundaries review in mental health research and evaluation. Regulators will present global initiatives followed by strategies to incorporate these program into an SMS. Two breakouts allow attendees discussion on peer support programs and clinical care. The workshop closes with a substantial time for open attendee discussion.*

[1] OUR HISTORY & OUR FUTURE: WHERE ARE WE & WHERE ARE WE GOING?

Quay Snyder
Aviation Medicine Advisory Service, Centennial, CO, United States

(Education - Program/Process Review)

INTRODUCTION: Mental well-being and its impact on aviation safety has gained worldwide attention following high-profile aircraft accidents and crew incidents in the previous decade. Within the aviation industry, several successful, but limited, programs to support the mental well-being of pilots have been established in the last 50 years. Increased attention to the magnitude and severity of reduced mental well-being in aviation has led to the discussion of strategies and establishment of programs to support mental health and aviation safety. This presentation will discuss past history, current progress, and future possibilities to optimize mental wellness in aviation professionals. **HISTORICAL BACKGROUND:** Previously, civil aviation authorities have medical disqualified pilots and Air Traffic Control Officers (ATCO's) who have been identified with mental illness diagnoses. Society stigmatized those with mental illnesses. The fear of loss of occupation if mental health help was obtained presented the biggest barrier to seeking help. The FAA/ALPA HIMS program proposed in 1974 was the first cooperative program using peer support, the medical community, the regulator, and the employer in assisting pilots with alcohol dependence. Fatal aircraft accidents in the late 1980's and early 1990's led to the creation of Critical Incident Response Programs (CIRP). The Germanwings murder-suicide by aircraft in March 2015 triggered worldwide calls for more widespread programs to support pilots' mental health. The result is a plethora of pilot union and regulator recommendations/regulations to institute pilot support programs industry wide. Recently, there is recognition at all aviation professionals and students should have similar resources available. **THE FUTURE:** A combination of strategies are proposed to enhance mental wellness in aviation. Primarily, regulators taking a salutogenic approach to mental health as opposed to the previous taxonomy based pathological approach to certification will remove barriers to seeking help. Transparency in certification and involvement of peers will reduce stigma and barriers to accessing assistance. Artificial Intelligence using biometric markers to assess fitness/wellness prior to duty compared to an individual baseline is a possible quantitative method of assessing fitness to fly. Workshop participants will be encouraged to offer their ideas to support future efforts.

Learning Objectives

1. Participants will understand of the historical evolution of various mental wellness enhancing programs in professional aviation.
2. Participants will understand current barriers to aviation professionals seeking mental health assistance and new strategies by aviation professional associations, employers, regulators, and training organizations to reduce those barriers.
3. Participants will become familiar with the role of artificial intelligence and other emerging technologies to enhance mental wellness and quantitate individualized assessments of fitness for duty.

[2] GENERATING WELLBEING, RESTORING HEALTH, FLYING SAFELY – HOW CAN WE PUT THE PUZZLE TOGETHER?

Kate Manderson
Civil Aviation Safety Authority, Canberra, Australia

(Education - Program/Process Review)

BACKGROUND: The connection between wellbeing, illness and flight safety has been described as a jigsaw puzzle, where we have only a few pieces and no clear final picture. More recently, we have suggested approaching the mental wellbeing and health puzzle in the same way as other medical certification decisions such as diabetes and heart disease, that had previously been too hard to put together safely because of missing pieces. **OVERVIEW:** Evidence-based aeromedical risk assessment relies on data about the individual pilot or controller that is matched with population-level data to identify, quantify and stratify risk. Each of these data points is a piece of that aeromedical "puzzle". Quality medical care is usually built around multidisciplinary teams, but we rarely expand the team membership beyond the clinical. That means the pieces of our puzzle are based on clinical parameters, test results, clinical reporting and assessment. However, many of these puzzle pieces are missing or don't exist at all when we try to use this approach for mental health certification. It's now time to look outside the box the jigsaw came in, and outside the purely clinical team, to build a picture of safe certification of pilots and controllers with mental health problems. We can also build a different picture, using these same pieces but aligned in different ways, of wellness and disease prevention. **DISCUSSION:** These pieces use input from colleagues, employers, qualified peers, flight performance data are shaped by the work, home and life environment to fit together into a cohesive whole. It's not a small task; these pieces occupy the spaces that no clinical measure or wellbeing policy can fill and each new piece needs to be found, shaped and polished before it can fit into our puzzle. Every sector – health, aviation, civil, military, academic and more – has a role in this. Eventually, our combined pieces will create a richer and more

complete picture of aeromedical certification and aviation safety than could ever have been achieved by clinical aeromedical risk measures alone, for not only mental health but all medical conditions and states of wellbeing.

Learning Objectives

1. The audience will learn about new approaches to risk assessment and stratification in aeromedical certification for pilots with mental illness and neurodiversity.
2. The participant will be able to explore ways that they can contribute to a salutogenic environment in their aviation and medical environment.
3. The participant will be able to identify processes to identify and assess risk for aviation medical certificate-holders with neurodiversity and mental health issues.

[3] BUILDING AN EVIDENCE BASED & HEALTH SYSTEMS APPROACH TO MENTAL WELLNESS IN AEROSPACE MEDICINE: ESTABLISHING A RESEARCH STRATEGY TO MEETING DATA NEEDS

William Hoffman
Columbia University Medical Center, New York, NY, United States

(Education - Program/Process Review)

BACKGROUND: Aircrew mental wellness is thought to support performance and system-wide safety. Many factors within the aerospace system are thought to influence aircrew mental wellness to include operational factors, aeromedical screening programs, peer support and wellness efforts among many others. Efforts to optimize and maintain aircrew mental wellness while sustaining safety in an evolving world will require continued research, but no consensus exists on the type of data and topics needed to support this aim. Further, how data collection might fit into the aerospace system of the future remains an open question. **OVERVIEW**: This session will first outline the AsMA Mental Health Research Subgroup's effort to generate a consensus statement defining the relevant research gaps in aviation related to mental health that, when accomplished, aims to enable aerospace leaders to optimize and maintain aircrew mental wellness while sustaining safety. The working subgroup included over 50 aerospace medicine professionals from 6 countries that employed an iterative, Delphi approach to generate a consensus statement between April and November 2023. Six topics areas were identified including clinical care, peer support and wellness programs, epidemiology, topics in special populations, wellness and safety programs, and emerging technology. The second part of this session will explore ways to build outcomes focused data collection and research initiatives into the aerospace system of the future that might support operations and policy. **DISCUSSION:** The paucity of research related to mental health in aviation is a limiting factor in building a data-backed approach to optimizing aircrew mental wellness while sustaining safety. Many challenges exist related to research in this area to include questions surrounding relevant questions, data ownership, implementation, ethics, and many others. This session explores one effort aimed at defining relevant questions and how data collection might fit into our rapidly evolving aerospace system.

Learning Objectives

1. Describe the two research topics identified by the AsMA Mental Health Research Working Subgroup that remain unanswered related to mental health in aviation.
2. Describe two challenges related to building an outcome-focused data collection effort into the aerospace system of the future.

[4] ETHICS OF MENTAL HEALTH SCREENING & PREVENTION PROGRAMS IN AEROSPACE MEDICINE

Diederik De Rooy
Transparant Center for Mental Healthcare, Leiden, Netherlands

(Education - Program/Process Review)

BACKGROUND: Programs to improve mental health, or to screen for or prevent mental health problems in aviation professionals, face ethical challenges. For professionals involved, it is important to know the major ethical values at stake, and to develop an understanding of how these values can be balanced. **OVERVIEW:** The most relevant values are privacy and safety, both for the general public and for those participating in programs. Programs need to balance confidentiality of individuals with the interest of public safety as well as the interest of gathering data for evaluation of these programs. Although the information participants in programs share may be comparable to medical information, medical confidentiality will not always be automatically applicable to programs, for example in case of a peer support program run by peers entirely. **DISCUSSION:** Notwithstanding the applicable law, it may be advisable for programs to apply a same level of confidentiality as is applicable to medical practice. If a program gathers data systematically, it may be considered to have this supervised by a medical or mental health professional that is bound by medical confidentiality rules. There are sound arguments for only sharing information with the consent of the individuals involved, unless there is a clear and imminent danger to others, as was set out for example in the Tarasoff case. To improve the quality of programs, analyzing data scientifically may be helpful. It may be advisable to only gather data for research with the consent of the individual, and to apply similar quality assurances as in medical research. In the near future, some programs may use automated data analyzation methods to predict or identify mental problems by using smartphone or social media use data, or data from simulator sessions or even from the aircraft themselves. If specific diagnostic tools for aviation professionals would become available, it will be important to test and validate them in the same way as regular new diagnostic procedures. These techniques should only be used with informed consent of the individual.

Learning Objectives

1. Attendees will learn about the major ethical challenges that exist with regards to Mental Health Screening & Prevention Programs.
2. Attendees will develop their own viewpoint on how to balance the interests of individual aviation professionals versus those of the general public and support programs.
3. Attendees will learn about ethical considerations in relation to new developments of automated data analyzation methods.

[5] BIOMARKERS: NEW PROTAGONISTS BRIDGING THE GAP BETWEEN BIOSCIENCES AND AEROSPACE MENTAL HEALTH

Nesrine Ramadan
University of Oxford, Oxford, United Kingdom

(Education - Program/Process Review)

BACKGROUND: Biomarkers are described as characteristics that are objectively measured and are indicators of health, disease, or a response to an exposure or intervention. There is growing evidence suggesting that biomarkers have the potential to bring new solutions in the field of aerospace mental health. Moreover, advances in various scientific fields such as digital health, MedTech, neurosciences, and molecular biology could be further exploited in mental health surveillance and assistance. This presentation is expected to be part of a workshop discussing emerging research, innovation, and technologies in the field of mental health with emphasis on the aerospace sector. **OVERVIEW:** This presentation will focus on the need and potential of biological and digital markers for mental health monitoring and the neuroscience of happiness and well-being. Advances in 'omics' technologies including genomics, proteomics, and metabolomics allow to identify new molecular markers and neurobiological mechanisms potentially associated with mental health and happiness. Equally, advances in computational methods and neurosciences are increasing the spectrum of digital biomarkers available for facial and vocal recognition as well as other parameters associated with emotions and mental health. Further, emerging tools for brain health

monitoring, intelligence measurements as well as technologies such as virtual reality (VR) are offering new solutions for dealing with anxiety, post-traumatic stress disorder (PTSD), adversity as well as developing resilient capabilities, wellbeing, and maximising human performance. **DISCUSSION:** Various emerging research trends in biosciences and technological innovation will be discussed to decipher the wide potential of biomarkers in mental health as well as precision and personalised medicine in the aerospace field and beyond. This will also allow to propose novel applications and perspectives in civilians, commercial, and military spheres.

Learning Objectives

1. To understand the importance and potential of biomarkers in the mental health field with emphasis on the aerospace sector.
2. To connect the progress in terrestrial mental health research and innovation with the aerospace field.

[6] BUILDING AEROSPACE MEDICINE REGULATORY POLICY

Cristian Ionut Panait[1], Susan Northrup[2], Penny Giovanetti[2], Kate Manderson[3], Janis Vegers[1], Virgilijus Valentukevicius[1], Mateja Kotnik Kerbev[1], Pedro Caetano[1]
[1]*European Union Aviation Safety Agency (EASA), Cologne, Germany;* [2]*FAA, Washington DC, United States;* [3]*Civil Aviation Safety Authority (CASA), Canberra, Australia*

(Education - Program/Process Review)

BACKGROUND: "Mens sana in corpore sano". For millennia mental health has remained a challenge for common people as well as medical professionals and regulators. This is not different in the field of aviation, where regulators and industry aim to identify safety risks and mitigate them as early as possible. **OVERVIEW:** "It is better to prevent than to treat". Nevertheless, prevention is a concept that involves multiple layers starting with the individual and continuing with the employer, the aero-medical examiner, the care provider, and the regulator working symbiotically. Acknowledgement of mental illness and asking for support with mental wellbeing continue to be the starting points of any preventive work. And here, denial, fear of consequences and stigma are major obstacles to overcome by the individual alone before getting to the point of asking for support. Regulating any preventive actions has always been a challenge for medical regulators and the mental health-related items are among the most challenging ones. Several aviation regulators are taking a best-practice preventive approach with the use of support groups and peer programs to facilitate the management of risk factors, and to prevent their evolution into established mental illnesses. **DISCUSSION:** "Hope for the best, prepare for the worst." The future of aviation medical certification for mental health as well as maintaining mental health and wellbeing have to be considered in the context of other medical and operational conditions that impact function and performance such as shift work and fatigue. Regulating the field of mental health for all categories of aeronautical personnel is a challenge in itself. However, we must strive to apply scientific method to the prevention, assessment and management of mental health issues. This panel will discuss: what and to which extent we need to regulate; how can we ensure maximum efficiency is achieved by the support groups; models for mental wellbeing, illness prevention and management in the aviation industry; opportunities for research and scientific endeavours in aviation mental health; a considerable amount of work is still ahead for regulators and industry to achieve the goal of having a balanced approach to mental health and wellbeing.

Learning Objectives

1. The audience will learn about the importance of mental health and wellbeing for aviation safety.
2. The audience will learn about regulatory challenges in mandating and enforcing support programmes.

[7] PILOT MENTAL HEALTH AND WELLNESS AND AEROSPACE MEDICINE IN BOWTIE ANALYSES

Anthony Tvaryanas, David Schroeder
FAA, Oklahoma City, OK, United States

(Education - Tutorial/Review)

INTRODUCTION: Approaching pilot mental health using the Safety Management System construct requires an understanding of its representation in risk analysis tools commonly used in aviation. **TOPIC:** The concept of barrier management – implementing and assuring a range of controls to protect against the risk of major losses – is widely used in high-hazard industries. While there are varying methods for evaluating barrier strategies, the Bowtie Analysis is in widespread and growing. The Bowtie Analysis focuses on a 'top event' such as of loss of aircraft control. In flight operations, there are multiple threats potentially causing the top event, resulting in the consequence of a major aviation accident event. Barriers in the bowtie appear on both sides of the top event. Barriers on the left side interrupt the scenario so threats do not result in the top event. Barriers on the right side make sure that if the top event is reached, the scenario does not escalate into an actual impact (the consequences) and/or mitigate the impact. There are different types of barriers, but there is an important subset that involve human performance (sociotechnical barriers). Once barriers are identified, you have a basic understanding of how risks are managed. All barriers have vulnerabilities that may lead to underperformance in preventing or responding to the top event. These vulnerabilities are called degradation factors and are inclusive of many issues addressed in human factors. For pilot medical-related issues, the bowtie focuses on sociotechnical barriers and their expectation for adequate pilot response (timing, accuracy, etc.) in performing one or more elements of the detect, decide and act barrier functions. Safeguards are degradation factor controls, i.e., barriers preventing the occurrence of the degradation factor (inadequate pilot response). Medical fitness for duty is addressed through safeguards. **APPLICATION:** In a Bowtie Analysis of a flight operation, pilot mental health issues impacting performance are potential degradation factors to some barriers. Understanding these barriers provides insight into mental health impacts on safety. The contributions of aerospace medicine and organizational employee stress management and wellness interventions can be understood in terms of safeguards against pilot mental health-related degradation factors. **RESOURCES:** Chartered Institute of Ergonomics and Human Factors. (2016). Human Factors in Barrier Management [White paper].

Learning Objectives

1. Understand how to use Bowtie Analysis to understand the contribution of pilot mental health to safety.
2. Understand how to use Bowtie Analysis to understand the need for and adequacy of aerospace medicine-related safeguards.

[8] EVOLVING TOPICS IN PEER SUPPORT PROGRAMS

Elizabeth Bjerke[1], Dave Fielding[2], Herwin Bongers[3]
[1]*University of North Dakota, Grand Forks, ND, United States;* [2]*BALPA Welfare Representative, West Drayton, United Kingdom;* [3]*Air New Zealand, Canterbury, New Zealand*

(Education - Case Study)

BACKGROUND: Pilot Peer Support Programs have emerged to play a pivotal role in the aviation industry to address pilot mental health and well-being concerns. Peer Support Programs have evolved over time to serve the mental health (MH) needs of pilots, while reducing the stigma to seek help through a trusted peer. Over time, there is a need to assess these programs and their effectiveness and uptake amongst the pilot community. In parallel to this, there is a growing realization that the same principles that underlie Pilot Peer Support Programs also apply to Peer Support Programs in other areas of aviation which come under ICAO, such as Flight Attendants, Air Traffic Controllers and licensed Engineers. Many of these programs are mature and have been running

for many years, but to date there has been little cross-fertilisation of ideas. Maturation since the provenance of peer support programs has highlighted that in addition to the wellbeing benefits they provide, the potential influence upon threat and error reduction in preventing system failures should accelerate the integration of MH expertise into safety programs. **OVERVIEW:** This workshop panel will be in three parts: 1) Examining how accepted Pilot Peer Support Program principles need to be adapted to service the next generation of airline pilots. Younger pilots have a very different relationship with technology and a different approach to mental health issues, and existing PSPs must reflect these differing needs. 2) Discussing how the proven benefits of Peer Support can be spread across all safety-critical areas of aviation. Can key principles of Peer Support be identified and standardized? Can solutions to address cultural requirements be adapted in other areas of aviation? 3) Exploring the role of peer support programs in providing aviation MH subject matter expertise (SME) to integrate MH wellbeing programs into SMS objectives of safety performance improvements through proactive strategies of threat and error management. **DISCUSSION:** This international panel represents various aviation organization entities to explore on a micro level how best practices in a changing landscape assist all types of Peer Support Programs succeed in helping their clients through challenging times; and on a macro level how the various elements of Peer Support for safety-critical aviation personnel can be drawn together to enhance the Positive Safety Culture of an operator.

Learning Objectives

1. As a result of this workshop, attendees will learn how the attitudes and approaches to mental health and wellbeing differ for the next generation of aviation professionals, and how current Peer Support Programs need to adapt in order to reflect these changing requirements.
2. As a result of this workshop, attendees will learn how Peer Support Programs in different ICAO areas can share ideas and learning in order to advance the field of Peer Support for all safety-critical roles in aviation.
3. As a result of this workshop, attendees will learn how the relationship between Peer Support Programs and an operator's SMS, and how this improves safety.

[9] OLD AND NEW PILOT MENTAL HEALTH CHALLENGES (ETHICS, SCREENING AND AI)

Kris Belland[1], Gerhard Fahnenbruck[2], Robert Bor[3]
[1]*Aerospace Medical Association, Keller, TX, United States;* [2]*University of Hamburg, Langen, Hesse, Germany;* [3]*University of South Africa/Universiteit van Suid-Afrika, London, United Kingdom*

(Education - Tutorial/Review)

BACKGROUND: Maintaining optimal human performance (physical and mental) of all aviation sensitive professionals is critical to the safe and effective aerospace (Space, Commercial, Military, Governmental, and Civilian) operations. **OVERVIEW:** This breakout panel will discuss three separate but complimentary parts of pilot physical/mental performance maintenance: Ethics, Screening Tools and Artificial Intelligence (AI)/ leveraging emerging technologies. **DISCUSSION:** The breakout presenters will discuss clinical challenges and ethics from aviator cases highlighting dilemmas of diagnosis when providing support and enhancing wellbeing. The session will consider the increasingly widespread use of clinical screen tools (including standardized psychometrics, non-standardized questionnaires, and the clinical interview). The use of clinical tests and related psychometric instruments for aircrew assessment has gathered momentum over recent years for mental health screening and fitness to fly assessments. This raises questions as to the suitability, compatibility, interpretation, and standardization of tests, as well as appropriate norms and comparison. This topic is of sensitivity due to competing interests of maintaining aviation safety against supporting individual aviator careers. The enhancements and limitations of Artificial intelligence, social media (Chatbots), Wearable Technology, use of wellbeing app's will be discussed. Time (50%) will be reserved for audience questions facilitating the exchange of ideas to improve knowledge in this area.

Learning Objectives

1. Attendees will better understand the ethics associated with pilot mental health programs.
2. Attendees will learn about possible incorporation of technologies such as biometrics in assessing and optimizing mental wellness in aviation.
3. Attendees will better understand the pilot MH screening and fitness to fly challenges.

Sunday, 05/05/2024 ***8:00 AM***
Randolph 3

[S-02]: WORKSHOP: AEROSPACE EPIDEMIOLOGY - THE SCIENCE OF THE DENOMINATOR

Sponsored by International Association of Military Flight Surgeon Pilots

Chair: Peter Mapes

WORKSHOP OVERVIEW: INTRODUCTION: *The learning objectives for the Workshop are as follows: Course Objectives – Individuals completing this course will be able to: 1. Understand the language of epidemiology and how it applied to aviation mishap analysis 2. Identify inadequate statistical analyses 3. Know about EPI INFO™ and have a rudimentary ability to employ it in the field 4. Design adequate studies of rudimentary parametric and non-parametric data 5. Understand the importance of adequate power 6. Understand the importance of adequate denominator data 7. Be able to look at displayed data and determine adequacy of analyses 8. Understand modeling and regression at a fundamental level 9. Understand the Bradford-Hill criteria for causality* ***TOPIC:*** *The Workshop on Aerospace Epidemiology will educate attendees on how the mathematics of epidemiology are applied to aerospace safety and mishap prevention.* ***APPLICATION:*** *The mathematics of epidemiology can be broadly and effectively utilized to conduct meta-analyses of aerospace mishap data. The results of these analyses can be used to focus actions and requirements on data driven conclusions that are currently largely absent from the safety process. The mathematical principles to be covered are well accepted but rarely utilized to analyze aerospace mishap data.* ***RESOURCES:*** *The course will be accompanied by a customized text serving as a reference for the mathematical applications well established in the public domain. The course will also be accompanied by problems for attendees to work through under supervision so that practical experience in aerospace epidemiology can be obtained. Attendees need to bring an adequately charged laptop computer to the course with a copy of the applicable EPI INFO programming loaded from the Centers for Disease Control & Prevention web site.*

[10] AEROSPACE EPIDEMIOLOGY

Peter Mapes
N/A-retired, Oscoda, MI, United States

(Education - Tutorial/Review)

INTRODUCTION: The learning objectives for the Workshop are as follows. Course Objectives Individuals completing this course will be able to: 1. Understand the language of epidemiology and how it applied to aviation mishap analysis. 2. Identify inadequate statistical analyses. 3. Know about EPI INFO™ and have a rudimentary ability to employ it in the field. 4. Design adequate studies of rudimentary parametric and non-parametric data. 5. Understand the importance of adequate power. 6. Understand the importance of adequate denominator data. 7. Be able to look at displayed data and determine adequacy

of analyses. 8. Understand modeling and regression at a fundamental level. 9. Understand the Bradford-Hill criteria for causality. **TOPIC:** The Workshop on Aerospace Epidemiology will educate attendees on how the mathematics of epidemiology are applied to aerospace safety and mishap prevention. **APPLICATION:** The mathematics of epidemiology can be broadly and effectively utilized to conduct meta-analyses of aerospace mishap data. The results of these analyses can be used to focus actions and requirements on data driven conclusions that are currently largely absent from the safety process. The mathematical principles to be covered are well accepted but rarely utilized to analyze aerospace mishap data. **RESOURCES:** The course will be accompanied by a customized text serving as a reference for the mathematical applications well established in the public domain. The course will also be accompanied by problems for attendees to work through under supervision so that practical experience in aerospace epidemiology can be obtained. Attendees need to bring an adequately charged laptop computer to the course with a copy of the applicable EPI INFO programming loaded from the Centers for Disease Control & Prevention web site.

Learning Objectives

1. Understand epidemiological terminology & its application to aerospace mishap analysis, be able to employ parametric and non-parametric analyses, determine adequate denominators & evaluate the adequacy of analyses.
2. Be familiar with the import of adequate power, modeling and regression & the Bradford-Hill criteria for causality.
3. Know about EPI INFO™ and have a rudimentary ability to employ it in the field.

Sunday, 05/05/2024 ***9:00 AM***
Randolph 1A, 1B

[S-03]: WORKSHOP: UNDERSTANDING AND MANAGING FATIGUE IN AVIATION

Chair: John Caldwell
Co-Chair: J. Lynn Caldwell

WORKSHOP OVERVIEW: INTRODUCTION: *Human fatigue stemming from lengthy work periods, circadian disruptions, and insufficient sleep poses a serious threat to performance, safety, and general wellbeing. Leaders, healthcare professionals, schedulers, and aircrew members need to understand the causes of fatigue and the scientifically valid strategies for fatigue mitigation.* ***TOPIC:*** *In modern aerospace settings, long work hours, shift work, time-zone transitions, and sleep disturbances are common. These factors often result in personnel reporting for duty in a fatigued state, leading to errors, cognitive difficulties, and mood disturbances that degrade readiness and compromise safety. It is possible to effectively mitigate these difficulties if scientifically validated strategies—administrative, environmental, behavioral, and pharmacological–are systematically applied. This workshop will provide a fully updated, science-based overview of fatigue factors, the effects of fatigue on health and performance, and details on the relevant countermeasures.* ***APPLICATIONS:*** *Effective fatigue management is an important key to optimizing operational performance and safety within aerospace contexts. Up-to-date, evidence-based information on this topic is of broad interest to professionals who are in positions to safeguard and augment human performance in today's demanding operational environments.*

[11] AIR CREW FATIGUE: CAUSES, CONSEQUENCES, AND COUNTERMEASURES

J. Lynn Caldwell, John Caldwell
Coastal Performance Consulting, Yellow Springs, OH, United States

(Education - Tutorial/Review)

INTRODUCTION: Human fatigue stemming from lengthy work periods, circadian disruptions, and insufficient sleep poses a serious threat to performance, safety, and general wellbeing. Leaders, healthcare professionals, schedulers, and aircrew members need to understand the causes of fatigue and the scientifically-valid strategies for fatigue mitigation. **TOPIC:** In modern aerospace settings, long work hours, shift work, time-zone transitions, and sleep disturbances are common. These factors often result in personnel reporting for duty in a fatigued state, leading to errors, cognitive difficulties, and mood disturbances that degrade readiness and compromise safety. It is possible to effectively mitigate these difficulties if scientifically validated strategies—administrative, environmental, behavioral, and pharmacological–are systematically applied. This workshop will provide a fully-updated, science-based overview of fatigue factors, the effects of fatigue on health and performance, and details on the relevant countermeasures. **APPLICATIONS:** Effective fatigue management is an important key to optimizing operational performance and safety within aerospace contexts. Up-to-date, evidence-based information on this topic is of broad interest to professionals who are in positions to safeguard and augment human performance in today's demanding operational environments.

Learning Objectives

1. Know how to recognize the dangers of fatigue in various settings.
2. Understand the major causes of fatigue (both operational and physiological).
3. Be able to know and apply one or more scientifically-valid countermeasures for fatigue in specific industrial/operational contexts.

MONDAY, MAY 06, 2024

Monday, 05/06/2024 ***10:30 AM***
Grand Ballroom CD South, EF

[S-04]: PANEL: RECENT DEVELOPMENTS IN NASA AND SPACEX DECOMPRESSION SICKNESS RISK MITIGATION TESTING AND PROTOCOLS

Chair: Andrew Abercromby

PANEL OVERVIEW: *NASA is partnering with SpaceX on development of the Human Landing System, which will require validation of an efficient and effective DCS risk mitigation protocol to enable the high-frequency extravehicular activities (EVAs) planned for Artemis missions. Through a separate agreement, NASA's DCS experts and facilities are supporting SpaceX's historic Polaris Dawn mission, which will include the first commercial EVA. Meanwhile, suited and unsuited human hypobaric ground testing and training occurs on an ongoing basis at NASA's Johnson Space Center (JSC) in support of the International Space Station (ISS), Artemis, and other NASA and commercial programs. This panel will describe results and medical outcomes of two multi-day experimental hypobaric tests aimed at informing Artemis and Polaris Dawn DCS risk mitigation protocols. Recent updates to NASA's rules regarding unplanned breaks in prebreathe protocols are also described, with implications for ISS EVAs, Polaris Dawn, and beyond.*

[12] DEVELOPMENT, VALIDATION AND APPROVAL OF A PLANETARY EXTRAVEHICULAR ACTIVITY PREBREATHE PROTOCOL: NASA EXPLORATION ATMOSPHERE TESTS 1 & 2

Alejandro Garbino[1], Monica Hew[2], Estep Patrick[1], Brett Siders[2], Edgar Lichar[2], Kadambari Suri[2], Constance Ramsburg[3], Karina Marshall-Goebel[4], Andrew Abercromby[4]
[1]*Geocontrol/NASA, Houston, TX, United States;* [2]*KBR/NASA, Houston, TX, United States;* [3]*USN/NASA, Houston, TX, United States;* [4]*NASA/JSC, Houston, TX, United States*

(Original Research)

INTRODUCTION: Denitrogenation prebreathe protocols used to mitigate DCS risk for Space Shuttle and International Space Station EVAs are validated for the microgravity environment, but the significantly increased risk of DCS during equivalent ambulatory surface EVAs make these protocols inapplicable to planetary/Lunar missions as planned by the Artemis program. Living in an "Exploration Atmosphere" of 56.5 kPa (8.2 psia), 34% O_2, 66% N_2 has been recommended by NASA for future Moon and Mars missions as a compromise that balances pre-EVA prebreathe duration, hypoxia, and flammability risk, assuming a 29.6 kPa (4.3 psi) spacesuit. A prebreathe validation campaign at NASA's Johnson Space Center in 2022–2023 has aimed to validate the prebreathe durations and is being operationalized by NASA for use in upcoming Lunar EVAs. **METHODS:** Twelve volunteers lived in a hyboparic chamber for 11 days with an "exploration atmosphere" of 56.6kPa/34% O_2 66% N_2. Subjects acclimated to this atmosphere for 48 hrs and thereafter participated in five 6-hour simulated EVAs at 34kPa/85% O_2/15% N_2 over the course of 11 days. Prior to each simulated EVA, subjects underwent a 20-minute prebreathe at 85% O_2. The EVA simulation was designed to include tasks that are physically and ergonomically representative of future planetary EVAs, proportionate to the subject's VO_2max. Decompression stress was evaluated during the simulated EVA by serial doppler and echocardiographs alternating every 15 min, as well as clinical monitoring for DCS signs/symptoms. Venous gas emboli (VGE) and DCS outcomes were verified against NASA Standard 3001, which guides allowable prebreathe protocol acceptance criteria. **RESULTS AND DISCUSSION:** Venous gas emboli (VGE) were identified during EVAs. No Grade IV VGE were observed. Two cases of mild, Type I DCS were identified in the subjects over the course of 50 EVA exposures. Ten planned EVA exposures were eliminated due to mask fit, metabolic rate, or subject safety concerns. One subject was removed from the study due to presence of left ventricular VGE. Additionally, two doppler techs also experienced DCS, and one case of hypoxia was noted. All cases of DCS resolved with treatment. No cases of severe DCS were observed. The observed incidence (4%, 1.1–13.5% at 95% confidence) met the NASA Standard 3001 criteria leading to the transition of this protocol from research to operational use for upcoming Lunar missions.

Learning Objectives

1. The audience will learn about the NASA Decompression algorithms and their applicability to EVA operations on Artemis/Moon.
2. The audience will learn about decompression diagnosis and treatment methods available for crew and for ground testing operations.

[13] MEDICAL OUTCOMES FROM NASA'S EXPLORATION ATMOSPHERES STUDY

Kristi Ray, Leisa Deutsch, Alex Garbino, Robert Sanders
NASA JSC, Houston, TX, United States

(Original Research)

BACKGROUND: The National Aeronautics and Space Administration's (NASA) Exploration Atmospheres study (EA) was done to evaluate alternative cabin atmospheres, hypoxia risks, denitrogenation protocols, and pre-breathing protocols for future spacecraft designs and planetary surface exploration of the Moon, Mars and beyond. **OVERVIEW:** NASA's EA study evaluated a proposed alternative cabin environment, for future spacecraft habitat, and planetary EVAs. EA included both 3-day and 11-day trials. These trials included a depressurization and saturation to 8.2psia at 34% O_2 with additional depresses to 4.3 psia breathing 85% O_2 for simulated EVAs. There was 1 EVA during the 3-day and 5 during the 11-day trials. The accepted DCS risk is </= 15% risk of type 1 DCS, no type 2 DCS, and </= 20% high grade VGE. There were 5 proposed cases of Type 1 DCS cases that were brought to NASA's DSSMB board for evaluation and a total of 3 cases that were confirmed. The 2 cases that were ruled out had a delayed presentation after the 3-day study and the 3 confirmed DCS cases were from the first 11-day study. Of the 3 confirmed cases, 2 occurred acutely during the study after simulated EVA days and 1 case presented with a >48 hour delay after completion of the study. In addition, there was one case of left sided cardiac bubbling during the 11 day study. **DISCUSSION:** Planning for and executing the medical monitoring and response plan for this project involved many partnerships within NASA and the community. An in-depth treatment algorithm was used during this study including the use of site level oxygen (SLO) (14.7 psia) and hyperbaric treatments using a chamber-side dual-lock deck decompression chamber with multiplace chamber back up available from NASA's NBL and local hospitals. The 2 acute cases were treated with at least 4 hours of SLO with complete resolution and the delayed case was treated by a hyperbaric treatment using USN TT5 with full resolution of symptoms. **CONCLUSION:** Testing of this nature is an essential part NASA's preparation for the upcoming Lunar Artemis missions. The effect of habitation pressure on the natural history of DCS symptoms had not previously been tested for these conditions. Our observations will lead to new protocols in nominal and contingency operations as we prepare for missions back to the Lunar surface while maintaining optimal health and performance of crew.

Learning Objectives

1. The audience will learn about medical outcomes including decompression sickness that occurred in NASA's Exploration Atmosphere study.
2. The audience will learn about medical monitoring and emergency planning for space medicine research.

[14] RISK CHARACTERIZATION OF POLARIS DAWN EVA DEPRESS PROFILE IN NASA'S 20FT CHAMBER

Marissa Rosenberg[1], Andrew Abercromby[2], Amran Asadi[1], Diana Dayal[1], Lichar Dillon[2], Patrick Estep[2], Alejandro Garbino[2], Monica Hew[2], Esther Putman[1], Jaime Mateus[1]
[1]*SpaceX, Hawthorne, CA, United States;* [2]*NASA, Houston, TX, United States*

(Original Research)

INTRODUCTION: SpaceX collaborated with NASA to develop and experimentally characterize the risk of a novel decompression profile to mitigate the risk of decompression sickness (DCS) on the Polaris Dawn mission. **METHODS:** Eight participants, including the Polaris Dawn crew and four age, gender, and BMI-matched participants, experienced the profile in NASA's 20ft Chamber. Conditions were intended to mimic flight, including limiting activity pre-EVA and matching expected metabolic rates during the EVA. The profile comprised: 24h at 11.8 psi, 21% O_2; 19h at 9.5 psi, 26.5% O_2; 6min prebreathe at 9.5 psi, 100% O_2; 90min EVA at 4.5 psi, 100% O_2. Theoretical models estimated the Type I DCS risk as <6% per person. However, these models rely on slow tissue compartments and may not accurately capture the Type II DCS risk. Additionally, there are limited data on profiles with very short 100% O_2 prebreathe times. An experimental characterization of the profile was therefore pursued in order to address these limitations. Ultrasound technicians monitored Venous Gas Emboli (VGE) in the heart at 10-minute intervals throughout the EVA and each observation was scored from 0 to 7, with 7 being the most bubbling. DCS symptoms were queried via medical conference every 30 minutes. **RESULTS:** VGE were detected in 4 participants during the EVA and the highest degree of bubbling was 4, which occurred in one participant. All participants had full bubble resolution upon repress to ambient pressure. No DCS symptoms were reported. **DISCUSSION:** The goal of this test was to characterize the risk of DCS on Polaris Dawn. The results are a promising indicator that this type of decompression profile, which reduces consumable utilization by having a multi-stage decompression followed by a short prebreathe is viable. Generalizable conclusions cannot be made from this study alone, the results are specific to the tested profile. Further testing with a larger subject pool or the effect of variables such as increased EVA duration or suit pressure may be explored.

Learning Objectives
1. The audience will learn how this study helped characterize DCS risk estimates for a novel decompression profile for the Polaris Dawn mission.
2. The audience will learn about a novel gradual decompression profile with reduced time on 100% O_2.

[15] UPDATES TO NASA'S BREAK-IN-PREBREATHE RULES DUE TO TYPE II DECOMPRESSION SICKNESS RISK CONSIDERATIONS

Andrew Abercromby[1], Alejandro Garbino[2], Matthew Makowski[3], Jason Norcross[4], Robert Sanders[1]
[1]*NASA JSC, Houston, TX, United States;* [2]*GeoControl Systems, Houston, TX, United States;* [3]*UTMB, Galveston, TX, United States;* [4]*KBR, Houston, TX, United States*

(Education - Program/Process Review)

INTRODUCTION: Investigation of a central neurological decompression sickness (DCS) case during ground testing at Johnson Space Center identified a break-in-prebreathe (BIP) 13 minutes prior to depressurization as the leading credible cause despite applicable prebreathe payback rules being followed. Applicable NASA rules, for ground and flight, directed 2:1 payback of breaks up to 10 mins in duration, regardless of when a break occurs relative to depress. Full restart of prebreathe is directed following breaks > 10 min. The adequacy of NASA's BIP rules was evaluated prior to resuming hypobaric ground testing or ISS extravehicular activities. **METHODS:** The following information sources were reviewed prior to formulating recommendations: i) Type II DCS case report and investigation findings; ii) documented rationale for existing flight rules, iii) consultations with subject matter experts involved in definition of existing flight rules (several of whom had since left NASA), iv) relevant published literature, v) model estimates of tissue on-gassing and off-gassing, and vi) NASA's operational experience with late breaks in prebreathe. **RESULTS:** NASA's nominal prebreathe protocols are validated via extensive ground testing to ensure DCS risk is reduced to within acceptable limits. Conversely, there exists a paucity of data, no validated models, and limited documentation regarding BIP risk for NASA prebreathe protocols. Flight rules for shuttle and later ISS appear based primarily on expert opinion and an assumption of equal on-gassing and off-gassing rates, which would make 2:1 payback a conservative mitigation for a BIP. Assumption of exponential gas kinetics makes late breaks higher risk, or requiring greater payback, than earlier breaks. Two BIPs have occurred using the current ISS prebreathe protocol, each of which was followed by greater than 2:1 payback and at least 59 minutes of 100% O_2 pre-depress. No DCS cases have been reported during EVA operations. **DISCUSSION:** Interim changes were implemented to protect against late breaks during ground and flight prebreathes by ensuring negligible difference in conservatively modeled ppN2 pre-depress compared to validated protocols. Additional documentation and literature review as well as chamber test planning are ongoing with the objective of further ground and flight rule updates and validation of a BIP risk model.

Learning Objectives
1. The audience will learn about considerations affecting the decompression sickness risk implications of interruptions in prebreathe protocols.
2. The audience will learn that different assumptions regarding nitrogen on-gassing and off-gassing rates during prebreathe interruptions can lead to significant differences in decompression sickness risk mitigation strategies.

[16] AN 'EQUIVALENT STRESS' APPROACH TO MODELING PREBREATHE INTERRUPTION & RECOVERY

Amran Asadi[1], Kaleigh Stabenau[1], Jaime Mateus[1], Alex Garbino[2], Andrew Abercromby[2]
[1]*SpaceX, Hawthorne, CA, United States;* [2]*NASA, Houston, TX, United States*

(Original Research)

INTRODUCTION: Interruptions in prebreathe during extravehicular activity (EVA) preparation may impact decompression sickness (DCS) risk. Interruptions may include technical challenges with environmental control, suit, or oxygen equipment. While a 'restart' may mitigate risk, application to exploration atmospheres and other novel protocol designs is not intuitive, and can come at the cost of lost critical mission objectives. Here, a modeling technique is explored to analytically determine payback requirements, and compared to existing flight data. **METHODS:** A symmetric 1st order model of tissue gas uptake was implemented and used to simulate breaks in prebreathe. Time-dependent functions for environmental and metabolic conditions were developed as inputs based on the In-Suit Light Exercise (ISLE) protocol. Theoretical tissue compartments were chosen with half-time constants (τ) between 5-480 minutes, and tissue tensions simulated from start of mask prebreathe to initiation of airlock depress. Breaks in prebreathe were generated by uniform pseudorandom sampling. Tissue tensions were re-computed and compared between the baseline ($P_{tissue,\tau,b}$) and modified ($P_{tissue,\tau,m}$) runs. The "payback" was computed as the maximum additional oxygen time required for $P_{tissue,\tau,m}$ to reach $P_{tissue,\tau,b}$ across compartments. The process was repeated with 10,000 replicates to map payback requirements. **RESULTS:** Modeled payback time demonstrates dependence upon interruption length and start time. When payback time is length-normalized, start time becomes dominant. A 2:1 payback multiple is suggested to provide near equivalent stress up to 60-80 minutes prior to planned depressurization, concordant with timing of prior events during ISLE in flight. Multipliers increase rapidly to >10x approaching depress. **DISCUSSION:** The addition of simulated interruption to existing biophysical models of tissue gas could provide a tool to accommodate interruption recovery guidance in a variety of future protocol designs, including those used on Polaris Dawn or Artemis 3+. When applied to ISLE, the model suggests a strong dependence of payback multiple on interruption timing. Despite data concordance with known events, dedicated human ground testing is required for model validation.

Learning Objectives
1. Modeling may be a useful tool for providing pre-breathe interruption recovery guidance in real time.
2. Estimated payback multipliers for ISLE are sensitive to interruption start time.

Monday, 05/06/2024 ***10:30 AM***
Grand Ballroom A

[S-05]: PANEL: PILOT SPATIAL DISORIENTATION RESEARCH, MODELING, AND MITIGATION

Chair: Richard Arnold
Co-Chair: Eric Groen

PANEL OVERVIEW: *Pilot spatial disorientation (SD) remains a leading contributory and causal factor in flight mishaps. Emerging knowledge, technology, and research tools are producing better understanding of SD phenomena and their effects on pilot behavior, which should ultimately lead to effective SD countermeasures. This panel will expand upon research featured in our 2023 AsMA panel by highlighting research efforts focusing on understanding, characterizing, and modeling sensory, perceptual, and cognitive factors involved in SD. The panel will discuss research and modeling of vestibular sensation and perception, visual perceptual illusions, sensory integration, and operational contributors to SD. The panelists will also discuss research gaps to inform future SD research, development, and modeling initiatives, in addition to how such efforts may ultimately inform safety mitigations.*

[17] AN ALTERNATIVE TO BAYESIAN INTEGRATION FOR VISUAL-VESTIBULAR AND OTHER MULTISENSORY INTEGRATION

Vincent Billock
Leidos, Inc., at Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States

(Original Research)

INTRODUCTION: How do visual and vestibular information combine to influence sensory orientation and disorientation? Bayesian reliability weighting is a well-established model that is hard to justify neurally and sometimes has problems with psychophysical data. In 1926 Erwin Schrödinger proposed a nonlinear weighted averaging model for binocular integration that could be an alternative to Bayesian models. Any kind of weighted average, Bayesian or not, will look like suppression when implemented in neurons, because the multisensory system's firing rate will be lower than its best unisensory firing rate. We have applied Bayesian reliability (inverse relative variability) weighting and Schrodinger's nonlinear magnitude weighting to suppressive binocular, audio-visual, audio-tactile and visual-tactile neurons. In every case Schrödinger's weighting was superior on two independent measures. **METHODS:** We examined visual, vestibular and visual-vestibular firing rate data from 89 visual vestibular neurons in macaque MSTd cortex, published by Fetsch *et al*., 2012). We divided the neurons into two groups: convergent neurons (neurons that have the same preferred visual and vestibular headings) and non-convergent neurons. We fit this data to two models: Schrödinger's nonlinear magnitude weighted average and the inverse relative variance model. Both models were completely constrained by the data except for a scaling constant. **RESULTS:** For both kinds of neurons and for the combined dataset Schrödinger's nonlinear magnitude-weighted model outperformed the Bayesian reliability-weighted model. **DISCUSSION:** The results make sense because it would be difficult to implement reliability weighting at the single neuron level. It may also be (given a small number of action potentials in a temporal decision window), that magnitude of response is a better gauge of reliability than inverse variance. The next step is to extend the modeling to psychophysical data on visual-vestibular interactions, including those that result in sensory disorientation.

Learning Objectives

1. Understand that there are at least two possibilities for the optimal combination of visual and vestibular signals in spatial orientation – magnitude weighting and inverse variance weighting.
2. Understand that weighting visual and vestibular signals by magnitude rather than inverse variability works better for visual-vestibular neurons and may apply to perceptual data on visual-vestibular orientation.

[18] TEMPORAL DYNAMICS OF SPATIAL ORIENTATION PERCEPTION AND AWARENESS DURING TRANSITIONS IN THE AVAILABILITY OF VISUAL INFORMATION

Jamie Voros, Lanna Klausing, Aadhit Gopinath, Nicholas Boggess, Sweta Alla, Nicole Rote, Torin Clark
University of Colorado-Boulder, Boulder, CO, United States

(Education - Program/Process Review)

BACKGROUND: Visually degraded environments hold the potential for pilots to misperceive the orientation of their aircraft. When visual information suddenly becomes available (or disappears), such as when flying out of (or into) clouds, the pilot must integrate that information to update their perception of vehicle orientation. Visual information may come in the form of naturalistic cues (e.g., the horizon) or artificial information (e.g., attitude indicator on the aircraft's instrument display). Further, orientation perception (i.e., the "sense" of orientation) may differ from a pilot's orientation "awareness" (i.e., best understanding of vehicle orientation). To our knowledge the temporal dynamics of spatial orientation perception and awareness have not been quantified following transitions in the availability of naturalistic or artificial visual information. **OVERVIEW:** We executed a series of human subject experiments in a motion device capable of roll tilt and lateral translation. Availability of visual cues was dynamically activated or removed on each trial, and presented either naturalistically (horizon and angular vection cues from a dot pattern, presented in virtual reality) or artificially (aircraft attitude indicator shown on a screen). Orientation perception was reported continuously using a subjective haptic horizontal psychophysical task. On separate trials, subjects were instructed to verbally report their orientation "awareness" at discrete moments. In summary, we found it took 3 seconds for subjects to integrate sudden naturalistic visual cues into their orientation perception. In contrast, it took roughly 7 seconds for the attitude indicator information to be integrated into perception. Orientation awareness became consistent with true orientation immediately after the attitude indicator appeared. When visual information disappeared, orientation perception and awareness both gradually transitioned over 7-9 seconds, whether naturalistic of artificial visual information was previously available. **DISCUSSION:** Sudden visual information can rapidly counteract disorientation (particularly instrumentation). Quantifying the temporal dynamics of how visual information affects both orientation perception and awareness is important for understanding pilot spatial disorientation. Further work should be done to examine the difference in impact between orientation awareness vs. perception on the manual operation of aerospace vehicles.

Learning Objectives

1. Understand the influence of visual and vestibular cues on orientation perception.
2. Distinguish between spatial orientation perception and spatial orientation "awareness" contructs.

[19] HYPOXIA ADVERSELY IMPACTS HUMAN VESTIBULAR FUNCTION

Kyle Pettijohn[1], Max Teaford[2], Zachary Mularczyk[1], Anne Crecelius[3], Daniel Merfeld[1]
[1]*Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States;* [2]*University of Tennessee - Chattanooga, Chattanooga, TN, United States;* [3]*University of Dayton, Dayton, OH, United States*

(Original Research)

INTRODUCTION: Pilots are exposed to a number of factors that may impact their ability to sense where they are relative to the environment, including hypoxia. Despite the potential for hypoxia to affect our ability to sense our spatial orientation, no prior studies have examined its influence on vestibular function in humans. Given this state of knowledge, we performed studies to investigate how hypoxia impacts the vestibular system, specifically vestibular thresholds. **METHODS:** Using a MOOG motion platform in conjunction with a Reduced Oxygen Breathing Device 2 (Environics) we had participants complete multiple sessions of z translation threshold tests while breathing gases with an O_2 content of 20.9%, 15.4%, 14.3%, 12.9%, 11.8%, and 10.7% – chosen to simulate O_2 content found at altitudes of 0 ("baseline"), 8,000, 10,000, 12,500, 15,000, and 17,500 feet. Thresholds were determined based upon participants' responses on a forced choice direction recognition task. **RESULTS:** Fifteen participants completed test sessions at 20.9% and 15.4% O_2. Earth-vertical translation thresholds were 23.5% greater when oxygen content was 15.4% than at baseline ($p=0.005$). A second set of participants was invited to complete test sessions at 20.9%, 14.3%, 12.9%, 11.8%, and 10.7% O_2. Earth-vertical translation thresholds increased as O_2 content decreased. **DISCUSSION:** The results of the present studies suggest that hypoxia resulting from simulated altitudes as low as 8,000 feet, can adversely impact our ability to reliably sense whether we moved upwards or downwards. Specifically, when hypoxic it takes larger movements for us to be able to sense these motions reliably. This is noteworthy because 8,000 feet matches the cabin pressurization required in the US by the FAA for commercial flights. Additional studies are needed to determine if this effect generalizes to other types of motion (e.g., roll-tilts) and if hypobaria

amplifies this effect. Regardless, the results of this study suggest that it may be beneficial to consider supplemental oxygen at altitudes as low as 8,000 feet.

Learning Objectives

1. The participant will learn what vestibular thresholds are and how they relate to aviation.
2. The participant will learn that hypoxia adversely affects humans' vestibular thresholds.

[20] REAL-TIME DETECTION OF PILOT SPATIAL DISORIENTATION TO TRIGGER A PILOT-AIDING SYSTEM

Caroline Dixon[1], Jordan Dixon[2], Taylor Lonner[1], Tristan Endsley[2], Torin Clark[1]

[1]*University of Colorado-Boulder, Boulder, CO, United States;* [2]*The Charles Stark Draper Laboratory, Cambridge, MA, United States*

(Education - Program/Process Review)

BACKGROUND: Pilot spatial disorientation remains a leading cause of Class A mishaps. Sustained vehicle accelerations and rotations that commonly occur during flight may lead to spatial disorientation, particularly in visually degraded environments. Of particular concern, disorientation may remain unrecognized by the pilot until it is too late to make appropriate corrective actions. Many of the sensory (e.g., vestibular) limitations and the brain's central processing mechanisms that contribute to spatial orientation perception are fairly well understood, advancing to the development of computational models. These models input vehicle motions and mimic the pilot's cognitive processing, leading to predicted perceptions of vehicle motion and orientation. These models have previously been used offline, post-flight for accident investigation to assess the potential role of spatial disorientation as a contributor in mishaps. **OVERVIEW:** Here, we aim to develop a computational tool for identifying pilot spatial disorientation in real-time, during vehicle motions. Our approach is to build upon an existing computational model for human spatial orientation perception in order to define a unidimensional metric of spatial disorientation that varies over time based upon vehicle motions. When the spatial disorientation metric is sufficiently high, we envision it to serve as a trigger for real-time interventions helping the pilot recognize their spatial disorientation, regain their spatial orientation, and make appropriate corrective actions. As a first step, we have implemented the real-time computational tool in a ground-based flight simulator and demonstrated feasibility for triggering an adaptive visual display in which the pilot's attention is directed to salient cues of vehicle orientation and motion. This pilot aiding system avoids adding an unnecessary burden when the pilot is not experiencing substantial spatial disorientation. **DISCUSSION:** We aim to show capability of the computational tool to correctly identify when the pilot is experiencing spatial disorientation, and efficacy in reducing performance decrements and enhancing safety. Such a system, if sufficiently capable, could help mitigate the effects of spatial disorientation in real-time, potentially preventing accidents before they occur. We anticipate the computational tool could have benefits across military aviation, commercial and general aviation, and spaceflight.

Learning Objectives

1. Understand the temporal dynamics of pilot spatial disorientation and how computational models can capture those dynamics.
2. Envision how accidents from pilot spatial disorientation could be prevented through a means of triggering a countermeasure in real-time.

[21] SPATIAL DISORIENTATION INTERFERES WITH COGNITIVE PERFORMANCE IN MILITARY HELICOPTER PILOTS

Annemarie Landman[1], Fleur Evertsen[2], Eric Groen[1], Mark Houben[1], Max Mulder[2], René van Paassen[2], Olaf Stroosma[2]

[1]*TNO, Soesterberg, Netherlands;* [2]*Delft University of Technology, Delft, Netherlands*

(Original Research)

INTRODUCTION: Spatial Disorientation (SD) contributes to a substantial proportion of military and civil aviation accidents. So far, research has largely focused on the direct effects of SD on control errors, but little is known about its effect on the availability of cognitive resources. As military piloting tasks are often characterized by high cognitive workload, the potential impact of SD on cognition may strongly affect mission effectiveness as well as safety. **METHODS:** Military helicopter pilots (n = 13) performed 4-minute SD scenarios in a six degrees of freedom Apache AH-64 motion-base simulator, in which the visual environment was presented in Virtual Reality (VR). The scenarios included the following SD stimuli: 1. Leans (vestibular); 2. Sloped cloud deck (visual); 3. Featureless terrain (visual); 4. Brownout (visual); 5. Loss of visual reference during night vision (visual); and 6. Somatogyral illusion (vestibular). Scenario's 1-3 were flown manually, and scenario 4-6 were flown as pilot monitoring. The manual flying task was always to maintain level flight. Corresponding scenarios without SD cues were used as control condition. A cognitive task was performed for 30 seconds during an SD stimulus, and consisted of 10 mental arithmetic calculations presented auditorily every three seconds. **RESULTS:** A repeated-measures ANOVA indicated that SD led to significantly longer response times in the Leans ($p = 0.001$), Featureless terrain ($p = 0.030$) and nearly significantly in the Brownout scenario ($p = 0.066$). Response accuracy was also decreased in the Leans ($p = 0.010$) and nearly significantly in the Featureless terrain scenario ($p = 0.083$). Effect sizes were large ($\eta^2 > 0.40$). Correspondingly, pilots rated the Leans and Brownout scenarios as highly disorienting (score: 4/5 on a 5-point scale), but interestingly, not the Featureless terrain scenario (2/5). **DISCUSSION:** This study shows that SD stimuli can negatively affect cognitive performance of pilots in the pilot flying role and possibly also in the pilot monitoring role. These effects were observed in scenarios which were rated as highly disorienting, but also in a scenario that was not, suggesting that unrecognized SD may also impact availability of cognitive resources. The results imply that effects of SD should be taken into account when managing workload, which is relevant information for the development of crew resource management training.

Learning Objectives

1. The audience will learn about the "Orientation First" principle, and how this applies to pilots.
2. The audience will learn the extent to which spatial disorientation can affect a pilot's capacity to perform cognitive tasks, and what this implies for the underlying processes of spatial disorientation.
3. The audience will learn about which factors could make scenarios for ground-based simulators effective or ineffective for inducing spatial disorientation in a controlled manner.

[22] EFFECTS OF HELMET MOUNTED DISPLAY FORMAT AND SPATIAL AUDIO CUEING ON PILOT PERFORMANCE AND SPATIAL DISORIENTATION PREVENTION

Henry Williams[1], Eric Geiselman[2], Thomas Schnell[3], Darci Gallimore[1], Kendra Carter[1], Dain Horning[1]

[1]*Naval Medical Research Unit–Dayton, Wright-Patterson AFB, OH, United States;* [2]*Air Force Research Lab, 711th HPW, Wright-Patterson AFB, OH, United States;* [3]*University of Iowa, IA City, IA, United States*

(Original Research)

INTRODUCTION: Helmet mounted displays (HMDs) have the potential to improve mission performance by providing visual information regardless of where the pilot is looking. However, with this increased display space it has been shown that pilots tend to look further off-axis and for longer durations, changes in scan behavior that could have unintended consequences. This study was designed to answer three research questions: 1) Do these changes affect the probability of spatial disorientation (SD), as compared to conventional "forward-anchored" displays? 2) What is the best symbology format for HMDs? 3) Can supplementing HMD information with spatial audio cueing improve performance and reduce SD incidence? **METHODS:** In NAMRU-D's Kraken, a Varjo VR-3

headset was integrated into an X-Plane flight simulation to display three different off-axis HMD formats: 1) a simple display format (SDF) with airspeed, altitude, and an aiming reticle; 2) an arc-segmented attitude reference (ASAR), with all SDF elements plus attitude information, and 3) conformal attitude reference (CAR) with the SDF elements plus a conformal horizon line and longitudinal lines converging at zenith and nadir. A traditional head-up-display (HUD) appeared when looking on-axis for all display formats, and all were tested with and without a spatial audio cue performing as a sky pointer. The participant's task was to visually track aerial targets while flying 45° angle-of-bank (AOB) turns while holding 10,000 feet MSL. **RESULTS:** Target-tracking performance was significantly better with ASAR as compared to the other formats, but only for less-experienced pilots, who, when flying with SDF, showed marginally significant trends for lower AOB and altitude error. HMD format had little effect for more-experienced pilots. SDF had the most instrument crosschecks back to "inside" displays, while ASAR had the fewest. Subjective ratings of SD, workload, and preferred format favored both ASAR and CAR. No effect for spatial audio was observed. **DISCUSSION:** The improved target-tracking with ASAR was likely due to fewer crosschecks, allowing pilots to maintain longer visual contact with the target. The trend for lower AOB error with SDF can be explained by more crosschecks with that format. Overall, combined objective and subjective measures tended to favor the ASAR format.

Learning Objectives

1. The audience will understand how Helmet Mounted Displays (HMDs) can change visual scanning behavior.
2. The audience will understand that different piloting tasks (e.g., target tracking vs. turn precision) are likely to be best supported by different HMD symbology formats.

Monday, 05/06/2024 ***10:30 AM***
Grand Ballroom B

[S-06]: SLIDES: CLINICAL PRACTICE GUIDELINES

Chair: Karen Klingenberger
Co-Chair: Marian Sides

[23] USAF EXPERIENCE ON CONGENITAL HYDRONEPHROSIS AND THE APPLICATION OF THE AMRAAM RISK ASSESSMENT MATRIX IN THE DEVELOPMENT OF USAF WAIVER GUIDELINES

Maximilian Lee
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Program/Process Review)

INTRODUCTION: This presentation will provide United States Air Force School of Aerospace Medicine (USAFSAM) Aeromedical Consultation Service (ACS) experience with congenital hydronephrosis in flying and operational personnel. Additionally, the presentation will provide an overview of the development of aeromedical guidelines for congenital hydronephrosis. Advances in the diagnosis and treatment options for urologic conditions have changed how the USAFSAM ACS assesses aeromedical risk for flyers and operators with congenital urologic anomalies. USAF and ACS waiver management systems were queried using the search terms "obstruction of urinary collecting system" and "hydroureter" that resulted in 54 cases. Twelve cases did not meet the definition of congenital urologic anomalies due to temporary obstruction from acute ureteral stones or cancer. Additionally, three cases were removed because other aeromedical diagnoses were the primary reason for medical disqualification. This resulted in a total of 39 cases of congenital hydronephrosis. With appropriate assessment of renal function, laboratory assessment of chronic renal disease, and absence of other urologic complications, 35 of 39 cases (90%) were granted aeromedical waivers. Demographics, clinical outcomes, advances in minimally invasive procedures, anatomic and functional assessments associated with long-term favorable aeromedical outcomes will be presented. Additionally, we will apply the USAFSAM ACS Medical Risk Assessment and Airworthiness Matrix (AMRAAM) to highlight risk assessment and risk mitigation strategies used in the development of the aeromedical waiver guide. Future research opportunities include longitudinal studies spanning the operational career and comparative studies for long-term renal function and clinical course for surgical versus non-surgical management of chronic ureteral obstruction.

Learning Objectives

1. Identify common conditions found in the development of hydronephrosis and hydroureter.
2. Describe clinical and ancillary findings associated with favorable clinical and waiver outcomes in USAF congenital hydronephrosis cases.

[24] THE 2023 UPDATE OF THE VA/DOD HEADACHE MANAGEMENT CPG – AEROMEDICAL APPLICATIONS

Aven Ford
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Tutorial/Review)

INTRODUCTION: The VA and DoD have recently published an updated clinical practice guideline (CPG) for the management of headache. This presentation will discuss the updated CPG and the available tools and how to apply them to aviators. **TOPIC:** The 2023 update of the Management of Headache CPG includes the full guideline, a provider summary, and a pocket card with updated algorithms. It reviews the expanding list of FDA approved medications and the CPG also evaluated evidence for and provides recommendations regarding nonpharmacologic therapies (complementary and integrative health), neuromodulation devices, injections, procedures, invasive treatments, comparative effectiveness of treatments, and the evaluation and management of medication overuse headache. The Work Group prioritized relevant outcomes frequently cited in the headache literature and, when possible, considered clinically meaningful changes rather than simply statistically significant once. The updated Pocket Card provides an algorithm as well. **APPLICATION:** This CPG presents increasingly strong recommendations for medications that can be considered. The CPG includes an updated a *Strong for* recommendation for multiple CGRP inhibitors for the prevention of migraine. Other potentially aeromedically-acceptable medications recommended for the prevention of migraine include multiple angiotensin receptor blockers, beta blockers, ACE inhibitors, oral magnesium, memantine, and botulinum toxin injections (chronic migraine only). In the acute treatment of migraine, this CPG provides new and updated *Strong for* recommendations for the use of aspirin/acetaminophen/caffeine and for five of the most used triptans. The CPG recommends against gabapentin and Lasmiditan for use in migraine. The CPG recommend physical therapy for the management of tension-type, migraine, or cervicogenic headache and aerobic exercise or progressive strength training for the prevention of tension-type and migraine headache. While there are number of commonly used FDA cleared devices and behavioral interventions for the treatment and/or prevention of headache, none of them had sufficient evidence to achieve anything higher than a *neither for nor against* recommendation.

Learning Objectives

1. The participant will know how to access and use the updated VA/DoD Headache Management Clinical Practice Guideline.
2. The participant will learn about the approach to an aviator with headache.
3. The participant will be able to apply the VA/DoD Headache Management CPG to aviators.

[25] DEHYDRATION-INDUCED COGNITIVE CHANGE IN THE FIGHTER PILOT FOLLOWING LONG-DURATION PASSIVE HEAT STRESS

Nate Deming[1], Stephanie Chayrez[2], Dyana Bullinger[3], Michelle Jilek[4], Joshua Dorcheus[4], John Gassaway[4], Anthony Acevedo[4], Brittaney Nores[5], Carolyn Price Moore[5], Ryan Scott[6]
[1]*U.S. Air Force Academy, Colorado Springs, CO, United States;* [2]*Eglin AFB, FL, United States;* [3]*Human Performance Laboratory, Colorado Springs, CO, United States;* [4]*Luke AFB, AZ, United States;* [5]*Joint Base San Antonio-Randolph, San Antonio, TX, United States;* [6]*Joint Base Langley-Eustis, Hampton, VA, United States*

WITHDRAWN

[26] AN ANALYSIS OF HEAD INJURY RISK FROM EJECTION AND NON-EJECTION SEAT AIRCRAFT ACCIDENTS

Matthew Lewis
RAF Center of Aerospace Medicine, RAF Henlow, United Kingdom

(Original Research)

INTRODUCTION: Some aircrew helmets used by the UK military do not meet the current UK military aircrew helmet impact standard but would typically pass many overseas helmet standards. This study aims to determine if aircraft accident injury outcomes would have differed had the aircrew been equipped with fully compliant helmets rather than the helmets used at the time of the accident. Also, a risk analysis was conducted to establish the overall risk of head injury in ejection and non-ejection accidents. **METHODS:** 317 RAF CAM accident reports were accessed, and the analyses divided into ejection and non-ejection seat accidents. Accidents where head injuries had occurred were interrogated and the cause of fatalities noted. The mechanisms of the head injuries were determined, and these data were used to calculate the overall head injury risks, from windblast slam back, parachute landing or cockpit impacts. **RESULTS:** Non-ejection accidents: 30 aircrew sustained fatal head injuries as well as other fatal injuries in non-survivable high-energy accidents. 2 aircrew sustained survivable multiple injuries coupled with a survivable head injury due to facial trauma. 2 aircrew had isolated survivable head injuries. The risk of a fatal head injury ranged from $1.3x10^{-7}$ to $2.1x10^{-7}$ FH depending on helmet type. Ejection accidents: there were 3 isolated fatal head injuries caused by forces way in excess of that which could be attenuated by any type of helmet. 27 relatively minor injuries occurred primarily because of rotational forces from windblast strikes. There was one survivable parachute landing head injury. The risk of a fatal head injury due to windblast or parachute landing was $1.1x10^{-8}$ and $7.6x10^{-8}$ PFH respectively. **DISCUSSION:** For ejection and non-ejection accidents it was unlikely that the number of fatalities would have reduced had aircrew been wearing helmets with improved impact energy attenuation. In 1 RW accident an isolated non-fatal head injury may have been lessened had the aircrew been provided with better head protection. For the most part aircrew tended to sustain either fatal head injuries coupled with other fatal injuries, or the forces were so extreme that the head protection was of limited benefit. It could be considered that the risk of head injury was as low as reasonably practicable.

Learning Objectives

1. The audience will learn about the causes of head impact injuries sustained during aircraft accidents.
2. The audience will learn about the overall risk of head impact injuries associated with aircraft accidents.

[27] OUTCOME COMPARISON OF LABORATORY-INDUCED AND OPERATIONALLY OCCURRING SPINAL INJURIES IN ROTARY-WING MISHAPS

Danielle Rhodes, Blake Johnson, Katie Logsdon, Frederick Brozoski, Valeta Carol Chancey
U.S. Army Aeromedical Research Laboratory, Fort Novosel, AL, United States

(Original Research)

INTRODUCTION: U.S. Army Aviators can be exposed to large vertical accelerations during a rotary-wing mishap. Black Hawk and Apache pilot seats were designed to meet crashworthiness requirements defined by Military Seat Specification MIL-S-58095A. However, Brozoski et al. (2020) reported that Army aviators are still at risk for thoracolumbar injuries in potentially survivable mishaps. The USAARL is investigating thoracolumbar injury tolerance to vertical loading to improve performance requirements for crashworthy seats. However, it must first be ensured that laboratory exposures are producing injuries like those observed in real-world mishaps. Laboratory-induced spinal injuries will be compared to operationally occurring injuries reported in the U.S. Army Combat Readiness Center (USACRC) aviation mishap database regarding type, severity, and location to ensure the laboratory-induced spinal injuries are operationally relevant. **METHODS:** Fourteen male cadavers were exposed to vertical accelerations (8 mirroring the configuration of MIL-S-58095A and 6 at a lowered pulse) on the USAARL Vertical Acceleration Tower (VAT) and then autopsied. Class A and B survivable rotary-wing mishaps between 1990 and 2018 (n=249), which were recorded in the USACRC mishap database were analyzed. The resulting spinal fracture (fx)/dislocation location, type, and AIS severity were tabulated and compared with the laboratory-produced cadaver injuries. **RESULTS:** Laboratory cadaver testing produced 48 spinal fx/dislocation (with top 3 categories being 17 burst fx, 8 spinous process fx, 9 rupture/dislocation of the intervertebral disc) from both vertical accelerations. The USACRC database yielded 84 spinal fx/dislocation with specified vertebral locations (with the top 3 categories being 53 compression fx, 16 fx type not specified, 7 burst fx). Laboratory-induced and operationally occurring spinal fx were primarily within the thoracolumbar region and ranged from AIS 1 to 3 in severity. **DISCUSSION:** The VAT used in this study is an effective tool for reproducing real-world injury outcomes sustained in rotary wing mishaps, which will be integral to assessing seat performance and injury risk for the Warfighter. Although the categorization of the compressive vertebral body fx differed, similar injury severities and locations were observed between laboratory-induced and reported rotary wing mishap outcomes, enabling the development of operationally relevant injury criteria.

Learning Objectives

1. The most common spinal injury types sustained in Army rotary-wing mishaps.
2. The range of AIS severities sustained in Army rotary-wing mishaps.

[28] EFFECT OF SPACEFLIGHT ON REFRACTIVE ERROR & AXIAL LENGTH: IMPLICATIONS FOR SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME (SANS)

Ganeev Singh[1], Jacob Altholz[2], Geoffrey Bocobo[3], Sara Mason[4], Millennia Young[5], Thomas Oswald[6], Suzi Osborne[6], Bob Gibson[6], Bill Tarver[5], Tyson Brunstetter[5]
[1]*University of Massachusetts Chan Medical School, UMass Memorial Medical Center, Worcester, MA, United States;* [2]*University of Nevada, Las Vegas, Las Vegas, NV, United States;* [3]*Jacobs School of Medicine and Biomedical Sciences, Buffalo, NY, United States;* [4]*Aegis Aerospace, Inc., Houston, TX, United States;* [5]*NASA JSC, Houston, TX, United States;* [6]*KBR, Houston, TX, United States*

(Original Research)

INTRODUCTION: Spaceflight-associated neuro-ocular syndrome (SANS) is a health risk for astronauts manifesting as hyperopic shifts in refractive error, globe flattening, choroidal fold formation, and/or optic disc edema. The pathophysiology behind these phenomena is thought to be due to microgravity-induced intracranial fluid shifts. Examining the specific alterations in ophthalmic measures like refractive error (RE) and axial length (AL), may provide insights into the mechanisms of SANS, especially as some clinical manifestations persist after return to Earth. **METHODS:** Data were obtained retrospectively from medical records of NASA astronauts associated with short-duration Space Shuttle (STS) missions or

long-duration International Space Station (ISS) missions. RE and AL data collected closest to launch and landing for 535 STS and 85 ISS astronauts were included. Each astronaut's RE was converted into angular data (i.e. rectangular vector components converting sphere, cylinder, and axis). Individual values for vision correction were represented as three vectors that represent the spherical component of vision correction (V1) and the magnitude of astigmatism in two predefined directions (V2 and V3). Data were analyzed by linear mixed effects models. **RESULTS:** Significant hyperopic RE shifts occurred in ISS astronauts (+0.15D, p<0.0001) but not in STS astronauts. ISS astronauts experienced significant decreases in AL (-0.122mm, n=55, p=0.0012), while no STS AL pre-flight data were available for comparison. Similar decreases in AL were observed between sexes (Male: -0.122mm, n=39 missions, p=<0.0001; Female: -0.116 mm, n=16 missions, p=0.0299), with equivalent results (p=0.9736). Eye laterality did not significantly affect decreases in AL (Right: -0.100mm, n=55, p=0.0339; Left: -0.137mm, n=55, p=0.0010), (overall p=0.4745). Finally, novice and veteran flyers showed similar changes in AL (Veteran: -0.079mm, n=207, p=0.0006; Novice: -0.175mm, n=185, p=0.0372), with magnitudes not being significantly different (p=0.2597). **DISCUSSION:** Notably, AL consistently decreased across sex, eye laterality, and astronaut flying experience, countering previous work suggesting certain biases. Additionally, significant hyperopic RE shifts occurred in ISS astronauts and were primarily spherical, suggesting that globe flattening may be the primary mechanism of RE changes in SANS. Continued research is critical as NASA and other organizations prepare for future long-duration missions.

Learning Objectives

1. Further characterize the contribution of axial length and refractive shifts related to visual impairment following spaceflight given the various microgravity-induced ocular perturbations that contribute to SANS.
2. Learn how axial length/refractive error changes in SANS do not appear to have a predilection for sex, eye laterality, or astronaut flier experience.

Monday, 05/06/2024 ***10:30 AM***
Grand Hall J

[S-07]: SLIDES: HUMAN PERFORMANCE AND TRAINING

Chair: David Kim

[29] ENHANCING TRAINING REALISM: A COMPARATIVE STUDY OF MASK-ON AND MASK-OFF HYPOBARIC HYPOXIA TRAINING

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Republic of Singapore Air Force, Singapore, Singapore

(Original Research)

INTRODUCTION: The Republic of Singapore Air Force (RSAF) has traditionally used mask-off hypoxia exposure within a hypobaric chamber to train aircrew members to identify in-flight hypoxia. To improve training realism and enhance fighter aircrew members' response to insidious cabin depressurization or OBOGS failure, mask-on hypobaric hypoxia training was introduced in 2019 following the operationalization of a new Breathing Quality Air (BQA)-compatible hypobaric chamber at the RSAF Aeromedical Centre. This study aimed to evaluate the effectiveness of mask-on hypoxia training compared to the traditional mask-off method. **METHODS**: 158 RSAF aircrew members whom had prior experience with mask-off hypobaric hypoxia training were selected to undergo mask-on hypobaric hypoxia training. Data was collected through post-training survey administration of hypoxia symptoms by participants and analysed using descriptive statistics. **RESULTS:** Almost all participants reported the new mask-on training method to be more realistic (98.8%) and effective (97.5%), with most (96.2%) stating a subjective preference for mask-on hypoxia training. The top three symptoms that participants experienced were dizzy/light-headedness, hot and cold flushes, and tingling in fingers/toes. **DISCUSSION:** This study compared mask-on hypobaric hypoxia training with the traditional mask-off hypobaric hypoxia training. Most participants expressed a subjective preference for mask-on training, citing its greater effectiveness and realism. However, it should be noted that the increased realism may not be universally applicable, particularly for aircrew members in non-fighter platforms. A limitation of the study was the inability to determine the direct relationship between reported symptoms and actual hypoxia, as participants' blood oxygen saturations were not measured. Notwithstanding, the top three symptoms reported by participants (i.e., dizziness, hot and cold flushes, and tingling in fingers/toes) were similarly the most common initial symptoms of hypoxia reported in other studies. This suggests that mask-on hypobaric hypoxia training was effective in training aircrew members to recognise their "hypoxia signature" and take appropriate recovery actions.

Learning Objectives

1. The audience will learn about the key components of the new mask-on hypobaric hypoxia training regime conducted in the RSAF Aeromedical Centre.
2. The audience will learn about the results of a subjective survey that compared participants' experiences between mask-off vs mask-on hypobaric hypoxia training.
3. The audience will learn about the top three most common hypoxia symptoms experienced by RSAF aircrew when undergoing mask-on hypobaric hypoxia training.

[30] OPTIMIZING COGNITIVE PERFORMANCE USING AN ACUTE INTERMITTENT HYPOXIA (AIH) PROTCOL

Wendy Olsen[1], Nicholas Napoli[2], Christopher Myers[3]
[1]*National Research Council Research Associate, Air Force Research Laboratory, Wright-Patterson AFB, OH, United States;* [2]*University of Florida, Gainesville, FL, United States;* [3]*Air Force Research Laboratory, Wright-Patterson AFB, OH, United States*

(Original Research)

INTRODUCTION: The optimal goal of any training paradigm is to enhance efficiency, accuracy, and long-lasting retention of relevant knowledge and acquire skill. Our aim is to characterize and determine if an acute intermittent hypoxia (AIH) protocol can facilitate and accelerate the acquisition of novel information that is presented through specific cognitive tasks targeting how humans learn and proceduralize paired associations. The physiological underpinning of AIH induces a positive, long-lasting neuroplastic effect. It is postulated that these benefits may arise from new neuron formation in the hippocampal dentate gyrus, which is essential for learning and memory. We hypothesized participants to demonstrate faster acquisition and longer retention of novel information than their control counterparts. The implications of these findings, optimizing cognitive performance outcomes, can potentially address critical shortages of skilled positions. **METHODS:** Eight healthy participants were recruited for the study. Participants were randomly assigned to a control or AIH group. AIH participants were asked to breathe fifteen trials of a one-minute bout of AIH (10.2% oxygen), immediately followed by a one-minute bout of normoxia (21% oxygen). Each control participant will receive fifteen trials of a one-minute bout of sham-normoxia (21% oxygen), immediately followed by a one-minute bout of normoxia. Subjects experienced the AIH and control protocols 60 minutes prior to performing two cognitive tasks: the digit-symbol substitution task and the change signal task. Physiological data were recorded. **RESULTS:** Preliminary results comparing the AIH and control protocols performance on cognitive tasks examining paired associations indicate significant accuracy differences between the groups at the initial acquisition phase ($F = 13.135$, $p = 0.015$). The follow-up point did not demonstrate significant accuracy differences ($p = 0.061$); however, it is trending towards

significance. Preliminary analyses indicate that the AIH group tends to perform better and faster than the control group. Participant recruitment is ongoing. **DISCUSSION:** The preliminary results indicate the impact of an AIH protocol informing our understanding of optimizing cognitive acquisition utilizing a well-tolerated paradigm that has yet to be explored within healthy adults. The potential application of these findings may inform optimizing training paradigms within the aerospace and aviation environments.

Learning Objectives

1. The audience will learn about a performance enhancing acute intermittent hypoxia (AIH) protocol that has proven tolerance within healthy adults.
2. The participant will be able to understand the potential cognitive neuroplastic benefits of an AIH protocol.

[31] QUANTITATIVE AND QUALITATIVE OUTCOMES OF SELF-ASSESSED SIMULATION-BASED TRAINING OF EXTERNAL FIXATION SKILLS FOR MARS ANALOGUE CREW MEMBERS

Alicyn Grete[1], Julielynn Wong[2], Patrick Bowers[1], William Fraser[3], Jaspreet Randhawa[4], Habila Umaru[5], Jason Barnhill[1], Michael Donohue[6]

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(Original Research)

INTRODUCTION: Astronauts on deep space missions are at risk of sustaining fractures. 6 Mars analogue crew members taught themselves to perform uniplanar external fixation of an simulated open tibial shaft fracture using an open-access simulation-based training module that uses locally reproducible, high fidelity 3D printed bone models and a procedure checklist for self-assessment. **METHODS:** While a previously reported analysis of the data showed that confidence with self-performance of this simulation-based procedure improved significantly on all 8 measures evaluated, further analysis was needed to determine the practicality of having crew members undergo this type of training. We report the simulation-based training times and qualitative observations of the simulation-based training experience for the 6 subjects who taught themselves to perform uniplanar external fixation of an simulated open tibial shaft fracture. Each subject tracked and verified the successful completion of each step of the procedure checklist of another subject before performing the simulated procedure themselves. **RESULTS**: It took between 90-120 minutes for subjects to review the knowledge topics (which included watching a skills training video that showed the entire procedure) and between 32-45 minutes for subjects to complete one simulation-based procedure. The first subject opted to practice the procedure twice. All other subjects felt confident to perform the procedure once after assisting a fellow subject perform this procedure by observing and confirming the successful completion of each step of the procedure checklist. Subjects requested clarification of the medical terms in the procedure checklist. **CONCLUSION:** Mars analogue crew members can use open-source, high fidelity, 3D printed bone models and an open-access, self-assessed training module in under 4 hours to become confident and competent in performing a simulated external fixation procedure in an austere environment without access to specialist support from Mission Control. Using a procedure checklist reinforces surgical skills acquisition for crew members. A glossary of terms can be added to the training module to clarify medical terms for primary and back-up crew medical officers who have not completed formal medical training. **LIMITS:** The size of the Mars analogue crew limits the generalizability of our findings. **KEYWORDS:** "long-duration space mission""fracture - external fixation""3D printing"

Learning Objectives

1. The audience will learn about how Mars analogue crew members can use open-source, high fidelity, 3D printed bone models and an open-access, self-assessed training module to become confident and competent in performing a simulated external fixation procedure in an austere environment without access to specialist support from Mission Control.
2. The audience will learn about how using a procedure checklist during simulation-based training reinforces surgical skills acquisition for Mars analogue crew members with no prior medical training.

[32] COMPREHENSIVE ASSESSMENT OF AIRCREW CONDITIONING PROGRAM: ENHANCING PHYSICAL PERFORMANCE AND MITIGATING INJURY IN AIR FORCE FIGHTER PILOTS

Stephanie Chayrez[1], Jared Blake[1], Christopher Parrott[1], Anthony Acevedo[2], Michelle Jilek[2], Clint Copeland[3], Haley Gill[4], Andrew Smietana[5], Brittaney Nores[6], Carolyn Price Moore[6], Ryan Scott[7]

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(Original Research)

INTRODUCTION: Physical performance is an essential component of operational readiness for Air Force fighter pilots. Adequate strength, endurance, and body composition are crucial to the pilot's ability to perform optimally. The purpose of this study is to assess the impact of an 8-week Aircrew Conditioning Program (ACP) on the Aircrew Conditioning Program Assessment (ACPA), including cervical endurance hold (CEH), inverted row (IR), isometric mid-thigh pull (IMTP), body fat analysis (BF %), and muscle mass (MM). We hypothesized that the ACP would result in significant improvements in the ACPA. **METHODS:** Student pilots (SPs) across two locations (Luke AFB male, $n = 195$, female, $n = 13$; Eglin AFB male, $n = 16$) completed the ACPA before and after an 8-week ACP. A paired-samples t-test was used to determine whether there was a statistically significant mean difference between CEH, IR, IMTP, BF %, and MM ($p<0.05$). This retrospective analysis was approved by the Air Force Research Laboratory Institutional Review Board. **RESULTS:** SPs significantly increased pre-CEH (87. 29 ± 35.67 sec) to post-CEH (117.95 ± 41.25 sec; $t = -14.562$, $p < .001$, $d = 1.00$), pre-IR (21 ± 7) to post-IR (26 ± 8; $t = -15.733$, $p < .001$, $d = 1.12$), pre-IMTP (31.69 ± 5.78 N/kg) to post-IMTP (32.66 ± 5.65 N/kg; $t = -2.746$, $p < .007$, $d = .21$), but not pre-MM (49.80 ± 14.85 kg) to post-MM (49.89 ± 14.61 kg; $t = -.681$, $p = .497$, $d = .05$), or pre-BF % (17.09 ± 5.80) to post-BF % (17 ± 5.45; $t = .746$, $p = .457$, $d = .05$). **DISCUSSION:** The findings suggest that the ACP improved CEH, IR, and IMTP, but not BF % or MM in SPs. The findings provide insight into the readiness of SPs, specifically emphasizing the role of back and neck endurance on the mitigation of injuries associated with operations. The results are expected to inform the development of more targeted and effective ACPs, tailored to optimize the physical performance of Air Force SPs while reducing the risk of injury. Future research should investigate the long-term effects of such training on pilot performance.

Learning Objectives

1. The audience will be able to analyze the training effect on the pre-post Aircrew Conditioning Program measures studied.
2. The audience will be able to discuss the importance that Aircrew Conditioning Programs have on performance and fight-related injury mitigation in fighter pilots.

[33] DEVELOPMENT AND ASSESSMENT OF A VIRTUAL REALITY TRAINER FOR LONG DURATION SPACEFLIGHT

Luca Bonarrigo[1], Esther Putman[1], Wyatt Rees[1], Benjamin Peterson[1], Ellery Galvin[1], Alessandro Verniani[1], Sandra Tredinnick[1], Sage Sherman[1], Karen Mae Baldonado[2], Eric Vance[1], Stephen Robinson[2]
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(Original Research)

INTRODUCTION: Long duration exploration missions (LDEM) require novel training methods to enable skill maintenance on mission-critical tasks such as entry, descent, and landing (EDL), extravehicular activity (EVA), and habitat maintenance and repair. This research explores virtual reality (VR) as a training modality for astronauts by developing a training environment for mission-critical LDEM tasks through experimental assessment. As a secondary goal, we quantify neurophysiological response in the cerebral cortex during training to assess the potential benefit of training in an adaptive, complex environment as a countermeasure to the neural decrements experienced in spaceflight. **METHODS:** This research has developed an LDEM-specific, multi-environment virtual training simulator called Trinity, which incorporates two Mars-focused environments: EDL and EVA with a surface rover. Each Trinity environment encompasses three subtasks, all presented in a VR headset. **RESULTS:** Using the EDL environment, we compared adaptive training in VR to assess skill transfer going from the virtual training environment to a high-fidelity test environment (physical mock-up). This training condition was compared to a 2D display and a non-adaptive VR training environment (n=24, 12M/12F). We found adaptive VR training to be the most effective regimen, and then evaluated 4 training algorithms for complex tasks (n=32, 16M/16F) to achieve personalized skill acquisition. Our data suggests 2-up, 1-down staircase algorithms as the most effective for skill acquisition. We evaluated the effect of training cadence and VR as a countermeasure to skill degradation (n=41, 24M/17F). Similarly, the EVA environment was evaluated to assess skill transfer. This environment was specifically developed to assess neural activation using functional near-infrared spectroscopy (fNIRS) and electroencephalogram (EEG). **DISCUSSION:** Using mission-critical, Mars-relevant operational tasks, this research investigates high-fidelity, adaptive VR as a promising medium for LDEM training. Specifically, it assesses skills transfer, retention, and generalizability to training in a physical mock-up, and quantifies neural activation to investigate the potential of VR training as a countermeasure for spaceflight neural decrements. Future work includes development of a third environment focused on habitat maintenance and repair. This research is supported by NASA under Grant No. 80NSSC21K1140.

Learning Objectives

1. [The participant will be able to…] Understand the effects of various adaptive algorithms on skill training.
2. [The participant will be able to…] Understand the effects of virtual reality training on cortical brain activation.

[34] THE ROLE OF AI-ASSISTANCE IN POINT-OF-CARE ULTRASOUND SKILL RETENTION FOR SPACEFLIGHT CONTEXTS

Victoria Hurd[1], Michael Del Valle[2], Victoria Kravets[1], Arian Anderson[3], Nhu Nguyen Le[2], John Kendall[2], Allison Anderson[1], Matthew Riscinti[2]
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(Original Research)

INTRODUCTION: Point-of-care ultrasound (POCUS) is a low-cost, low-mass imaging modality that will facilitate healthcare for human spaceflight. However, POCUS skills have been shown to degrade over time, presenting a barrier to effective use during missions. While some astronauts are clinically trained, many only receive limited training on POCUS, making acquisition and diagnostic skills less robust to degradation with time. Artificial intelligence (AI) tool integration may minimize skill degradation for novice, technically competent users, but this has not been experimentally investigated. This is the first study investigating whether AI assistance prevents POCUS skill degradation over time in a subject pool that mimics astronaut candidates. **METHODS:** 30 subjects, (15 male/15 female) were recruited in an IRB-approved human subjects study. Subjects possessed or were working towards a STEM university degree and had no medical training. Subjects were evenly grouped into 2 cohorts: conventional POCUS and POCUS with AI-assistance. During the first data collection session, subjects underwent didactic and hands-on training and performed their first experimental trial. 2 additional trials took place 2 weeks and 8 weeks after the initial session. In each trial, subjects performed 5 renal scans, 5 bladder scans, and 5 bladder volume estimations and completed the System Usability Scale and a self-confidence survey. Images were independently graded by 2 physicians and scored based on target organ acquisition rates. Dependent variables were analyzed via chi-square tests, Levene's tests, and linear mixed effects models. **RESULTS:** The AI-assisted group correctly imaged the bladder more often than the conventional group ($p<0.0005$) and exhibited improved diagnostic accuracy in bladder scans at 2 weeks ($p=0.0416$) but not at 0 or 8 weeks. AI-assistance did not significantly affect skill degradation in renal scans throughout the study. AI-assistance improved perceived system usability over time ($p=0.0407$) but not user confidence. **DISCUSSION:** POCUS AI-assistance improves novice, technically competent user ability to correctly image the bladder and accurately perform bladder diagnostics while increasing perceived system usability with time. These effects augment the applicability of POCUS in spaceflight contexts where astronauts may not have advanced sonography training. Future work includes study replication in more realistic operational scenarios or with upgraded AI algorithms.

Learning Objectives

1. The audience will be able to understand the utility of point-of-care ultrasound in human spaceflight healthcare and recognize that point-of-care ultrasound skills have been shown to degrade over time, necessitating a study that investigates methods of skill degradation prevention for subject pools that mimic that of astronaut candidates.
2. The audience will learn that the integration of artificial intelligence tools into point-of-care ultrasound scanning modalities improved subject ability to correctly capture the bladder and accurately perform bladder diagnostics.

Monday, 05/06/2024 ***10:30 AM***
Grand Hall K

[S-08]: SLIDES: SPACE MEDICINE EVOLUTION

Chair: Allen Parmet
Co-Chair: Karen Keats

[35] This abstract was moved to session S-48.

[36] SPACE-RELEVANT HUMAN-AUTONOMY TEAMING TASK TO STUDY THE MULTI-DIMENSIONAL AND DYNAMIC NATURE OF TRUST

Sarah Leary[1], Jaekeun Sung[1], Victoria Hurd[1], Christian Lee[1], Yimin Qin[2], Zhaodan Kong[2], Torin Clark[1], Allison Anderson[1]
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(Original Research)

INTRODUCTION: Human-autonomy teaming is an integral component of civilian and DoD missions. A human must appropriately trust the autonomous system (AS) to collaborate effectively. Historically, trust has been obtrusively obtained via surveys. Because of this limitation, trust is often modeled as static, rather than dynamic, and one-dimensional, rather than having nuance. For example, Cognitive Trust (CT) forms due to rational, logical thinking, whereas Affective Trust (AT) is based on feelings and emotions. CT and AT are two-dimensions of trust. Our goal is to affect CT and AT in participants and obtain survey-based "ground-truth" trust measurements over time, while simultaneously collecting unobtrusive psychophysiological (e.g., skin conductance responses), neurophysiological (e.g., oxygenated hemoglobin), and embedded measures (e.g., button clicks). We can then use these unobtrusive measures as predictors and develop metrics and models that can infer and predict "ground-truth" trust in real-time. **METHODS:** We developed a space-relevant, human-autonomy teaming task to study multi-dimensional trust. The task was developed using PyQT and displayed on a 2D screen. Participants act as the "supervisor" of their simulated AS teammate in a ground troop monitoring task. The AS receives simulated data captured from ground imaging satellites (e.g., visual and thermal images) and classifies the data as containing troops or not containing troops. The AS then relays the classification and data to the human. The human has the option of agreeing, disagreeing, or ignoring the recommendation of the AS. Throughout the experiment, subjects are compelled to report their trust using a pop-up slider which serves as the "ground-truth". **RESULTS:** To affect CT, we varied AS "reliability". Reliability is the number of correct classifications the AS makes and is 65\% in the "low reliability" cases or 85\% in the "high reliability" cases. To affect AT, we varied AS "explainability". Explainability is how the AS justifies its classification to the human. "Low explainability" is robotic-like rhetoric, whereas "high explainability" is human-like rhetoric. Our results indicate subject trust in the AS varied with reliability and over time. **DISCUSSION:** This task is specifically designed to affect multi-dimensional trust when working with an AS. Future work will build models from psychophysiological, neurophysiological, and embedded measures for real-time trust inference and prediction.

Learning Objectives

1. Biosignals and embedded measures provide an unobtrusive method of inferring trust.
2. Reliability is known to affect Cognitive Trust. This experiment aims to use robotic or human-like rhetoric to affect Affective Trust as well, which is less studied.

[37] USE OF ARTIFICIAL INTELLIGENCE DURING SURGICAL PROCEDURES ONBOARD LONG DURATION EXPLORATION SPACECRAFT

Ryan Lacinski[1], Arthur Formanek[2], Tovy Kamine[3], Ariana Nelson[4]
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(Original Research)

INTRODUCTION: While there are no historic instances of surgery onboard spacecraft, given the predicted expansion of space travel, the future need for at least minimal procedural intervention is likely. Numerous factors increase the difficulty and risk of surgery in weightless environments. However, when considering the limited possibility of medical evacuation of critically ill crew members during long duration exploration missions (LDEMs), it is necessary to begin devising onboard surgical intervention support systems. Artificial Intelligence (AI) will soon be implemented to support all aspects of medicine from diagnosis to care. The purpose of this study was to investigate AI tools that could assist a crew medical officer performing surgical procedures onboard spacecraft. **METHODS:** Using PubMed and Google Scholar, we reviewed AI tools applicable to surgical procedures suggested for LDEMs. Keywords included "artificial intelligence" "[procedure]", with [procedure] comprising anesthesia alongside minimally invasive, robotic, endoscopic, thoracoscopic, robot-assisted and open surgery. Article inclusion criteria included publication between the years 2017-2023, as the sentinel paper discussing the transformer architecture essential to ChatGPT among other AI applications was published in June 2017. We excluded any AI tools whose training sets were exclusive to a pediatric patient population. Where applicable, we reviewed only the top 1000 research articles (based on relevance) for each keyword. **RESULTS:** Our literature search yielded a total of 54,577 original research articles and reviews. Nearly 40% (19,970) of all articles were related to the use of AI in anesthesiology. This was followed by publications pertaining to the use of AI in robotic (14.6%, 7956 articles), laparoscopic (14.3%, 7830 articles), endoscopic (10.4%, 5666 articles), minimally invasive (9.6%, 5219 articles) or open (8.4%, 4590 articles) surgery. **DISCUSSION:** Tools for assistive laparoscopic/endoscopic surgical navigation, landmark identification and image analysis were uncovered in this review. Models for ultrasound-guided regional anesthesia and airway management during surgical procedures have also shown preliminary promise. Whether AI could mitigate some of the risk associated with surgical intervention onboard spacecraft requires further investigation, especially considering that any surgical procedure performed on LDEMs is likely to be open, for which there are no current data.

Learning Objectives

1. [The audience will be able to…] appreciate that while surgical intervention onboard spacecraft is associated with immense risk due to numerous physiological and technical factors, intervention may be necessary for critical crew member care during space exploration missions.
2. [The audience will learn about…] the artificial intelligence tools that have been developed to assist medical professionals with space-relevant laparoscopic, endoscopic, robot-assisted and open surgical procedures.

[38] INCREASED GRAVITY AND WEIGHTLESSNESS MAY AFFECT BLOOD PRESSURE THROUGH COMPRESSIVE EFFECTS ON TISSUE

Sara Rothrock[1], Jay Buckey[2], Mimi Lan[3]
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(Original Research)

INTRODUCTION: Blood pressure often decreases in long-duration spaceflight, yet the cause is poorly understood. To investigate if gravitational forces influence blood pressure, data from a G_X centrifugation study were analyzed. G_X centrifugation simulates the high gravity conditions during Earth re-entry. When G_X centrifugation increases tissue weight, it could also elevate resistance to blood flow. If this is true, then reductions in tissue compressive forces by the removal of gravitational forces in weightlessness might reduce total peripheral resistance. **METHODS**: Lindberg et al. examined the impact of G_X centrifugation on cardiovascular parameters. Six healthy subjects underwent G_X centrifugation with cardiac output, heart rate, mean arterial pressure, stroke index, total peripheral resistance, blood pressure, and central venous pressure monitored. Only 4 participants had data going from 1 to 2 G_X. Total peripheral resistance (TPR) under the conditions of 1 and 2G were then re-analyzed and extrapolated to a 0G condition. **RESULTS:** TPR values for the 4 individuals all increased at 2 G_X (#1 705.4 to 1045.9, #2 764.9 to 1083.8, #3, 927.0 to 1154.1, #4, 1273,0 to 1408.1). Extrapolating the centrifugation results to 0 G predicted a TPR of 662. Heart rate was not increased. **DISCUSSION**: Lindberg et al. demonstrated that as the gravitational force increased from 1G to 2G, a substantial rise in TPR occurred. The response to G_X is complex, and the changes in TPR could be from direct effects on vessels or baroreflex responses to reduced cardiac output. In this study, however, the heart rate from 1 to 2G did not increase as expected from a reduction in cardiac output. These changes could be due to increased tissue weight and the

resulting compressive forces. When extrapolating these findings to a 0G environment, the opposite is expected, with reduced resistance to blood flow as tissue weight becomes negligible. This underscores the importance of studying tissue compressive forces and their effects on blood pressure across different gravitational conditions. To further investigate the physiology underlying these changes, future research can leverage numerical modeling techniques. Such modeling enables the simulation and prediction of cardiovascular responses as a function of varying tissue weights in microgravity.

Learning Objectives

1. The audience will understand the impact of weightlessness on blood pressure.
2. The audience will learn about the application of lumped-parameter numerical modeling in predicting the effects of microgravity on the cardiovascular system.

[39] WOMEN'S HEALTH CONDITIONS PERTINENT TO COMMERCIAL SPACEFLIGHT – A SCOPING REVIEW

Satyam Patel[1], Jessica D'Urbano[2], Alexia Tasoula[3], Saswati Das[4], Patrizia Borzi[5], Rachel Steffes[6], Yuka Uemura[7], Wakako Migaki[8], Roshan Patel[9], Yui Okamura[10], Yuika Shimo[11], Begum Mathyk[12]

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(Original Research)

INTRODUCTION: As commercial spaceflight experiences unprecedented growth, it is imperative to note its increasing inclusivity, particularly in terms of female space traveler participation. With space tourism transitioning from a dream to reality for a broader demographic, delving into women's health for the spaceflight paradigm becomes essential. This scoping review consolidates current literature on women's health challenges in commercial space endeavors, pinpointing areas that need clarity. The synthesis will aid primary care providers in executing informed medical risk evaluations. **METHODS:** In alignment with objectives set by the women's health team, a structured search strategy was defined. The focal points of our investigation included areas of reproductive health, hormonal dynamics, and prevalent gynecological conditions such as abnormal uterine bleeding, ovarian torsion, ectopic pregnancy as well other concerns the effect of radiation in space. A search was performed across PubMed, EMBASE, CINAHL, PSYCINFO, and Web of Science for the considered literature extended from 2000 to 2023. Covidence software was used for abstract screening and full text reviews. A rigorous dual-review protocol was employed to assess each article's suitability, with senior members resolving instances of discrepancy. The main goal is to identify studies pertaining to commercial spaceflights. **RESULTS:** Our database search yielded 4,416 potential articles. After screening, a set of articles was chosen for in-depth analysis. The significant portion of the literature pertaining directly to women's health in space conditions was grounded in animal models, while direct data from professional female astronauts was markedly limited or dated. Further, majority of the studies did not stratify and compare participants in terms of sex differences in hormone sensitive tissues. Nonetheless, based on animal models spaceflight may impact reproductive health. **DISCUSSION:** This comprehensive scoping review illuminates the current knowledge regarding women's health in relation to commercial spaceflight, and the limitations on available knowledge due to fewer female participants in spaceflight. It underscores the importance of understanding women's health issues in the unique environment of space, giving direction to primary care providers. Additionally, there's a pressing need to refine commercial spaceflight medical screening procedures and establish evidence-driven safety standards.

Learning Objectives

1. Understand the unique women's health challenges and conditions as they relate to commercial spaceflight, with a focus on reproductive endocrinology, hormonal dynamics, pregnancy, prevalent gynecological conditions, and gynecologic cancer risk.
2. Analyze the current state of literature on women's health in the context of space travel, emphasizing the importance of addressing the gap in knowledge.
3. Recognize the significance of refining commercial spaceflight medical screening procedures to encompass women's health specifics and the establishment of evidence-driven safety standards.

Monday, 05/06/2024 ***10:30 AM***
Grand Hall GH

[S-09]: SLIDES: INDOOR AIR QUALITY

Chair: Roland Vermeiren
Co-Chair: Mark Ivey

[40] INDOOR AIR QUALITY: A NEXUS OF HEALTH AND COGNITIVE PERFORMANCE

Abigail Anderson

Case Western Reserve University and SAFE ASAP Council, Cleveland, OH, United States

(Education - Program/Process Review)

BACKGROUND: For years, efforts to address public health concerns regarding air quality have focused on outdoor air. However, as the average person spends 80-90% of their life indoors, the scientific community and the regulatory system of society should apply this same level of focus to indoor air applications. Recognizing the impacts of indoor air quality on human health, development, and cognition is essential to optimize safety and human performance in enclosed environments. **DESCRIPTION:** The COVID-19 pandemic brought special attention to indoor air and its role in disease transmission. It also highlighted the impact indoor environments have on human health as well as human performance. Indoor air quality can be affected by poor ventilation, tobacco use, dust, pollen, and off-gassing of volatile organic compounds. Natural events such as wildfires and manmade events, such as pollution from vehicles or industry, can also impact indoor air quality. These agents' impacts have been extensively described in outdoor environments, but the prevalence and impact that they hold in an indoor environment should be explored further. **DISCUSSION:** Indoor air quality has been recognized to play a major role in the development of certain health conditions such as asthma, allergies, or other respiratory diseases. However, recent findings have highlighted a connection between contaminated indoor air and changes in concentration levels, decision making abilities, and other markers of human performance and productivity. This presentation will explore the contaminants found in indoor air, review their correlation with health outcomes, and describe the impact of indoor air quality on human performance in terrestrial and aerospace environments.

Learning Objectives

1. Recognize the common factors influencing indoor air quality and identify their effects on human health.
2. Highlight the relationship between poor indoor air quality and cognitive performance, decision making, and concentration.
3. Define the importance for workplace evaluation of indoor air quality to maximize workplace efficiency and safety.

[41] ADVANCED AIR QUALITY SYSTEMS FOR SPACE HABITATS: LESSONS, APPLICATIONS, AND INNOVATIONS

Mollie Scanagatta-Long[1], Anushka Gupta[2], Shavan Patel[3]
[1]*University of Oregon Phil and Penny Knight Campus for Accelerating Scientific Impact and SAFE ASAP Council, Eugene, OR, United States;* [2]*George Washington Milken Institute School of Public Health and SAFE ASAP Council, Washington, DC, United States;* [3]*Northwestern Pritzker School of Law and SAFE ASAP Council, Chicago, IL, United States*

(Education - Program/Process Review)

BACKGROUND: Similar to Earth, spacecraft such as the International Space Station (ISS) encounter challenges with maintaining indoor air quality. To address this, intricate systems must blend air filtration technologies with the management of carbon dioxide (CO_2) levels, temperature, humidity, and oxygen/nitrogen levels, all essential for astronaut health and safety. This air filtration technology has applications beyond the ISS, extending to long-duration missions or potential lunar bases, demonstrating their broader relevance in any enclosed terrestrial environment. **DESCRIPTION:** Air quality systems aboard the ISS face several hurdles. Upkeeping HEPA filters is resource-intensive, requiring crew time and spare part storage. However, these filters do not eliminate all harmful contaminants and microorganisms, jeopardizing long-term health. Carbon dioxide removal systems that use zeolite beds may not effectively reduce CO_2 levels because they require frequent regeneration or replacement. Compounding these issues, energy consumption strains the limited ISS power supply. Adapting these systems for extended missions or varying environments presents difficulties, with microgravity complicating filtration and circulation processes. System failures require manual intervention, highlighting the need for more dependable, self-sustaining systems for the success of longer space missions. **DISCUSSION:** Addressing these challenges calls for new solutions, including compact, energy-efficient filtration, and enhanced pathogen elimination. By adopting sustainable approaches, such as biological systems and progressive chemical methods, we can reduce dependence on resupply missions. Advanced designs, such as fiber-based particulate filters, improve filtration. Moving to autonomous and self-regulating systems eases the demands of resource-intensive maintenance. Human-centric designs are vital, emphasizing crew comfort and streamlined upkeep. Techniques such as UV-C sterilization, advanced filters, and self-sanitizing surfaces will lower maintenance demands. Also, incorporating automation and artificial intelligence (AI) can improve air quality management, decreasing astronaut workload while boosting operational efficiency. Continued research in these air quality systems will aid in ensuring mission success, safeguarding astronaut health, improving terrestrial quality of life, and paving the way for the future of space exploration as commercial spaceflight expands.

Learning Objectives

1. Understand lessons learned from protecting the IAQ in space and applications to terrestrial activities, highlighting similarities and differences between their challenges, solutions, and gravitational environments.
2. Understand accomplishments and challenges of International Space Station air quality management and applications for potential deep-space and lunar base missions.
3. Understand areas for future research into additional methodologies to maintain optimal air quality within closed-loop life support systems.

[42] IN-FLIGHT EMERGENCY RESPONSE AND MANAGEMENT FOR A COMMERCIAL AIRLINE PASSENGER WITH SEIZURES: A CASE STUDY

Azeem Ali
Emirates Airline, Dubai, United Arab Emirates

(Education - Case Study)

INTRODUCTION: This case report describes a 4-year-old passenger who was previously well during boarding, experienced recurrent seizures at cruising altitude, and was unresponsive between each episode. Our unique in-house ground-based medical support (GMS) service based in Dubai managed this case. **BACKGROUND:** Neurological symptoms account for up to 30% of all in-flight medical events that require ground-based medical support (GMS) services. Recurrent seizures and other suspected neurological emergencies are time-sensitive with a limited window for emergency treatment; hence they account for approximately 10-30% of all medical diversions in commercial aviation. Recurrent seizures in a child without recovery between each episode for more than 15 minutes require a detailed review by a GMS service before making an impactful recommendation like an aircraft diversion. **CASE PRESENTATION:** The passenger was a 4-year-old female traveling from Dubai to New York with her parents and previously connected from India, with no problems. Approximately 4 hours after take-off from Dubai at a cruising altitude of 39,000 feet, the aircrew contacted GMS as the child was unresponsive for more than 15 minutes – eyes were repeatedly blinking, and all limbs were limp with spontaneous jerking movements of the legs. Additionally, she had episodes with increased facial and eye twitching. The parents recognized this as a seizure since she was hospitalized and diagnosed one year ago with similar symptoms but was never on anti-seizure maintenance medication. An Emergency Medical Technician volunteer on board assisted with the assessment but was unable to administer parenteral benzodiazepine. The GMS physician made the recommendation to divert the aircraft to the nearest destination in Moscow and the child received emergency medical treatment for status epilepticus. **DISCUSSION:** Enhanced communication and collaboration between cabin crew, medical professionals, and GMS are essential for ensuring optimal in-flight medical care. Although parenteral benzodiazepine is indicated, it is still unclear how the child would have responded with another 11 hours of in-flight monitoring. The aircraft was on the ground in less than an hour, the ambulance began emergency care, and the child was admitted to a local hospital in Moscow. This case highlights the severity of neurological conditions that can lead to a medical diversion and some of the challenges for medical volunteers and GMS physicians.

Learning Objectives

1. Participants will learn how a commercial airline's in-house GMS service remotely manages serious medical conditions inflight and the role of a medical volunteer.
2. The audience will understand the complex decision-making required by an in-house GMS service for recommending a commercial aircraft diversion due to a medical emergency that significantly impacts operations.

[43] NUMERICAL PREDICTIONS OF AIRFLOW PATTERNS ABOARD MILITARY AIRCRAFT TO INFORM CROSS-INFECTION RISK

Karsten Hendrickson, Daniel Reilly, Jennifer Melendez, Christin Duran
Air Force Research Lab, Dayton, OH, United States

(Original Research)

INTRODUCTION: Recent research has shown that infectious particles in exhaled breath and coughs have a median diameter of about 1 micron. Aerosols in this size range do not contain enough mass to deposit efficiently by gravity so transport is dominated by airflow dynamics. Therefore, airflow patterns in aircraft cabins influence cross-infection risk during passenger transport and open-air high-capacity airlift. **METHODS:** We developed high-fidelity computational fluid dynamic models to investigate internal cabin flow physics on a range of military air mobility, special operations, and trainer aircraft, including the C-17, KC-135, C-130J, C-5M, KC-46, KC-10, C-146a, and T-1A. Virtual cabin geometries were generated from real world aircraft cabins using a high-definition laser scanner paired with computer aided engineering. Virtual geometries were uploaded to commercial CFD solver Star-CCM+, on an unstructured polyhedral grid. Boundary conditions for inlet and outlet vents were defined based on either manufacturer provided values or direct measurements for mass flow rates and pressurization during flight. The steady

Reynolds Averaged Navier Stokes equations were solved, with the SST K-Omega turbulence model. Airflow patterns were analyzed for flow direction, speed, and compartment-to-compartment transition. **RESULTS:** Model output indicated that airflow patterns significantly varied airframe to airframe and were dependent on both the locations and configuration of the inlet and outlet vents. Air mass movement direction and efficiency was highly recirculatory in most aircraft, particularly in compartments with relatively large volume to mass flow ratio. **DISCUSSION:** CFD models of airflow patterns provide critical information needed to implement protective actions to mitigate cross-infection on each airframe. In follow-on studies, these models may be manipulated in a high-throughput manner to mimic different cargo and passenger scenarios during different phases of flight. Further, bioaerosols can be introduced to evaluate dispersion, deposition, and removal from the aircraft for different airflow dynamics and bioaerosol release locations.

Learning Objectives

1. Computational simulations can be used to predict airflow patterns and corresponding cross-infection risk in aircraft compartments.
2. Airflow patterns in aircraft are unique by airframe and are highly dependent on the locations and configuration of inlet and outlet vents where the vent configuration may vary based on mission requirements.

[44] FROM RAILS TO ROCKETS: A SYSTEMATIC STRATEGY TO IMPROVING AIR QUALITY IN THE TRANSPORTATION SECTOR

Hyun Yi Woo[1], Anushka Gupta[2]
[1]*University of Szeged Albert Szent-Györgyi Medical School and SAFE ASAP Council, Szeged, Hungary;* [2]*George Washington Milken Institute School of Public Health and SAFE ASAP Council, Washington, DC, United States*

(Education - Tutorial/Review)

INTRODUCTION: Maintaining consistent air quality is not only a fundamental human right and crucial to both environmental and public health, but it also impacts the operation of a developed society. The COVID-19 pandemic exposed the vulnerability of the 16 interrelated "critical infrastructure sectors," designated by the United States Department of Homeland Security, to airborne hazards, whether natural or man-made. Air quality in transportation sectors can be improved by three primary strategies: managing pollution sources, upgrading ventilation systems, and implementing air purification methods. This presentation develops a standardized approach to assess and optimize indoor air quality across various indoor transportation environments—including rail, public transit, cruise lines, aircraft, and aerospace—identifying areas for both improvements and development of uniform standards. **TOPIC:** Traditionally, exposures leading to medical issues have been tackled by clinical specialties, with insights from preventative medical fields. However, in the aerospace environment, beyond mitigating the traditional stressors of flight (hypoxia, temperature, humidity), aerospace and preventive medical specialists are now addressing additional components of indoor air quality (IAQ). Our analysis targets key IAQ parameters, encompassing particulates, volatile organic compounds, other hazardous pollutants, as well as biological contaminants. The review additionally assesses current air quality standards, regulations, practices, and technologies. It delves into their mechanism of action, strength of evidence to support their use, innovations, and potential limitations. **APPLICATION:** This research explores the progression of standards and dives into the current status of IAQ in space and air travel. Moreover it employs this standardized methodology holistically across other modes of the transportation system broadly. Technological advancements in the identified sectors may include elements such as fuel innovations and efficient control systems. Future strategies tailored to the unique needs of each industry will foster broader enhancements in air quality standards. These strategies will not only reduce health risks, but also improve safety and long-term mission outcomes. Nonetheless, it is crucial to recognize challenges while emphasizing the role of aerospace medicine in guaranteeing comprehensive health and safety of transportation systems.

Learning Objectives

1. Understand and compare the ways to address air quality across the rail, transit, cruise, aircraft, and aerospace industries.
2. Learn about cutting-edge technologies being developed and implemented to improve air quality within these sectors.
3. Identify and analyze obstacles impeding air quality advancements, and investigate solutions adopted by these industries for collective problem solving.

[45] FFP2 RESPIRATOR USE MILDLY BUT SIGNIFICANTLY REDUCES AIRBORNE BUT NOT AGROUND O_2 SATURATION IN FLIGHT CREWS

Fabian Hofmann, Thomas Schmitt, Christian Kollmannsberger, Joachim Klaus, Michael Kempf
Lufthansa Group Business Services GmbH, Frankfurt, Germany

(Original Research)

INTRODUCTION: Facemasks proved to be an additional layer of protection in limiting the spread of SARS-CoV-2 onboard commercial airplanes. Therefore, since the start of the COVID-19 pandemic, most countries and airlines implemented mask mandates. However, published data on the effect of mask wear on in-flight O_2-saturation of flight crews is scarce. **METHODS:** We conducted a small case series of volunteers (pilots and cabin crew) to examine the above-mentioned effect. Volunteers were asked to assess their peripheral O_2 saturation (SpO_2) (using a personal pulse oximeter) on ground as well as during different flight phases while wearing a surgical mask (SFM), FFP2 respirator or no mask. We evaluated the average SpO_2 according to mask type, wear time and ambient pressure. We used Mann–Whitney U test to assess statistical significance and Pearson's correlation coefficient to determine correlation. **RESULTS:** Eight volunteers participated in this series. A total of n= 481 measurements was taken during 39 flight legs. SpO_2 aground did not differ between the mask groups (unmasked: μ (mean) = 97.6%, σ (standard deviation) = 1.5%; SFM μ = 97.6%, σ = 0.9%; FFP2 μ = 97.6%, σ = 0.9%). Airborne use of FFP2 respirators resulted in a slight but significant (Δ = 1.1%, $p = 0.00004$) reduction of SpO_2 (unmasked: μ = 95.6%, σ = 1.9%; SFM: μ = 96.2% σ = 1.2% and FFP2: μ = 94.6%, σ = 0.9%). No relevant correlation between the duration of mask use and oxygenation could be demonstrated ($r = -0.16$, $p = 0.12$). Airborne SpO_2 was significantly lower than aground independent of mask type ($p < 0.0001$ for each). **DISCUSSION:** Our exploratory case study suggests, to our knowledge for the first time, that SpO_2 in flight crews is slightly impaired while using FFP2 respirators. This impairment is however minimal (1.1%) and therefore unlikely to have any effect on performance or health. The underlying reasons require further investigation. Limitations to this study exist due to the limited number of participants and measurement data as well as the assumption of statistical independence.

Learning Objectives

1. The audience learns about O_2 saturation in aircrews aground as well as airborne while using different mask types. As a byproduct the audience learns about physiological responses in spO2 to a change in ambient pressure.
2. The audience should be sensitized that there are still questions unanswered that sparked during airline travel throughout the COVID19 pandemic.

Monday, 05/06/2024 ***2:00 PM***
Grand Ballroom CD South, EF

[S-10]: PANEL: HUMAN PERFORMANCE DURING SPACEFLIGHT: EXERCISE, EVA AND INJURY PREVENTION

Chair: Karina Marshall-Goebel
Co-Chair: Judith Hayes

PANEL OVERVIEW: *As we prepare to send humans back to the moon as part of Artemis, the approach to maintaining and optimizing human health and performance to enable mission success on the Lunar surface must be addressed. Exercise countermeasure hardware for exploration missions will have significant mass and volume limitations necessitating new approaches to maintaining fitness inflight. Further, extravehicular activity (EVAs) on the surface of the moon will be more physically demanding compared to microgravity EVAs and will be performed at a cadence that has never been done in human spaceflight history. Optimizing human fitness with exercise countermeasures (pre-flight and in-flight) will be key to preventing injuries and enabling human exploration of the moon in a safe and productive manner. This panel will discuss the relationship between exercise countermeasures, EVA performance, and suited injury with an outlook for surface exploration considerations.*

[46] EVA SPACESUIT INCIDENCE TRACKING

Nathaniel Newby[1], Rachel Thompson[1], Aaron Drake[1], Jeffery Somers[2]
[1]*KBR, Houston, TX, United States;* [2]*NASA, Houston, TX, United States*

(Original Research)

INTRODUCTION: Extravehicular Activity (EVA) suit-related injuries to crew during training and inflight operations are not uncommon. Systematic tracking of these issues has waxed and waned throughout NASA's history. Given two new EVA suits in development and an increase in EVA training, the need for dutiful recording of this data is critical. The Suited User Incident Tracking System (SUITS) was developed in the last decade to track all suited exposures, recording exposure details and any related issues, pains, or injuries that arise. **METHODS:** SUITS data collected from 2017 to 2022 was analyzed for issue frequency and severity for each body location and plotted to visualize where issues were occurring. Clustering techniques using a k-modes approach were also applied to the data set to generate profiles of populations that experienced issues in the suit, and populations that did not. **RESULTS:** A key finding from SUITS is that discomfort and pain observed in the new planetary spacesuits are occurring in new body locations than those experienced in the microgravity space suit (Extravehicular Mobility Unit (EMU)). To date, the lower body and torso regions account for most pain reports in planetary spacesuits whereas most reports in EMU were shoulders and hands. **DISCUSSION:** SUITS will continue to be used to capture exposures for all suit types. As training suit availability improves and training cadence increases in preparation for planetary missions, it is critical to capture and assess all suit incidences. Further, a Suited Anomaly Assessment Team (SAAT) consisting of a broad range of EVA stakeholders was formed to share and act on SUITS data with the goal of developing robust solutions to issues/injuries as they arise. Understanding the types and locations of injuries that occur during suited operations will help inform future work related to EVA fitness training requirements, suit design, and modeling efforts to avoid injury.

Learning Objectives

1. Systematic tracking of suited exposures and issues is critical for understanding the complex interaction between the human and the EVA space suit.
2. As EVA suit issues/injuries arise it is important to share that data with a broad group to ensure robust strategies are developed.

[47] DETERMINING THE IMPORTANCE OF IN-FLIGHT TREADMILL RUNNING CAPABILITIES FOR MAINTAINING ASTRONAUT HEALTH AND PERFORMANCE

Alyssa Varanoske[1], Nicole Strock[1], Brian Prejean[1], Karina Marshall-Goebel[2]
[1]*NASA/KBR, Houston, TX, United States;* [2]*NASA, Houston, TX, United States*

(Education - Program/Process Review)

BACKGROUND: Deconditioning induced via spaceflight is most effectively attenuated through in-flight exercise training. Throughout its evolution, NASA has implemented advances to exercise countermeasures, culminating in the triad of devices currently used on the International Space Station (ISS): a treadmill (T2), cycle ergometer (CEVIS), and resistance exercise device (ARED). Despite high-quality devices and prescriptions, many astronauts experience reductions in aerobic capacity (VO_2peak pre-post mean change: -10%) and strength (knee isokinetic pre-post mean change: -15%). As NASA moves towards exploration missions, imposing size, power, and time constraints on exercise systems in addition to physically demanding surface extravehicular activities (EVAs), providing robust capabilities to protect performance should be prioritized. **OVERVIEW:** Future missions to the Lunar and Martian surfaces will include EVAs requiring ambulation and greater physical exertion than those in Apollo missions. While exercise device concepts planned for exploration missions include resistive and aerobic capabilities, ambulation is not protected. Specifically, the countermeasure planned for Artemis Lunar transit is a flywheel device, which provides both exercise modalities through one resistive cable. While more robust than the flywheel, the devices planned for the Lunar orbital space station and subsequent Mars habitats will provide distinct aerobic and resistance modalities capable of achieving high intensities, but also do not include a treadmill. Recent spaceflight research suggests that greater in-flight running intensity and volume protect against aerobic capacity and strength loss; however, this has not been experimentally confirmed. The Exploration Exercise Treadmill Requirements study is currently underway, aiming to determine the effects of exercising without a treadmill on aerobic capacity, strength, bone density, and sensorimotor function during long-duration spaceflight. **DISCUSSION:** Providing running capabilities on exploration missions may help maintain astronaut fitness and reduce injury. Studies quantifying the effects of using exploration exercise devices are in progress, which will provide critical recommendations on whether a treadmill is a necessary component of the in-flight training regime. This presentation will discuss the capabilities of exploration exercise devices and potential implications of not having running capabilities during spaceflight.

Learning Objectives

1. The audience will learn about the progression of exercise devices used by astronauts in-flight since the initiation of the space program and how these have contributed to mitigating spaceflight-induced physical deconditioning.
2. The audience will learn about the in-flight exercise capabilities currently planned for future exploration missions and how this may impact the extent of physical deconditioning experienced during spaceflight.
3. The audience will learn about the physical demands of extravehicular activities (EVAs) planned for future missions to the Lunar and Martian surfaces and how in-flight exercise capabilities may dictate mission success.

[48] SURFACE EVA PHYSICAL READINESS AND PERFORMANCE OPTIMIZATION: AN INTEGRATED APPROACH

Danielle Anderson
U.S. Air Force, NASA JSC, Houston, TX, United States

(Education - Program/Process Review)

INTRODUCTION: The training environment to prepare for an Extravehicular Activity (EVA) offers a multitude of physical and cognitive challenges posing threats to decreasing physical performance and increasing the risk of sustaining a musculoskeletal injury (MSKI). Due to the historical pattern of MSKIs in preparation for Shuttle and International Space Station (ISS) missions, the Surface EVA Physical Readiness and Performance Optimization (SERPO) team was established to provide a transdisciplinary and operational perspective to integrate the various disciplines required to enhance performance and reduce injury risk while training for lunar surface EVAs. During this section of the panel, the presenter will discuss the need for an integrated approach for maximizing performance and reducing injury risks as it relates to suited training. **BACKGROUND:** Like other operational environments, MSKIs were commonly reported to medical during the increased operational tempo and suited training events for Shuttle and ISS missions. Due to this, an integrated panel of experts, provided several logistic recommendations (e.g avoiding prolonged inverted positions), developed a functional fitness program, termed the "work hardening program", and provided an established pathway for early reporting of injury and quick access to care. These factors, in addition to reduction in training volume, lead to a drastic reduction in the severity of MSKI enhancing the physical readiness of the Astronaut corps. Due to this historical trend, the SERPO team was developed to integrate key stakeholders through multiple divisions at Johnson Space Center to capture a variety of background information related to lunar surface EVAs. This process will allow the team to identify potential tasks and physical and cognitive demands for surface EVAs that may predispose an Astronaut to a performance decrement and further increase the risk of sustaining an injury. **CONCLUSION:** Musculoskeletal injuries are multifactorial and have a complex interworking of risk factors. Based on the understanding of the current literature to date, providing recommendations to enhance physical performance and reduce the risk of injury while preparing for surface EVAs, must include an integrated approach of several disciplines, which will be discussed in the Surface EVA Readiness and Performance Optimization: An Integrated Approach section of this HP panel.

Learning Objectives

1. The Audience will learn about key factors necessary for implementing a successful integrated team for reducing injury risk and enhancing physical performance.
2. The Audience will learn about an integrated approach to identifying MSKI mechanisms, specifically related to surface EVA, and ideas for mitigating training related injuries through early reporting, protective barriers, a training program, and access to conservative and effective care.
3. The Audience will have a framework transferrable to any environment to enhance performance and reduce injury risks.

[49] CONSIDERATIONS FOR HEALTH AND PERFORMANCE DURING SURFACE EXTRAVEHICULAR ACTIVITIES

Patrick Estep[1], Taylor Schlotman[1], Jason Norcross[1], Karina Marshall-Goebel[2], Jeffrey Somers[2]
[1]*NASA - KBR, Houston, TX, United States;* [2]*NASA, Houston, TX, United States*

(Education - Program/Process Review)

BACKGROUND: NASA's objectives for expanding human presence beyond low Earth orbit will require Extravehicular Activities (EVAs) on lunar and planetary surfaces. Given the physiological and functional demands of conducting surface EVAs in a pressurized spacesuit in reduced gravity environments, there is a possibility that crew injury and compromised physiological and/or functional performance may present. **OVERVIEW:** Many human health and performance knowledge gaps exist in regards to exploration EVA that require characterization to ensure safety, reliability, and mission success. To address knowledge gaps, EVA simulations in Earth-based analog environments and/or spacesuit simulators can be utilized to provide valuable insights into task-based physiologic and metabolic costs, cognitive loads, and associated operational limitations to inform future mission concepts. Physical workloads approaching 60% of maximum metabolic rates and 85% age-predicted heart rate maxima; core body temperatures approaching 100° F; and subjective responses indicating limited spare cognitive capacity via Bedford scale have been observed during ground-based exploration EVA simulations in the NASA Active Response Gravity Offload Simulator (ARGOS) and Neutral Buoyancy Lab (NBL) during simulated planetary EVAs in pressurized suits. Further, ground-based EVA analogs vary in their ability to simulate planetary EVA and resulting physical workloads. **DISCUSSION:** Metabolic costs, thermal burdens, functional strength, and cognitive impacts have been and must continue to be assessed in ground-based analogs to fully characterize operational demands and crew readiness levels for exploration EVA. Considerations should be given to enabling a new concept of high-tempo surface EVA operations and associated work-rest intervals, understanding human health and performance impacts of evolving commercial suit designs and capabilities, and predictive modeling and decision support capabilities to enable safe and successful EVA operations.

Learning Objectives

1. Understand the high-performance physiological and functional demands, associated risks, and open knowledge gaps of operating in a self-contained extravehicular activity or training spacesuit in various gravity fields and system environments.
2. Understand ongoing and forward efforts to close knowledge gaps associated with exploration extravehicular activities.

[50] EVALUATION OF AEROBIC CAPACITY IN RELATION TO SIMULATED LUNAR SURFACE EXTRAVEHICULAR ACTIVITIES

Nicole Strock[1], Dillon Frisco[2], Patrick Estep[3], Jason Norcross[1], Taylor Schlotman[1], Brian Prejean[1], Karina Marshall-Goebel[4]
[1]*KBR, Houston, TX, United States;* [2]*JES Tech, Houston, TX, United States;* [3]*GeoControl Systems, Houston, TX, United States;* [4]*NASA, Houston, TX, United States*

(Original Research)

INTRODUCTION: Astronauts will need to be physically prepared to successfully execute strenuous Extravehicular Activities (EVA) on the Lunar surface. Compared to Apollo missions, Artemis missions will include EVAs of increased physical demand, frequency, and duration, thus requiring adequate fitness to successfully and safely complete mission objectives and potential contingency scenarios. Currently, aerobic fitness standards for partial gravity (g) surface EVAs are not well supported by high-fidelity EVA analog data. This investigation aims to characterize metabolic demands from Lunar analog EVA simulations in relation to the current NASA standards for celestial partial-g aerobic fitness (aerobic capacity (VO2pk) ≥36.5ml/kg/min). **METHODS:** To evaluate current Lunar EVA aerobic fitness requirements, a pilot study was performed to characterize metabolic rates during 6 hour simulated EVAs. The EVAs were performed in pressurized MKIII (n=2 male) and xEMU (n=3 female) spacesuits offloaded to 1/6 g in the NASA Active Response Gravity Offload System. VO2pk was assessed via graded exercise testing on a cycle ergometer and physical workload was quantified as percent of VO2pk. **RESULTS:** Four out of five subjects did not meet the current NASA celestial surface EVA aerobic standard (3 xEMU, 1 MKIII; 35.1±0.9 ml/kg/min). During simulated EVAs, subjects (xEMU: 35±1 ml/kg/min; MKIII: 44±10 ml/kg/min) worked at an average 36% VO2pk (xEMU) and 31% VO2pk (MKIII). For xEMU subjects, the tasks with the greatest average metabolic rates were 2km treadmill traverse (0% grade: 47.2% VO2pk [max 69.1%]), object relocation (45.2% VO2pk [max 60.5%]), and 1.5km traverse (0% grade: 45% VO2pk [max 59.7%]). For MKIII subjects, the tasks with the greatest average metabolic rates were 0.5km treadmill traverse (30% grade: 35.4% VO2pk [max 45.5%]), object relocation (31% VO2pk [max 40.8%]), and treadmill traverse (0% grade: 29.9% VO2pk [max 45.9%]). **CONCLUSIONS:** While average metabolic rates

for simulated Lunar EVA fall within sustainable work ranges of 30–40% VO2pk and life support system limitations, task-specific metabolic rates exceed this range and may indicate that greater fitness is necessary for more strenuous tasks expected to be performed on the Lunar surface. As few subjects met the standard, more data is needed to adequately evaluate the NASA 3001 standard.

Learning Objectives

1. The audience will learn about the celestial surface EVA NASA 3001 aerobic capacity standard.
2. The audience will learn about high metabolic demand tasks completed in simulated extravehicular activities.

Monday, 05/06/2024 ***2:00 PM***
Grand Ballroom A

[S-11]: PANEL: SUBTLE SPATIAL DISORIENTATION IN COMMERCIAL AIRCRAFT

Chair: Eric Groen

PANEL OVERVIEW: *The somatogravic illusion is a false sensation of pitch which is commonly associated with accelerated flight in (military) high-performance aircraft. However, accident investigations suggest that the illusion also occurs in less agile commercial aircraft, where it may manifest itself in a more subtle way than in fast-moving jets. This panel will give a comprehensive analysis of the appearance of the somatogravic illusion in commercial aircraft. The first presentation will provide an overview of accidents and incidents with transport airplanes related to spatial disorientation (SD), with a focus on the somatogravic illusion. The second presentation will shed light on how the somatogravic illusion develops during a go-around, based on the analysis of two mishaps with a mathematical model of human spatial orientation perception. The third presentation will describe the results of an in-flight study on the inversion illusion, which is a form of the somatogravic illusion that occurs when an aircraft levels off after a climb, similar to a go-around. The fourth presentation will provide an analysis of a helicopter mishap where the somatogravic illusion seems to have played a role. The final presentation will describe a closed-loop model which may provide insight in how the somatogravic illusion may affect pilot control inputs.*

[51] A REVIEW OF SD ACCIDENTS AND INCIDENTS IN TRANSPORT AIRPLANES

Randy Mumaw
University of Pittsburgh, Pittsburgh, PA, United States

(Education - Program/Process Review)

BACKGROUND: Vestibular illusions (spatial disorientation, or SD) can occur in flight when the pilot misperceives airplane movements or accelerations. These illusions can lead to inappropriate control actions (or failures to act), and subsequently a safety event (airplane upset or accident). While there is a well-established record of vestibular illusions leading to safety events in military jets (e.g., Stott, 2013), there was a common belief that these illusions do not afflict pilots of slower and less-maneuverable large commercial transports. However, we believe there is strong evidence that these vestibular illusions occur in transport airplanes, as well, and that these events and their causes need to be better understood. **OVERVIEW:** A review of transport airplane accidents and incidents identified, on average, about one SD-related safety event per year for the last 20 years (Mumaw et al., 2015). These safety events were responsible for 1126 fatalities. This review of 20 transport airplane safety events suggests that 11 of the 20 events were likely the result of a somatogravic illusion. Nine of those 11 somatogravic events resulted in an airplane crash and fatalities; these events produced 512 fatalities. Seven of these 11 somatogravic events were preceded by a go-around maneuver. This paper will describe those events to understand the factors that may contribute to the onset of the somatogravic illusion. **DISCUSSION:** Reduced go-around thrust was considered as a potential mitigation for reducing somatogravic-related events. Other factors that might make this illusion more likely, according to existing vestibular models, are vertical acceleration, longitudinal acceleration, and perhaps pitch rate and maximum pitch angle. In this presentation, I will review the "somatogravic" accidents and incidents to determine whether these flight parameters were outside the expected range of a large set of "normal" go-arounds (go-arounds with no safety event). Further, I will discuss other forms of vestibular illusions in commercial transports. Analysis of the events that did not appear to be the result of a somatogravic illusion suggested two other vestibular illusions that might play a role in transport airplane accidents: the somatogyral illusion and the sub-threshold roll illusion. I will also provide examples of these events.

Learning Objectives

1. The audience will learn about the influence of vestibular illusions on safety events in large commercial transport airplanes.
2. The audience will learn how well these vestibular illusions are linked to the characteristics of the go-around maneuver.

[52] MODEL ANALYSIS OF SOMATOGRAVIC ILLUSION IN ACCIDENTS RELATED TO A GO-AROUND

Torin Clark[1], Michael Newman[2], Randall Mumaw[3], Mark Houben[4], Eric Groen[4]
[1]*University of Colorado-Boulder, Boulder, CO, United States;* [2]*Reorient Corporation, Philadelphia, PA, United States;* [3]*San Jose State University, San Jose, CA, United States;* [4]*TNO, Soesterberg, Netherlands*

(Education - Program/Process Review)

BACKGROUND: Sustained aircraft forward acceleration can often lead pilots to have an illusory sense that the aircraft is pitching. Known as the somatogravic illusion, this can occur during a "go-around" maneuver when a landing approach is aborted. The resulting pilot spatial disorientation can coincide with incorrect pilot control inputs which can lead to an accident due to go-arounds often occurring at low altitudes. Conceptually, it is thought the somatogravic illusion occurs due to the otoliths of the vestibular system (and other graviceptors) being unable to distinguish between inertial acceleration and gravity. However, this is difficult to quantitatively capture during piloted aircraft flight. Computational models of human spatial orientation perception offer a means of studying the somatogravic illusion. **OVERVIEW:** Here, we applied a computational "observer" model to two inflight go-around scenarios in which the somatogravic illusion was thought to have potentially occurred. Specifically, the flight data recordings of the aircraft motion trajectories were processed to serve as inputs to the computational model. The model mimics the mechanisms which the brain is thought to use to perceive self-orientation. By inputting the aircraft motions which the pilots were exposed to, the models can provide a prediction of the pilots' perceptions of aircraft orientation and motion during the go-around maneuvers. Comparing the model predictions of pilot perception to actual aircraft orientation can help to quantitatively identify the occurrence of the somatogravic illusion. **DISCUSSION:** We aim to show the potential for applying a computational model to go-around flight maneuvers to better understand the somatogravic illusion. Comparing two flight scenarios will help identify commonalities which may occur leading to spatial disorientation during go-arounds. Studying previous flight scenarios, such as these, will help to elucidate potential means for preventing future spatial disorientation accidents.

Learning Objectives

1. Describe the mathematical mechanisms involved in modeling human spatial orientation perception.
2. Understand the quantification of the somatogravic illusion in real flight data using computational modeling approaches.

[53] RE-EXAMINATION AND RE-CALCULATION OF THE INVERSION ILLUSION

Geoffrey McCarthy
None, Portland, OR, United States

(Education - Tutorial/Review)

INTRODUCTION: Reports on the perception of the theoretical rotation of the G vector while pushing over (bunting) are conflicting. We have identified several large aircraft incidents which might have produced an illusion of inversion. This extreme form of the somatogravic illusion is impossible to reproduce in a centrifuge simulator and has been examined rarely in flight. In 1990, Money et al. subjected five passengers in a T-33 to a transition from +1 to -1G in 3 seconds to search for perception of this Inversion Illusion. Two perceived a backwards rotation of the G vector and inversion. We performed another experiment in flight to further investigate this illusion. **METHODS:** Each of ten subjects was flown in the Royal Air Force Institute of Aviation Medicine 2-seat jet Hawk or Hunter through this manoeuvre: With sun visor down and eyes closed, the subject was asked to report what the aircraft was doing. Flight profile: stabilise 30 seconds, accelerate level from 200 to 250 Kts (+ 0.15 - 0.25 Gx), gently pull to 250 Kts, 3000 ft/min climb. After 30 sec, push over to -1G in 3 seconds and hold 3 seconds. **RESULTS:** Eight of 15 manoeuvres produced sensations of inversion in seven of ten subjects. Two subjects reported backwards rotation of the aircraft to the inverted; one other felt a rotation of indetermined direction, four felt sudden inversion. 2/2 naive non-pilots, 5/6 pilots, and 0/2 test pilots experienced this illusion. Computation of the perceived vector will be demonstrated. Further, we will show the perceived vector, and probable pilot control inputs from contemporary orientation models. Also the possibility of reproducing the necessary conditions in a contemporary 6 degree of freedom centrifuge, e.g. Desdemona, Kraken will be discussed. **CONCLUSIONS:** The Inversion Illusion exists; not all subjects perceived it . Paradoxically, the rate of pitch may be greater at slower speeds, and large aircraft manoeuvres may induce this illusion.

Learning Objectives

1. Attendees will learn how to explore Spatial Disorientation in flight, with specific focus on an extreme form of the Somato-Gravic Illusion, the Inversion Illusion.
2. Attendees will learn that large aircraft maneuvers can impose accelerations that may induce the Somato-Gravic illusion, not just highly maneuverable small aircraft.

[54] A VECTOR ANALYSIS OF ACCELERATION EVENTS RESULTING IN SOMATOGRAVIC ILLUSIONS

Angus Rupert
U.S. Army Aeromedical Research Laboratory, Fort Novosel, AL, United States

(Education - Program/Process Review)

INTRODUCTION: The typical somatogravic (SMG) illusion associated with take-off or go-around maneuvers is accompanied by a resultant gravito-inertial force (GIF) vector that is both increasing in magnitude as well as rotating in direction from head-to-seat orientation to behind the pilot. The associated pilot perception is an increasing pitch-up, which if the pilot responds with forward stick/cyclic input, results in the positive feedback somatogravic illusion of ever-increasing pitch-up. The Atlas Air Boeing 767 mishap discussed in detail in the previous presentation was associated with a pilot unloading maneuver prior to the very strong pitch forward input from the pilot at the controls leading some perceptual modelers to question whether the unloading event possibly contributed to the initiation of the illusion. **METHODS:** Utilizing black-box data information from several transport and helicopter mishaps we have compared GIF in each category of aircraft. **RESULTS:** Several helicopter mishaps attributed to SMG illusion, based on either survivors' descriptions or voice recorder data, follow the traditional pattern of increased magnitude and rearward shifting of the GIF vector. However, we now present a confirmed helicopter SMG illusion in which the initiating event is an unloading maneuver followed by strong forward cyclic input until impact. **DISCUSSION:** The presented helicopter mishap together with the Atlas Air mishap raises the question of whether the reduced GIF may be a strong contributor to initiating the SMG illusion. Aviation mishaps are frequently associated with acceleration forces that are unable to be replicated on earth-bound acceleration devices. These mishaps contribute to our understanding of illusory mechanisms and modify our perceptual models as well as suggest further in-flight experiments to extend the envelope of perceptual modeling.

Learning Objectives

1. Understand the potential safety risk of the somatogravic illusion in commercial aircraft.
2. Understand that the somatogravic illusion may be subtle and still affect pilot control inputs in not-so-agile aircraft.

[55] CLOSED-LOOP MODELING OF THE SOMATOGRAVIC ILLUSION IN HUMAN-VEHICLE SYSTEMS

Akshay Kothakonda[1], Megan Reissman[2], Timothy Reissman[2], Torin Clark[3], Faisal Karmali[4]
[1]*Massachusetts Institute of Technology, Cambridge, MA, United States;* [2]*University of Dayton, Dayton, OH, United States;* [3]*University of Colorado, Boulder, Boulder, CO, United States;* [4]*Massachusetts Eye and Ear Infirmary, Boston, MA, United States*

(Education - Program/Process Review)

BACKGROUND: Spatial disorientation is defined by incorrect estimation of linear translation, angular rotation, and direction of gravity, posing risk to aviators and astronauts during certain maneuvers. Vestibular organs, located in the inner ear, are a key contributor to the sense of motion. An under-explored cause of spatial disorientation is the difficulty the brain faces in resolving linear accelerations from changes in direction of gravity. In this so-called somatogravic illusion, sustained linear acceleration is misinterpreted by the human controller as tilt, which is implicated in many aviation disasters. Large linear accelerations also occur in spaceflight, and additionally, astronauts may adapt to interpret gravity as linear acceleration. In order to develop countermeasures against these hazards, conditions for, and the extent of, spatial disorientation must first be investigated. **OVERVIEW:** To better understand this hazard, we are developing closed-loop human-vehicle computational models that combine models of human spatial orientation estimation, human motor control and vehicle dynamics. Spatial orientation estimation is modeled using the well-validated "Observer" model, which reproduces many of the errors that occur in human motion perception. These models are being implemented for scenarios such as a high performance aircraft departing a carrier ship using a catapult launch and performing go-around maneuvers. In the case of carrier takeoffs, these models predict that vestibular misinterpretation of large linear acceleration stimuli as pitch tilts relative to gravity results in rapid, incorrect, and dangerous pitch inputs to the vehicle. The human-estimated and actual pitch angle profiles over time under constant linear acceleration show an overall increase and decrease respectively, resulting in descending altitude, in line with known mishaps. **DISCUSSION:** To our knowledge, this is the first closed-loop model of somatogravic illusion that includes models of both the human and the aircraft, and it reproduces known behavior. We expect that these models could assist in developing training for pilots and astronauts to prevent associated mishaps, in accident investigations to explain mishaps, and in developing countermeasures, for example enhancing aircraft systems to detect incipient spatial disorientation. Future work will include incorporating the effect of visual input, and implementing vehicle dynamics associated with a lunar landing vehicle.

Learning Objectives

1. The audience will be able to understand the role of acceleration in spatial disorientation among pilots and astronauts.
2. The audience will get an insight into closed loop modeling of human-vehicle systems, in how it pertains to vestibular functioning.

Monday, 05/06/2024 ***2:00 PM***
Grand Ballroom B

[S-12]: PANEL: AEROSPACE PSYCHOLOGY

Chair: Joe Wood
Co-Chairs: John Heaton, Justin Bunn, Monica Malcein

PANEL OVERVIEW: *TITLE: Aerospace Psychology BODY: This panel presents diverse topics in mental health from clinicians at the Neuropsychiatry Branch of the Aeromedical Consultation Service (ACS). The first presentation outlines the history and evolution of United States Air Force mental health flying standards and discusses current trends. The second presentation is a retrospective epidemiological review examining 620 aviators evaluated by the ACS between January 2018 and September 2023. Next, the diagnosis of obstructive sleep apnea is discussed in detail, including concerns regarding cognitive deficits and mental health symptoms, and recommended neuropsychological evaluation characteristics are provided. Finally, guidance is given for the use of a widely used psychological measure, the Millon Clinical Multiaxial Inventory-IV, when administered in aviation evaluations.*

[56] UNITED STATES AIR FORCE MENTAL HEALTH FLYING STANDARDS: MORE EVOLUTIONARY THAN REVOLUTIONARY

Joe Wood
USAFSAM/ACS, Wright-Patterson AFB, OH, United States

(Education - Tutorial/Review)

INTRODUCTION: Mental health flying standards are designed to ensure that aviators who are selected are healthy and remain so. For flyers who do develop a mental health disorder, there is a reliable process to return to flying status. **TOPIC:** Mental health standards are crucial for both the selection and retention of aviators. They ensure that the United States Air Force (USAF) selects highly qualified candidates with less risk for developing duty-impacting psychiatric disorders than the general population. For those who do require treatment for psychiatric conditions, supporting factors for returning to flight status include completion of an empirically-based treatment program, controlled and/or resolved symptoms, low risk of recurrence, and lack of duty impairments or safety concerns. For the USAF, these standards are listed in the Medical Standards Directory, which provides standards for retention, flying classes, and special operational duty. The Aeromedical Waiver Guide (AMWG) adds guidance regarding waivers for aviators who have been diagnosed with a disqualifying condition. It includes summaries of disqualifying diagnoses, waiver potential based on historical data, and requirements for waiver submission. The AMWG, first published in 1993, and updated periodically, originally contained six remarkably concise mental health chapters, most with recommendations for six to twelve month waiting periods post-treatment prior to consideration of a flying waiver. Subsequent updates added chapters on ADHD/Learning Disorders, Eating Disorders, Somatic Symptom and Related Disorders, and Posttraumatic Stress Disorder (PTSD) and contained more delineated guidance. Significant changes occurred in 2012 with the approval of the use of select antidepressant medications while on flying status. Additionally, in the past decade there has been a notable increase in waiver recommendations for conditions, such as PTSD, that were rarely waived in the past. Current issues being discussed in this area include access to care, visibility of treatment documentation, and post-treatment waiting periods. **APPLICATION:** Gaining a historical perspective of flying standards can provide context and guidance for clinicians, flight surgeons, and policy makers considering updating the standards to better fit current preferences and needs.

Learning Objectives

1. The audience will learn about the development of mental health flying standards.
2. Participants will be able to identify recent changes in policy.

[57] UNVEILING PREVALENCE AND TRENDS IN NEUROPSYCHIATRIC CONDITIONS: A 5-YEAR EPIDEMIOLOGICAL ANALYSIS

John Heaton, Joe Wood
USAFSAM, Wright-Patterson AFB, OH, United States

(Original Research)

INTRODUCTION: The evaluation and understanding of neuropsychiatric disorders within the context of U.S. Air Force are of paramount importance to ensure the safety and well-being of USAF pilots and aircrew. In this study, we delve into a comprehensive 5-year epidemiological review conducted at the Aeromedical Consultation Service (ACS), where we assessed the prevalence and examined the evolving trends of neuropsychiatric conditions in individuals seeking a waiver to resume flying. By shedding light on the patterns and prevalence of these conditions, our study contributes to the ongoing efforts to maintain aviation safety while supporting the mental and emotional well-being of Air Force pilots and aircrew. **METHODS:** This study is a retrospective epidemiological review of data retrieved from internal medical records on 620 aviators evaluated by the Neuropsychiatry Branch at the ACS between January 2018 and September 2023 for at least one evaluation (93 individuals have 2+ evaluations). Sample includes 531 (85.65%) male and 89 (14.35%) female aviators. Age ranged from 20.05 to 60.08 years old (mean 35.75). The data reviewed consisted of ICD-10 diagnostic codes, and branch-level coding categories. Aeromedical Information Waiver Guide Tracking System (AIMWTS) was accessed to gain MAJCOM disposition (waiver outcome). **RESULTS:** The top 10 diagnoses or categories observed at ACS evaluations included obstructive sleep apnea (n=212, 34.19%), adjustment disorders (n=126, 20.32%), antidepressant use (n=104, 16.77%), mood disorders (n= 77, 12.42%), phobic and other anxiety disorders (n= 70, 11.29%), traumatic brain injury requiring neuropsychological testing (n=61, 9.84%), posttraumatic stress disorder (n=55, 8.87%), and suicidal behavior (n=32, 5.16%). Waiver rates were consistent with other studies, with 545 (87.90%) aviators receiving waivers, 56 (9.03%) disqualified, and 19 (3.06%) having other outcomes. **DISCUSSION:** The examination of disease prevalence within the population of USAF pilots and aircrew seeking waivers to return to flying status not only provides valuable insights into the health of this specific group but also plays a pivotal role in shaping aviation policies and health protection measures. By identifying prevalent conditions and trends, we can tailor policies and interventions aimed at mitigating risks associated with these disorders and maintaining the overall safety.

Learning Objectives

1. Understand the significance of evaluating neuropsychiatric disorders within the U.S. Air Force context and its direct impact on aviation safety and the well-being of pilots and aircrew.
2. Analyze the findings of a 5-year epidemiological review conducted at the Aeromedical Consultation Service (ACS) to assess the prevalence and evolving trends of neuropsychiatric conditions in individuals seeking waivers to resume flying, with a focus on the unique challenges faced by this specialized population.

[58] NEUROPSYCHOLOGICAL SCREENING IN EVALUATION OF OSA FOR FLYERS

Monica Malcein
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Tutorial/Review)

INTRODUCTION: Obstructive sleep apnea (OSA) is a condition which, if left untreated, can have significant aeromedical complications such as excessive daytime sleepiness, heart rhythm disturbances, stroke, hypertension, and cognitive changes. OSA is associated with cognitive dysfunction in the general population, with the the most widely noted deficits including reduced attention/vigilance, memory, visuospatial abilities, and executive functioning in individuals with untreated OSA. Adequate treatment of OSA does appear to improve cognitive

functioning in those who exhibit deficits, although a return to baseline is not always seen. Within the aviation environment, sleepiness, lapses in attention,or decreased executive functioning that may accompany untreated or undertreated OSA, can have significant safety implications. **TOPIC:** Given the potential for changes in cognitive functioning in individuals with OSA, neuropsychological testing is included in the evaluation for some pilots and aircrew seen at the Aeromedical Consultation Service (ACS). While the literature on cognitive dysfunction associated with OSA in the general population identifies deficits in attention/vigilance, memory, and executive functioning, little is currently known about the impact that OSA has cognitive abilities in the aviator population. It is well-established that aviators are a unique population with superior intellectual and cognitive abilities. Neuropsychological screening data from 100 USAF pilots and aircrew personnel that were seen at the ACS for evaluation with sleep medicine (to include PSG, MWT) from 2017 to 2022 were collected as part of the clinical evaluation. The neuropsychological data included measures of intellectual functioning (MAB-II), neurocognitive functioning (MicroCog), and sustained attention (CPT-II). A review of these findings, including a discussion of any change from pre- to post-test for pilots for whom baseline testing was available, relationship of OSA severity to neurocognitive findings, and contribution to aeromedical dispositions will be presented. **APPLICATION:** Neuropsychological deficits associated with OSA have the potential to negatively impact functioning in the aviation environment. This presentation will focus on the potential usefulness of neuropsychological screening in aviators as part of the overall evaluation with sleep medicine and will present findings from a series of evaluations conducted with pilots and other aircrew.

Learning Objectives

1. The audience will understand the impact of obstructive sleep apnea (OSA) on cognitive functioning.
2. The participant will have a greater understanding of assessing cognitive functioning in aviator population.
3. Learners will understand how neuropsychological screening can be implemented in the evaluation process of those with a history of OSA.

[59] PERSONALITY TURBULENCE IN AVIATORS

Justin Bunn
U.S. Air Force, Fairborn, OH, United States

(Education - Tutorial/Review)

INTRODUCTION: King (1994) retrospectively sampled 82 pilots, advanced student pilots, and other aircrew members who had completed the Millon Clinical Multiaxial Inventory (MCMI) as a part of their flight waiver evaluation with the Aeromedical Consultation Service (ACS). Findings reflected base rate elevations on multiple scales, with consideration for maladaptive personality traits, and possible personality disorder. Of note, only one individual was subsequently diagnosed with a personality disorder "not otherwise specified," after completion of a full psychiatric evaluation. This led to consideration of possible over-pathologizing personality traits in the military aviation community that could be considered adaptive in their various crew positions. Almost 30 years later, similar hypotheses were considered in utilizing the Millon Multiaxial Inventory, 4th edition (MCMI-IV) in assessing current AF pilots/aircrew at the ACS. With the possible significant negative impact on AF pilot/aircrew careers due to the potential diagnosis of a personality disorder, consideration must be given to how personality assessments are utilized and interpreted. **TOPIC:** 57 USAF pilots and aircrew with mental health diagnoses were evaluated at the ACS for waiver recommendation. At the time of clinical evaluation, the MCMI-IV was administered as a part of a battery of psychological assessments. This presentation discusses base rate elevations on multiple scales (Turbulent, Compulsive, and Histrionic) and how careful consideration should be given to understanding the personality traits and behaviors associated with these scales. Additional discussion will focus on how to utilize data most effectively from the MCMI-IV with pilots and aircrew in the aerospace environment. **APPLICATION:** This presentation explores the utilization of the MCMI-IV in the clinical evaluation of AF pilots and aircrew. Base rate elevations on specific scales were noted and considered as a part of the comprehensive mental health evaluation. Consideration of these elevations will invite discussion on the need to carefully consider the application of findings from the MCMI-IV in trained pilots and aircrew in a clinical setting. **RESOURCES:** 1. King, R.E. (1994). Assessing aviators for personality pathology with the Millon Clinical Multiaxial Inventory (MCMI). *Aviation, Space, and Environmental Medicine*, 65, 227-231.

Learning Objectives

1. Enhance understanding in utilizing the MCMI-IV in the clinical evaluation of pilots and aircrew with mental health diagnoses.
2. Discuss base rate elevations on specific scales (Turbulent, Compulsive, and Histrionic) when evaluating pilots and aircrew.
3. What to consider in utilizing data from the MCMI-IV in assessing pilots and aircrew with mental health diagnoses in the aerospace environment.

Monday, 05/06/2024 ***2:00 PM***
Grand Hall J

[S-13]: SLIDES: ANTHROPOMORPHIC MEASURES AND METHODS

Chair: Samir Alvi
Co-Chair: Douglas Hamilton

[60] ESTABLISHING BASELINE OLFACTORY PERFORMANCE IN AIRCREW PERSONNEL

Maya Avni[1], Aya Ekshtein[1], Dana Berger[1], Yuval Kozlov[2], Oded Ben-Ari[1]
[1]*Aeromedical Center, Israeli Air Force, Ramat-Gan, Israel;*
[2]*Hebrew University of Jerusalem, Jerusalem, Israel*

(Original Research)

INTRODUCTION: Changes in olfaction are correlated to various medical and cognitive conditions, hence early detection of olfactory decline may prove useful in identifying cognitive deterioration. The evaluation of the olfactory function can be carried out using validated kits. Limited literature exists on olfactory function in aircrew. This study aimed to evaluate and establish normative values of olfaction in young, healthy Israeli flight candidates and cadets. **METHODS:** Medical records of 668 (93% male) flight academy candidates and cadets who underwent routine medical exams at the Israeli Air Force Aeromedical Center (IAF AMC) were analyzed. The mean age was 18±0.6 (range 17-19). The "Burghart sniffin' sticks" Identification test (IT) was used. The IT consists of 16 pens containing various odorous substances that the subject needs to identify with an objective score of 1-16. Objective olfaction scores in addition to subjective ratings of olfaction (on a scale of 1-10), that were completed prior to the IT were collected. This study was approved by the Institutional Review Board. **RESULTS:** IT scores exhibited a normal distribution with a mean of 12.32±1.78, median of 13, and interquartile range of 3, showing no significant gender differences. Participants received 43.3% higher objective scores than subjective ratings, with no statistically significant gender difference. **DISCUSSION:** Based on our results, IT normal values for young flight candidates and cadets were established. With objective olfaction scores having a normal distribution around the mean of 12.32, 95% (2SD) of our population would fall between 8.76 and 15.88. Participants' subjective estimation of olfaction is lower than objective scores. Our subjects scored below the normative data obtained from a larger, healthy population aged 16-35 on the IT. This normative data, derived from a meta-analysis involving 1434 participants across various countries (excluding Israel), indicated a mean IT score of 13.60. This disparity may be explained by the different age ranges and by cultural customs.

Learning Objectives
1. Baseline olfactory assessment can be used to detect otolaryngological medical conditions and can also be used to detect olfactory deterioration over time, which may be related to various cognitive conditions.
2. Cultural norms can influence individuals' ability to recognize specific odors.

[61] BREATH ACOUSTIC ANALYSIS-BASED NOVEL APPROACH TO DEVELOPING A REAL-TIME SENSOR FOR HYPERCAPNIA DETECTION AND MONITORING IN EXTREME ENVIRONMENTS

Archna Bhatia, Arash Mahyari, Ian Perera, Jeffrey Phillips
Institute for Human and Machine Cognition, Pensacola, FL, United States

WITHDRAWN

[62] AEROMEDICAL SUPPORT NEEDS FOR CANADIAN OPERATIONAL MILITARY FEMALE PILOTS

Joelle Thorgrimson[1], Karen Breeck[2]
[1]*Canadian Forces Health Services, Pensacola, FL, United States;* [2]*N/A, Ottawa, ON, Canada*

(Original Research)

INTRODUCTION: Women continue to remain a minority of Canadian Armed Forces (CAF) operational pilots equalling <2% in 2000 and <6% in 2022. Limited research has been completed on the unique experiences and needs of female pilots, however, in 2000 an unpublished internal CAF study examined recruitment, retention, and aeromedical support needs for CAF operational female pilots. This study is now being repeated almost a quarter of a century later to compare the sex and gender specific aeromedical support needs of Canada's military female pilots. **METHODS:** This mixed methods epidemiological study involved semi-structured interviews with all operational female pilots. Interviews included questions from the United States Air Force Aviator Occupational Interest and Concern Questionnaire, a medical questionnaire and medical records review. A community based participatory research approach was used throughout, including several community leaders, who served as advocates and liaisons between the study population and the investigators to ensure accountability to do no harm. **RESULTS:** 50 (57%) of current CAF operational female pilots from 15 different platforms with a wide range of ranks completed interviews. Mean time in the military was 20 years with a range from 11 to 41 years. Mean total flying hour estimation was 2400 hours with a range of 500 to 8500 hours. A review of period health exams showed expected documentation of female specific medical issues, such as birth control use, menstruation history, pregnancy intention and outcomes, occurred less than 50% of the time. Standard preventative health screenings were variable ranging from 100% for breast cancer to 30% for cardiovascular screening. Common lived experience themes included concerns surrounding female specific medical care around potentially career impacting issues like pregnancy and menopause. **DISCUSSION:** This snapshot looks at women's health related medical care and documentation for CAF's female pilots suggesting there is room for improvement. Ensuring optimization of military women's health management and care will help the military to recruit and retain women in general, but military female pilots in specific.

Learning Objectives
1. Current status of health related medical and preventative care for CAF operational female pilots.
2. Community based participatory research approach in a unique aircrew community.

[63] HEIGHT AND BLOOD PRESSURE AS PREDICTORS OF G-LOC RISK IN JET PILOTS: INSIGHTS FROM THE ISRAELI AIR FORCE

Maya Harel[1], Idan Nakdimon[2], Oded Ben-Ari[3]
[1]*The Israeli Air Force Aeromedical Center, Hod Hasharon, Israel;* [2]*The Israeli Air Force Aeromedical Center, Bat Yam, Israel;* [3]*The Israeli Air Force Aeromedical Center, Or Akiva, Israel*

(Original Research)

BACKGROUND: G-induced Loss of Consciousness (G-LOC) is a major physiological challenge for jet pilots. The risk of G-LOC can be mitigated by correctly performing Anti-G Straining Maneuver (AGSM). The aim of this study was to analyze G-LOC cases in the Israeli Air Force (IAF) and identify relevant risk factors. **METHODS:** This was a case-control study that included all G-LOC cases reported in the IAF between 2015 and 2022. Different G-LOC-related parameters were investigated: G level to induce G-LOC, control over the aircraft ("holding the stick"), flying experience, height, blood pressure, incapacitation duration, and preceding symptoms. Each case was matched with a control of the same age and squadron. The Institutional Review Board approved the study. **RESULTS**: There were 15 G-LOC cases that were matched with controls. The average age was 23.4 ± 5.58 years. They were all males. The average height of subjects in the G-LOC group (183.93 cm) was significantly higher than that of the control group (177.47 cm, $p<0.001$). The systolic blood pressure in the G-LOC group (123 mmHg) was significantly lower than that of the control group (128.4 mmHg, $p = 0.03$). G levels to induce G-LOC were significantly higher in aircrew as opposed to cadets and also in subjects that were in control over the aircraft. **DISCUSSION:** The results of this study, albeit performed on a small cohort, align with results that up until now have only been shown within centrifuge studies.

Learning Objectives
1. Understand the physiological parameters correlated to higher G-LOC risk: as height and lower systolic blood pressure.
2. Learn about the effect of flight experience and the ability to control the aircraft over G-LOC risk.

[64] COMPARISON OF 3-D LASER SCANNING ANTHROPOMETRIC TECHNIQUE WITH CONVENTIONAL DIRECT METHOD FOR HEAD AND FACIAL PARAMETERS

Raghunandan Veeranna
DTE GEN Medical Services (Air), New Delhi, India

(Original Research)

INTRODUCTION: Anthropometric measurements of head and face are critical for aircrew helmet and oxygen mask design. The Indian Air Force is equipped with Laser whole-body scanner which enables capture of 3-D image of the head and face. From this 3-D image, anthropometric surface measurements of the head and face can be quantified. These parameters are smaller in magnitude and any deviation from actual measurements critically affect sizing and fitment of aircrew helmet and mask. Hence, there is a need to assess the reliability of the 3-D laser head and face anthropometry by comparing with those measured by direct method. This, in addition to performance evaluation of technical equipment, would also assist in preparation for a large-scale anthropometric survey. **METHODS**: Head and face anthropometric parameters namely, head circumference, head length, head breadth, bizygomatic breadth, nasion menton length, nasion pogonion distance, nose length, nose breadth, ear length, ear breadth and width of mouth were measured for 250 volunteers by direct manual and laser scanning method and compared using Bland-Altman analysis and mean error percentage. **RESULTS**: Using Bland-Altman analysis, the limits of agreement were calculated as mean ± 1.96*SD and expressed as a percentage of the mean manual measurement for all the 12 parameters. Only head circumference, head length, head breadth and nasion-menton length

parameters were found be comparable between the two techniques. The mean error percentage (maximum absolute error percentage) for these parameters were 1.6% (4.5%), 4.5% (12.9%), 7.2% (15.2%) and 3.4% (15.7%) respectively. **DISCUSSION**: Comparison revealed that the laser scanning method produces unreliable results for majority of head and face anthropometric parameters essential for helmet and mask design. Inaccuracy in measurement from laser scan image can be attributed to subjective difficulty and variation in identifying landmarks on the scan image for taking measurements. Considering the small measurements involved, it is recommended to use markers for head and face scanning and to conduct extensive training on identifying landmarks and measuring parameters from the scan image. Separate high resolution laser scanners may also be explored for head and face laser 3D anthropometry.

Learning Objectives

1. The participants will learn that head and face anthropometry using 3-D laser scanner can be unreliable due to subjective difficulty and variation in identifying landmarks on the 3-D head and face image generated by the scanner. Therefore, extensive training on identifying landmarks and measuring parameters is essential.
2. The participants will learn that laser scanner in head and face anthropometry is less reliable for transverse parameters like bizygomatic breadth, nose breadth, ear breadth and width of mouth and more accurate for head circumference, head length, head breadth and nasion-menton length parameters.

[65] MECHANICAL DAMAGE TO THE ANNULUS FIBROSUS FROM CYCLIC LOADING MAY TIE TO NECK AND BACK PAIN ONSET

Jack Seifert[1], Lance Frazer[2], Alok Shah[3], Dennis Maiman[3], Narayan Yoganandan[3], Keith King[4], James Sheehy[4], Glenn Paskoff[4], Daniel Nicolella[2], Timothy Bentley[5], Brian Stemper[1]
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(Original Research)

INTRODUCTION: Fighter pilots and military helicopter aircrew experience chronic neck and back pain at rates significantly higher than civilians. Their unique loading conditions, including high-G exposures and whole-body vibration, likely contribute to accelerated degenerative changes that can alter the response of the spine to external loads and contribute to spine-mediated pain. This study aimed to characterize mechanical changes to the annulus fibrosus (AF) associated with repeated loading modeling in the military aviation environment. **METHODS**: Fresh porcine AF specimens were used in this study which have been previously identified as representative of human tissue. Test specimens were harvested from the anterior superficial region of the AF and exercised in tension using a protocol that quantified pre- and post-damage stiffness and viscoelastic (i.e., time/rate dependent) properties. Tissue damage was induced using repeated subfailure tension loading with one of nine pre-defined groups with a combination of different strain magnitudes (11%,28%,44%) and cycle counts (400,1600,6400). Damage loading time ranged from 1 to 81 minutes. Following damage and post-damage material characterization, specimens were quasi-statically pulled to failure. **RESULTS**: Stiffness and viscoelasticity of AF tissues decreased significantly after damage loading for all damage groups and changes were correlated with both the magnitude of applied loading and the total number of cycles. Despite significant dose-dependent changes to the viscoelastic and elastic properties, the ultimate properties during quasistatic distraction to failure did not change. This indicates the mechanical response during low-strain magnitudes is significantly affected, but not the high-strain mechanical response. **DISCUSSION**: This study quantified changes in AF mechanics caused by tensile damage loading and found decreases in viscoelastic and elastic properties post-damage. These changes reduce the ability of the intervertebral disc to absorb energy associated with external loads and can contribute to disc laxity, which can lead to spine segmental instability. These changes can increase the loading of the surrounding apophyseal joints and may contribute to discogenic and radicular pain symptoms. These findings may partially explain a mechanism of acute flight-related pain symptoms in military aircrew, highlighting a need to reduce the magnitude of cyclic loads an AF is exposed to during flight.

Learning Objectives

1. The audience will learn how the mechanical response of the annulus fibrosus changes in response to damage caused by cyclic loading.
2. The audience will be able to understand why changes in the mechanical response of the annulus fibrosus may contribute to discogenic and radicular pain symptoms.

Monday, 05/06/2024 ***2:00 PM***
Grand Hall K

[S-14]: SLIDES: PRECISION MEDICINE INNOVATIONS FOR SPACE HEALTH, SAFETY AND PERFORMANCE

Chair: Ian Mollan
Co-Chair: Annette Sobel

[66] RELATIONSHIP MATRIX FOR 'HUMAN RESEARCH FOR CIVILIANS IN SPACEFLIGHT AND SPACE HABITATION' (HRP-C) ROADMAP

Simon Evetts[1], Bettina L Beard[2], Angie Bukley[3], George C Nield[4], Michael Schmidt[5], Annette Sobel[6]
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(Education - Tutorial/Review)

INTRODUCTION: The ability to safeguard civilians travelling to/from and spending time in Space requires an international, interdisciplinary effort to efficiently implement the necessary research and operational procedures. A venture was started in 2020 to this end to establish a Roadmap to aid coordination and optimization of precision medicine and multi-omics efforts at an international level. This presentation relates to this panel by developing an effective methodology for application of emerging precision medicine technologies and platforms. **TOPIC:** The venture, termed Human Research for Civilians in Spaceflight and Space Habitation (HRP-C), documents fields of recommended research according to currently known Space hazards and risks. The objective is to describe these fields in sufficient detail to guide international research teams and funding agencies to coordinate the necessary research to support the emerging commercial human spaceflight sector. A matrix has been designed to underpin this work which illustrates the relationships between the categories of hazards, the effects of these hazards, and the impact of the effects on health conditions and disabilities expected to be present in civilians travelling to Space. The matrix once complete will outline the necessary training, preparation, countermeasures and mitigations, where known, required to prevent or minimise such impacts. Gaps in such knowledge will be evident and facilitate future R&D efforts. The necessary information is captured according to Design Reference Missions such as LEO, cis-lunar missions, and Lunar exploration. Outline descriptions of the research study designs, methodology, appropriate platforms, data collection and analysis techniques, and the size and nature of subject populations deemed necessary

to efficiently develop effective mitigations and responses to the adverse impact of spaceflight on civilian human health, will be detailed within the roadmap. **APPLICATIONS:** The ultimate objective of the venture is to facilitate the coordination, optimization and efficiency of research across disciplines and the international human spaceflight community and aligned sectors, to map the civilian Space travellers' comprehensive response to spaceflight, provide a view into how spaceflight influences the health of Spaceflight Participants (as opposed to government astronauts), and to develop the necessary countermeasures so that civilians can travel, live, work, and thrive in Space.

Learning Objectives

1. The audience will understand general gaps in knowledge of space health and research study designs to address those gaps.
2. The audience will become familiar with an approach to relating environmental hazards to health conditions to new mitigation strategies.
3. The participant will understand new approaches to potential precision medicine applications to space medicine.

[67] BUILDING AN ASTRONAUT DIGITAL TWIN: PRACTICAL APPLICATIONS IN PRECISION MEDICINE

Caleb Schmidt[1], Michael Schmidt[1], Tom Paterson[2]
[1]*Sovaris Aerospace, Boulder, CO, United States;* [2]*Embody Biosciences, Corte Madera, CA, United States*

(Education - Tutorial/Review)

INTRODUCTION: Space exploration presents unique challenges to human physiology, necessitating innovative approaches to comprehend and mitigate the health risks and performance issues faced by astronauts. Industries such as aviation and aerospace have successfully implemented virtual digital twin models to understand the real-time performance of engineered systems. The translation of the digital twin paradigm, termed biodigital twins, into biological systems and precision medicine, has been rapidly advancing into areas such as cardiovascular and cognitive health. **TOPIC:** The core of biodigital twin modeling involves quantitatively representing homeostasis using diverse data sources, including published literature, publicly available datasets, and novel data to capture population variability. Since modeling the entire human system is of daunting complexity and, often, intractable, this is achieved by using constrained network approaches that incorporate a reduced number of inputs having the greatest effect size associated with the desired output. Modeling methods include the application of systems of nonlinear differential equations and Bayesian inference. Biodigital twin models streamline the representation of complex interactions, focusing on the relevant subset of an astronaut's molecular phenotype, physiology, behavior, and/or environment for a specific objective (e.g., mitigating issues caused by fluid shifts associated with microgravity). Sources of variation encompass genetic, molecular, physiological, lifestyle-centric, and xenobiotic and environmental factors. **APPLICATION:** The deployment and utilization of biodigital twins is twofold: one goal is to enable precise real-time predictions of health status and performance trajectory during missions. Through simulating changes in microgravity and other spaceflight-associated stimuli, biodigital twins can proactively identify potential health risks and performance issues, optimize countermeasures, and generate precision medicine intervention strategies. A second application views the digital twin through a research lens and can facilitate a unique understanding of novel datasets, uncovering novel mechanisms and patterns for iterative discovery in spaceflight.

Learning Objectives

1. The audience will understand what a biodigital twin is and how it differs from other embodiments of digital twins.
2. The audience will learn the basic underlying principles of biodigital twins, how they can represent homeostasis in biological systems, and how they capture the variability in a population.
3. The audience will learn how biodigital twin models can be deployed clinically for precision medicine applications and for research purposes in a spaceflight environment.

[68] ENHANCING EXPLORATION PLATFORMS AND ANALOG DEFINITION: A PLATFORM FOR MEDICAL DECISION-MAKING, PRECISION, AND PERSONALIZED MEDICINE

Emmanuel Urquieta[1], Jimmy Wu[1], Dorit Donoviel[1], Jennifer Fogarty[2]
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(Education - Tutorial/Review)

INTRODUCTION: The recent expansion in civilian commercial spaceflight missions brings a new and unique opportunity to understand edge cases and implement precision, and personalized medicine. A new platform has been established to collect data from these unique opportunities: Enhancing eXploration Platforms and Analog Definition (EXPAND) Program. **METHODS:** EXPAND collects biomedical data and bio-samples from commercial spaceflight participants; store the original and processed biomedical, environmental, and mission data in a robust database; and distribute the data to researchers, stakeholders, and government agencies with legitimate scientific inquires. **DISCUSSION:** EXPAND is an all-encompassing program with a biobank that stores samples as well as a space omics protocol. Assay results are stored in the EXPAND database to avoid repeated studies and maximize samples. A variety of biomedical, environmental, and mission data types are ingested. The data access and governance model allows researchers to access and visualize their data quickly and easily. EXPAND has one unified, generic institutional review board (IRB) protocol. A broad single consent form allows the future use of data and bio-samples in compliance with international privacy and medical data use laws. EXPAND has established a set of essential measures to collect data from the highest-priority human spaceflight areas. They standardize the data/biosamples collected and the hardware, training, and procedures for data collection. In the arena of space omics, the platform collects standardized preflight, in-flight, and post-flight bio samples, which include: blood, urine, saliva, fecal and body swabs for microbiome sequencing. On each sample proteomics, metabolomics, single-cell sequencing (RNAseq, Immune profiling), cfDNA sequencing, transcriptomics (RNAseq), and epigenomics are performed. Analyses also include CLIA whole genome sequencing (20X) for clinically actionable pathogenic variants, and pharmacogenomics assays which interrogate various sites in each of the 7 genes known to affect response to many common medications. Gender and age-matched controls are also enrolled to increase the scientific value further. EXPAND has already successfully collected data from Inspiration4, MS-20, Ax-1, Ax-2, and Polaris Dawn. This work is supported by the Translational Research Institute for Space Health through NASA Cooperative Agreement NNX16AO69A

Learning Objectives

1. To understand new opportunities to use medical edge cases in commercial spaceflight.
2. To understand new uses of pharmacogenomics, pathogenic variants, and deep phenotyping in commercial spaceflight for precision medicine use.

[69] ANESTHESIA IN SPACE: PHARMACOLOGY AND PHYSIOLOGY

Robert Fong
University of Chicago, Chicago, IL, United States

(Education - Tutorial/Review)

INTRODUCTION: Conducting surgical procedures in the microgravity environment of space is quite challenging and in general efforts are made to avoid having to do so. However, as the frequency, duration and application of space travel increase moving into the future, the likelihood of needing to perform such procedures, likely on an urgent or time sensitive basis, will increase in parallel. An understanding of the principles of providing safe and effective care in these constrained circumstances

will be increasingly important. Providing an anesthetic to facilitate a surgical procedure requires a customized approach that takes into consideration the individual patient and his or her underlying physiology and comorbid burden; the intensity, anatomic location and invasiveness of the planned procedure, and the preferences of the proceduralist. A variety of anesthetic approaches are available that span a range of patient consciousness and awareness as well as analgesic strategies. The anesthetist's pharmacological toolbox contains a variety of drugs that have varying effects and can be incorporated into a personalized cocktail to provide a safe and comfortable procedural experience for the patient. This discussion will provide an overview of these principles, along with a summary of the pharmacology of the most commonly used anesthetics. The unique environment associated with space travel and microgravity engenders known physiological alterations and significant technical challenges that impact the safe conduct of an anesthetic. A summary of these physiological changes will be provided, along with current thinking regarding anesthetic planning and conduct in this context. **TOPIC:** Physiologic alterations in microgravity

Anesthetic considerations in space environment

Anesthetic pharmacology

APPLICATION: Providing safe and effective procedural anesthesia in space environments

Learning Objectives

1. The participant will be able to summarize the physiologic alterations engendered by microgravity.
2. The audience will learn about the pharmacology of commonly used anesthetic agents.

[70] REGIONAL ANESTHESIA AS AN EFFECTIVE SOLUTION FOR SPACE MEDICAL PROCEDURES

Fayyaz Ahmed
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(Education - Tutorial/Review)

INTRODUCTION: The success of spaceflight missions is increasingly threatened by emergency medical situations, especially as missions venture further from terrestrial medical support. Limited attention has been given to administering safe and effective anesthesia. The likelihood of a medical condition requiring anesthesia is estimated at 2.56%. Administering general anesthesia in microgravity poses numerous logistical and physiologic challenges. However, regional anesthesia could be used to overcome many of these obstacles and provide safe anesthesia and pain relief during deep space missions. **TOPIC:** Regional Anesthesia can provide long-lasting and effective pain relief for a wide range of injuries while maintaining physiologic homeostasis. It can enable astronauts to return to their mission duties more quickly. Regional anesthetic techniques can be adapted to spaceflight with relatively few changes to existing on-Earth protocols. All associated materials for regional anesthesia are compact, highly portable, and non-combustible. Portable ultrasound technology can be used to facilitate regional, which can also provide medical diagnostics. Developing technical expertise in regional anesthesia can be achieved by mastering a limited number of blocks, with an average of 20 procedures required to reach a learning curve plateau. Reasonable upper and lower extremity analgesia could be achieved with three commonly used nerve blocks: supraclavicular, femoral, and sciatic. Trunk and hip coverage can be provided by administering peri-neuraxial or fascial plane blocks since providing neuraxial blockade is not advisable due to unpredictable drug spread. Onboard medical providers can be trained pre-mission to accomplish these technical skills, with onboard support from guidelines and AI-assisted devices like ScanNav Anatomy. **APPLICATION:** The challenge of managing emergency medical situations with anesthesia during prolonged deep space flights can be effectively addressed by relying on regional anesthesia. It is a relatively safe and effective way to manage various conditions, including burns, cellulitis, elbow/shoulder dislocations, upper and lower extremity fractures, and skin lacerations. It will provide a mental cushion for planning emergency medical needs for future missions venturing away from Earth. By mastering essential blocks and techniques, astronauts can be well-prepared to handle medical emergencies in space successfully.

Learning Objectives

1. The audience will learn about the benefits of utilizing Regional Anesthesia as a means to manage the challenges of administering anesthesia in space.
2. The audience will learn about the process of incorporating regional anesthesia tools in space missions.
3. The audience will learn about the common nerve blocks to facilitate regional anesthesia in space and the process to develop technical expertise.

[71] PHARMACOGENOMICS IN SPACEFLIGHT: A FOUNDATION OF PRECISION MEDICINE IN ASTRONAUTS

Michael Schmidt, Caleb Schmidt
Sovaris Aerospace, Boulder, CO, United States

(Education - Tutorial/Review)

INTRODUCTION: Pharmacogenomics is the study of how genes influence an individual's response to medication (gene-drug interaction). In spaceflight, pharmacogenomics is the precise analysis of gene variants that influence the regulation of drug metabolism and the attendant development of therapeutic strategies for spaceflight. Pharmacogenomics represents a technology available today to tailor drug therapy to the individual astronaut, so that the drug countermeasure optimizes the chance for benefit (efficacy), minimizes the chance for adverse events (safety), and limits adverse operational encroachment (performance). **TOPIC:** Pharmacogenomics (PGx) requires the precise molecular analysis of the individual astronaut genotypes of Phase I enzymes, such as CYP450: 1A2, 2B6, 2C9, 2C19, 2D6, 3A4, 3A5, and others. This also includes Phase II enzymes such as glucuronidases, sulfotransferases, glutathione-*S*-transferases, methyltransferases, and others. Practical examples of gene-drug interactions include how tramadol conversion to morphine in astronauts with the CYP450 2D6 ultra-rapid metabolizer phenotype can be accelerated, thus risking safety on an EVA. Astronauts on statins who possess the SLCO1B1 gene variant are at greater risk for myopathy, regardless of dose. The PGx profile allows one to characterize drugs that should be avoided due to lack of efficacy or poor safety. Amplifying the impact of gene-drug interactions in spaceflight are the convergent effects of drug-drug, drug-food, and drug-nutrient interactions. **APPLICATION:** The implication for space missions is of great practical importance today. First, precise personalized drug prescribing profiles can be designed for each astronaut. Second, a crew prescribing profile can be built for each mission, so that flight surgeons have a pre-mission prescribing repertoire from which to operate clinically. Our five-step approach can be operationalized today and scaled across any and all flight operations in any aerospace application. This warrants immediate attention because many types of adverse drug responses are predictable, repeatable, and avoidable.

Learning Objectives

1. The participant will be able to understand the basic features and limitations of pharmacogenomics in spaceflight.
2. The participant will understand a series of basic steps that must be addressed in considering the precision medicine application of pharmacogenomics governing personalization and stratification in practice.
3. The participant will understand the convergence of pharmacogenomics (gene-drug interactions) with drug-drug, drug-food, and drug-nutrient interaction.

Monday, 05/06/2024 ***2:00 PM***
Grand Hall GH

[S-15]: SLIDES: AIR TRANSPORT: TRIALS AND TRIBULATIONS

Chair: Tarek Sardana
Co-Chair: Melchor Antunano

[72] EUROPEAN AIR TRANSPORT COMMAND AND MULTINATIONAL MRTT UNIT - A NOVEL EUROPEAN COOPERATION IN THE FIELD OF STRATEGIC AEROMEDICAL EVACUATION

Martin Gascón, Adolfo Simonetti, Erwan Dulaurent, Anne Schenk, Ralph Vermeltfoort, Alessandro Fiorini, Frank Lamers, Wagner Stephan, Matthieu Gaboriaud, Mathias Borsch
European Air Transport Command, Eindhoven, Netherlands

(Original Research)

INTRODUCTION: European Air Transport Command (EATC) is an integrated command of 7 nations and among its core capabilities is that of Strategic Aeromedical Evacuation (StratAE). 6 European partners participate in the Multinational MRTT Unit (MMU), which consists of 9 A330 MRTT aircraft. One of them is utilised as an AE asset on 24-hour notice-to-move standby. The cooperation between the two entities started in June 2023. **MATERIAL AND METHODS:** The new collaboration between the two multinational entities in the field of StratAE and its impact on current procedures was analysed based on number and characteristics of patients and executed missions from July till October 2023. **RESULTS:** 7 patients were transported in 4 missions. 4 of them were from Germany and 3 from the Netherlands. Both countries belong to both EATC and MMU. Neither death nor disease contagion were reported during the AE performances. Priority 3 cases were 5, the 2 remaining were classified as Priority 2. Dependancy 2 was stated in 4 of 7 cases. Niger, Norway, Poland and Spain were the countries of origin. Patients' diseases included rectal bleeding, long QT syndrome, spontaneous pneumothorax and 2 traumatological cases. In all cases the aircraft used was the StratAE version of the Airbus A330 MRTT based in Cologne. **CONCLUSIONS:** Since the asset is Dutch, the medical crew is German and the patient can be from a different nation, cooperation between EATC and MMU represents a challenge in terms of multinational environment, language barriers and harmonization of medical equipment, among others. With seven patients transferred, it has proven to be a safe and effective means of transportation, however, there is still room for improvement regarding standardization and smoothing procedures.

Learning Objectives

1. The audience will learn about EATC and MMU as two multinational entities involved in StratAE.
2. The audience will learn about the benefits and challenges to StratAE missions resulting from the cooperation between EATC and MMU.

[73] MODELING THE IMPACT OF FLIGHT CONDITIONS ON PULMONARY FUNCTION IN TRANSPORTED CASUALTIES TO FACILITATE FUTURE UNMANNED CASEVAC SAFETY

Bria Morse[1], Michael Tibbs[1], Lonnie Petersen[1], Casper Petersen[2]
[1]*Massachusetts Institute of Technology, Boston, MA, United States;*
[2]*Harvard University, Boston, MA, United States*

(Original Research)

INTRODUCTION: It is anticipated that commanders will want to reduce the risk to personnel in future military theaters by employing unpiloted aerial vehicles (UAV) in combat zones. Evasive maneuvering required for casualty evacuation in contested environments can expose patients to flight conditions and forces that put their health at risk. Pulmonary function is highly susceptible to gravitational impact. Although it is known that hypergravity and hemorrhagic blood loss are factors that can independently lead to atelectasis, the combined and potentially synergistic impact of these two factors remains unknown. This study aimed to assess the feasibility of developing pulmonary models to identify threshold values for when hemorrhagic patients begin having difficulty tolerating gravitational G-force-related stress. **METHODS:** The study was approved by the AFRL IRB. Six healthy volunteers (two female, age 33±10 years) were placed supine inside the centrifuge. Moderate hemorrhage was simulated by -20 mmHg LBNP. Evasive maneuvers were simulated by 15-sec +4Gx acceleration in isolation and in combination with LBNP. Electrical impedance tomography (EIT) (Enlight 2100, Timpel Medical, Brazil) was used to measure changes in ventilatory distribution at the 4th and 5th intercostal spaces. **RESULTS:** LBNP alone had limited impact on air distribution within the lungs, while the +Gx-only condition contributed to a shift in ventilation towards the anterior portion of the lungs. However, the data indicate that the combination of +Gx and hemorrhage further exaggerates the lung's uneven posterior and anterior air distribution. **DISCUSSION:** The data suggests that supine exposure to +Gx elicits a disturbance in the lung's ventilation-perfusion relationship. The apparent further exacerbation of this mismatch in simulated hemorrhage conditions should be considered in future models used to create safe and robust autonomous flight-restraint systems for UAV-CASEVAC.

Learning Objectives

1. Evasive flight maneuvers (steep bank) can lead to uneven air distribution in the lungs, increasing the risk of atelectasis for patients with mild/moderate blood volume loss.
2. To aid in the initial investigation of mapping physiological data to suitable flight envelopes and trajectories.

[74] ROYAL FLYING DOCTORS SERVICE – TOWARDS 100 YEARS OF AEROMEDICAL EVACUATION AND REMOTE TELEHELTH.

Meg O'Connell
Royal Flying Doctors Service- Queensland, Cairns, Australia

(Education - Program/Process Review)

BACKGROUND: The Royal Flying Doctors Service (RFDS) is one of the world's oldest and largest aeromedical organisations, focused on aeromedical evacuation and remote telehealth. Over the past 96 years, healthcare has been delivered by necessity across extreme distances and challenging circumstances, supporting remote indigenous communities, ranger stations, isolated towns, islands, rural nurses and ships at sea. As fuel costs and pilot shortages continue to impact operations, a critical services review identified ways to pivot to augment healthcare delivery with virtual health, remote patient monitoring, telepharmacy and UAV pharmacy delivery to better deliver healthcare with less aircraft utilisation. **OVERVIEW:** This presentation aims to both highlight the important historic contributions of the RFDS to aerospace medicine, but also prepare for the future as we continue to advance our health care delivery to best meet the needs for remote and isolated patients whilst encountering aviation challenges. Pivoting from face to face, fly in, fly out healthcare delivery to a stronger focus on telehealth and virtual health has reduced costs for both patients and the organisation, and enabled more efficient healthcare delivery. A range of organisations was reviewed, including international space station healthcare operations, to identify new ways of working to employ. **DISCUSSION:** The creation of virtual clinics, virtual communities and virtual wards has allowed for multi day and planned episodes of care delivery via telehealth, and subsequently reduced the need for aeromedical evacuation in a significant cases. An organisational pivot from on demand reactive healthcare, to planned virtual proactive healthcare, is a key future focus to improving the healthcare of remote patients and reducing the need for aeromedical evacuation. Finally the difficulties of delivering this type of care in remote and resource limited settings are discussed, and how technology, like UAV is planned to be utilised to overcome these challenges.

Learning Objectives
1. Understand the operations of a large state based remote medicine service, and identify new ways of delivery healthcare to remote patients.
2. Explore virtual healthcare as a way of delivering multi-day episodes of care and preventative care to reduce cases resulting in aeromedical retrieval.
3. Understand new was of augmented healthcare delivery for an aeromedical organistion, including augmented virtual care, remote patient monitoring, telepharmacy, UAV medication delivery and virtual clinics to meet the needs of remote patients.

[75] UNITED STATES AEROMEDICAL EVACUATIONS FROM ANTARCTICA FROM 2015-2023: A RETROSPECTIVE REVIEW OF MILITATY AND CIVILIAN DATA

Jay Rathod[1], Dan O'Conor[1], James McKeith[2], Craig Nowadly[3]
[1]*Brooke Army Medical Center, San Antonio, TX, United States;* [2]*UTMB, Galveston, TX, United States;* [3]*59th Medical Wing/Brooke Army Medical Center, San Antonio, TX, United States*

(Original Research)

INTRODUCTION: While the primary mission of United States operations in Antarctica is scientific discovery, the Department of Defense (DOD) provides permanent support to the National Science Foundation (NSF) through Operational DEEP FREEZE. One of the major responsibilities of the DOD is to provide logistics and transport capability to the continent, including medical evacuation. Due to logistical challenges, an attempt to comprehensively analyze U.S. aeromedical evacuations from Antarctica, reconciling both civilian and military records across multiple deployment seasons, has not been described in the literature. **METHODS:** This study was approved by the 59th Medical Wing Institutional Review Board. De-identified aeromedical evacuation records involving a patient within/from Antarctica or labeled "Operation Deep Freeze" was obtained from the DOD TRAC2ES database. NSF records were reviewed in person by DOD medical extractors at the University of Texas Medical Branch (UTMB) Center for Polar Operations. De-identified medical data was extracted, including relevant medical history, diagnosis, medical treatments, destination, and en-route care interventions. Twenty percent of UTMB records were reviewed by both extractors for intra-rater reliability. A third extractor reconciled discrepancies as needed. **RESULTS:** 71 DOD TRAC2ES records and 93 UTMB records were included in the final analysis. A preliminary review identified a total of 129 distinct patient movements for calendar years 2015 – 2023. Only 35 records (27.1%) could be reconciled between TRAC2ES and UTMB as the same patient movement. Of the remaining patient movements, 36 were unique TRAC2ES records (27.9%), 58 were unique UTMB records (45.0%). Musculoskeletal pathology (28.9%), genitourinary/reproductive (12.5%), gastrointestinal (14.1%), cardiac (11.7%), and neurologic (9.4%) pathologies were the most common body systems requiring aeromedical evacuation. **DISCUSSION:** These results show that the NSF, DOD and, UTMB work cooperatively to safely transport patients with a wide variety of medical pathologies out of Antarctica. This project highlights the limitations of retrospective chart reviews, especially those requiring data extraction from paper charts and deidentified databases. This knowledge will facilitate immediate follow-on studies to further analyze trends of medical capabilities in Antarctica.

Learning Objectives
1. Understand the differences between DOD and NSF records from Antarctica patient movements.
2. Understanding the trends of United States aeromedical evacuations from Antarctica between 2015 and 2023.
3. Understand the limitations of a retrospective chart review and the next steps planned for data extraction involving United Sates Antarctica medical care.

[76] LESSONS LEARNED DURING A MILITARY AEROEMEDICAL EVACUTION OF A REMOTE CIVILIAN HOPSITAL THREATENED BY FOREST FIRES

Maj Laura Devlin[1], Maj Melissa Gear[2], Maj Richard Grainger[3]
[1]*Canadian Armed Forces, Trenton, ON, Canada;* [2]*Canadian Armed Forces, Winnipeg, MB, Canada;* [3]*Canadian Armed Forces, Victoria, BC, Canada*

(Education - Program/Process Review)

BACKGROUND: Summer 2023 was an unprecedented forest fire season in Canada. Mid-august, the city of Yellowknife, North West Territories, was evacuated due to fast spreading fires threatening the community. 68 inpatients remained in the local hospital, and the closest receiving facility was >1500 km by road. There was no Canadian civilian agency capable of transporting this volume of patients in a short time frame. The Canadian Government requested the assistance of the Canadian Armed Forces to evacuate by air an unknown number of inpatients > 2000 km to the city of Vancouver. **OVERVIEW:** The Canadian Forces Aeromedical Evacuation (CF AE) flight is based in Trenton, Ontario and has the mandate of providing strategic aeromedical evacuation to CAF members anywhere in the world. Care or transport of civilians is only provided if requested and approved by the Minister of National Defence. The Royal Canadian Air Force (RCAF) does not have dedicated AE aircraft and instead uses a platform of opportunity. The vastness of Canadian geography creates a tyranny of distance, and in this case, the providers and aircraft were located 5000km from the area in need. With careful but quick consideration of aircraft, crew composition and size, equipment, load plan, communication and coordination, a crew was launched for the remaining 39 patients (23 stretcher, 6 wheelchairs, 10 ambulatory). The CC177 departed CYZF with all patients less than 36 hours after the initial request was approved. **DISCUSSION:** This was the first time the RCAF and CF AE flight conducted a mass civilian hospital evacuation. Serendipitously, these groups had just participated in Mobility Guardian 2023 and had exercised some larger scale, interoperable, unregulated evacuations. Lessons learned for discussion include; importance of a liaison officer and unrestricted comms between sending, transporting and receiving facility; integration of military and civilian care teams; prolonged care requirements to include medication administration and hygiene; ramp access for medical transport and medical teams; and aircraft equipment to facilitate load plan. It is hoped that the lessons learned during this event can be of use to other organizations who may be required to preform a similar task in the future.

Learning Objectives
1. The audience will understand planning factors which are of importance during large-scale time-bound aeromedical evacuations.
2. The audience will explore the potential challenges and considerations when integrating military and civilian care teams/facilities for joint missions.

[77] UAV FOR CASUALTY TRANSPORT: QUANTIFYING REDUCTION IN G-TOLERANCE IN HEMORRHAGIC PATIENTS

Lonnie Petersen[1], Bria Morse[1], Michael Tibbs[1], Casper Petersen[2]
[1]*Massachusetts Institute of Technology, Boston, MA, United States;* [2]*Harvard University, Boston, MA, United States*

(Original Research)

INTRODUCTION: Future CASEVAC will likely include Unpiloted Aerial Vehicles (UAV) for casualty-transport (drone-ambulances) from combat-zones. Elimination of human-in-the-loop with regards to pilot and medical personnel to monitor flight-impact on patients increases the risk of inadvertent unsafe flight maneuvers. It is presumed that G-tolerance is reduced in casualty, particularly relative to blood-loss, however, we have no physiological data to quantify this reduction. We used long-arm human centrifuge to simulate evasive flight maneuvers (+Gx) and a custom-built lower body negative pressure (LBNP) device

to simulate hemorrhage in a controlled and reversible way. **METHODS:** The study was approved by the AFRL IRB. Six healthy volunteers (two female, age 33±10 years) were placed supine inside the centrifuge. Moderate hemorrhage was simulated by -20 mmHg LBNP. Evasive maneuvers were simulated by 15-sec +4Gx acceleration in isolation and in combination with LBNP. Mean arterial pressure (MAP) and stroke volume (SV) were collected using Nexfin (BMEye). Delta values were analyzed using RM-ANOVA and Šídák's multiple comparisons test. **RESULTS:** Blood pressure was not reduced by LBNP alone (DMAP= -3.4±7.4 mmHg; P=0.8). +Gx alone significantly reduced MAP (DMAP= -19.4±11.4 mmHg; P<0.0005), and when +Gx was combined with LBNP, the reduction was exacerbated (DMAP= -36.1±5.2 mmHg; P<0.0001). Thus, synergistic effect of hemorrhage and G-load significantly reduced MAP compared to either intervention in isolation, absolute value of MAP during LBNP+Gx was 58.5±24.5 mmHg. Neither LBNP nor Gx in isolation decreased SV significantly (DSV= -6.8±6.3 mL; and -8.4±11.6 mL; P>0.05), however, combined effect of LBNP+Gx significantly reduced SV (DSV= -24.2±13.0 mL; P=0.0019). Synergistic effect of hemorrhage and G-load reduced SV to an absolute value of 78.0±19.4 mL. **DISCUSSION:** These data indicate a synergistic effect between +Gx maneuvers and simulated hemorrhage which was significantly more pronounced than either intervention in isolation. Understanding and quantifying G-tolerance of casualties is critical to create safe autonomous flight-restraint systems for UAV-CASEVAC.

Learning Objectives

1. Evasive flight maneuvers (steep bank) simulated by short periods of +4Gx can lead to severe reduction in MAP in patients with mild/moderate blood volume loss.
2. Qualitative and quantitative mapping of physiology is critical to develop suitable flight envelopes and trajectories.

Monday, 05/06/2024 ***2:00 PM***
Grand Hall I

[S-16]: SLIDES: AND THE BEAT GOES ON AND ON!

Chair: Peter Lee
Co-Chairs: Eddie Davenport

[78] THE HEART OF AVIATION: A FITNESS FOR DUTY LITERATURE REVIEW AND COHORT ANALYSIS

Wiaam Elkhatib[1], Thomas Flipse[2], Leigh Speicher[2], Hanna Sledge[2], Zhuo Li[2], Shahyar Gharacholou[2]
[1]*Mayo Clinic Rochester, Rochester, MN, United States;* [2]*Mayo Clinic Jacksonville, Jacksonville, FL, United States*

(Original Research)

INTRODUCTION: The aviation environment imparts unique stressors which increase medical incapacitation risk, with metabolic and cardiovascular disease remaining a leading cause in pilots. Delineating the current status of cardiovascular health and outcomes informs screening protocols, health policy, and fitness for flight duty. Airline pilots are hypothesized to be healthier than the general population from a cardiovascular perspective due to relatively increased health screenings. **METHODS:** A literature review via Scopus, PubMed, Google Scholar, and Web of Science electronic databases through October 1st, 2023, with citation mining was conducted to assess objective cardiovascular screening outcomes and disease prevalence among aviators. An adult pilot cohort undergoing cardiac screening was also retrospectively identified via medical record review at a high-complexity referral facility between 1991 to 2023 for statistical descriptive analysis of demographics, comorbidities, screening and diagnostic tests. Of 364 pilots, 212 (193 male) met inclusion criteria. Kaplan-Meier models were generated for major adverse cardiovascular events (MACE). IRB approval was obtained. **RESULTS:** Less than 20 studies investigated objective cardiometabolic disease measures with variable parameters reported and none were found to report diverse cardiac screening test outcomes with cardiovascular events in a large cohort. The sample included majority commercial airline pilots having a mean age 59 years, median BMI of 27, comorbid hyperlipidemia (48%), hypertension (32%), cancer (27%), sleep apnea (15%), arrhythmia (12%) and coronary disease (6%). Echocardiograms (N=57) revealed valvular disease (21%) and dilated aortas (16%). Functional stress tests (N=118) showed mean aerobic capacity of 109% reaching 12 METS with <7% abnormal. Two left heart catheterizations (N=6) required percutaneous intervention. MACE incidence was 22% (15% excluding non-cardiac hospitalizations). **DISCUSSION:** Airline pilots have similar comorbid disease prevalence and cardiometabolic characteristics compared to published general population evidence including Center for Disease Control data. BMI and aortic dilatation are higher than average. Cardiovascular fitness remains favorable. Ongoing study seeks to incorporate predictive artificial intelligence and cross-matched institutional cohorts for stronger comparisons and outcome predictions.

Learning Objectives

1. The audience will learn about disease distributions and outcomes of special populations which help inform medical screening protocols, public health policy, and fitness for duty.
2. The audience will understand that pilots generally have multiple cardiovascular comorbidities with favorable cardiovascular fitness.

[79] A SINGLE HEART

Tim Sprott, Sarita Dara, Claude Preitner
Civil Aviation Authority New Zealand, Wellington, New Zealand

(Education - Case Study)

INTRODUCTION: This case report describes a commercial civilian helicopter pilot who had incidental findings that lead to a diagnosis of hypertrophic cardiomyopathy (HCM). **BACKGROUND:** HCM is a common disorder, generally agreed to be present at a rate of at least 1:500 in the general population. The clinical course of HCM is variable and there is a spectrum of low to high risk for adverse cardiac outcomes. The potential risks of aeromedical significance associated with this condition include sudden cardiac death (SCD) and ventricular arrhythmias, as well as non-sudden cardiac events such as atrial fibrillation with associated stroke risk, and syncope. For these reasons Regulators apply restrictions especially on single pilot commercial operations. **CASE PRESENTATION:** The subject pilot was a 50-yr old New Zealand asymptomatic AS 350 pilot with 5310 flying hours involved in single pilot scenic and commercial flying. A diagnosis of HCM was made in 2021 following cardiac investigations, including cardiac MRI. He was recertified with a restriction from single Class 1 (commercial) flying. In 2023 he applied for this restriction to be lifted to allow for single pilot Class 1 operations. **DISCUSSION:** The assessment of his aeromedical risk was undertaken taking his risk of SCD, as well as non-sudden cardiac events including atrial fibrillation. In this pilot's case the estimated risk of cardiac related acute medical incapacitation was about 1% or less. This presentation outlines this risk assessment process that led to the decision to lift the restriction on single pilot operations.

Learning Objectives

1. HCM may present from incidental case finding to severe symptomatic disease. The progression of HCM is highly variable as are the risks for adverse cardiac events.
2. SCD risk • Prior cardiac arrest or ventricular arrhythmias • Family history of first-degree or close relative.
3. Evaluating the risks of adverse cardiac events is challenging and well recognised with HCM. For this reason Regulators apply restrictions especially on single commercial operations. There is a subgroup of people living with HCM were the risk is at or below 1% for an adverse cardiac event. In this group this presentation outlines the rationale for considering single pilot commercial flying in this group.

[80] DILATED CARDIOMYOPATHY IN A COMMERCIAL PILOT: A CASE REPORT

Alexandra Mejía-Delgado[1], Johana Giraldo-Alzate[1], Diego García[2], Nohora Inés Rodríguez[3]
[1]*Colombia Civil Aviation Authority/National University of Colombia, Bogotá, Colombia;* [2]*National University of Colombia, Bogotá, Colombia;* [3]*The Colombian Hearth Association - Aerocivil/Civil Aviation Authority of Colombia, Bogotá, Colombia*

(Education - Case Study)

INTRODUCTION: This case study evaluates the impact of dilated cardiomyopathy (DCM) on the aeromedical fitness assessment of an airline transport pilot. Following a history of reduced ventricular function exacerbated by COVID-19 myocarditis, the pilot underwent treatment and safely resumed flying duties through an evidence-based aeromedical decision process. **BACKGROUND:** Cardiomyopathies are disorders of the heart muscle caused by dilated, hypertrophic or restrictive pathology. DCM is defined as a heterogeneous spectrum of myocardial disorders characterized by ventricular dilation and myocardial functional impairment in the absence of hypertension, valvular disease, ischemic or valvular heart disease. More commonly seen in men, prevalence is estimated at 36/100,000 cases. American consensus classifies DCM as genetic, mixed, or acquired, while Europeans group DCM as familial or non-familial. Patients have significantly increased cardiac mass with myocyte enlargement, leading to ventricular dilatation and systolic dysfunction. Diagnosis is made with 2-dimensional echocardiography. Progression and prognosis depend on ejection fraction decay and etiologic factors. Negative prognostic factors include advanced NYHA classification, male sex, severe congestive heart failure, and renal failure. **CASE PRESENTATION:** A 47-year-old male airline transport pilot with 5000 hours of flight experience, with electrophysiological evaluation within normal limits. In June 2022 was diagnosed with myocarditis related to mild COVID-19. During his medical certificate renewal, a slightly dilated left ventricle with diffuse hypokinesia and severe systolic dysfunction LVEF 38% was documented. Optimized therapy for heart failure was started with adequate response. Since September 2022 he has presented a stable improved ejection fraction >50% and he has remained asymptomatic. **DISCUSSION:** The aeromedical group of the Colombian Civil Aviation Authority assessed this case using an evidence-based approach with aeromedical risk-management tools in compliance with ICAO provisions and considerations for a special issuance with a dual-crew restriction. Semestral cardiovascular function is being closely monitored. With cardiology follow-ups including NYHA re-classification, electric instability studies, cardiac function assessments, specific biomarkers measures and continued etiological studies. This case illustrates a safe pathway to aeromedical certification for moderate heart dysfunction.

Learning Objectives

1. The audience will be able to understand how the medical advances play a role to change the aeromedical considerations about fitting to fly.
2. The audience will be able to understand the aeromedical approach and accepted risks assessments are accepted in the decision process.

[81] AN INVESTIGATION INTO THE VALIDITY OF SPORTS WEARABLES FOR HEART RATE MONITORING IN GENERAL AVIATION

Aiden Coffey[1], Pete Marston[2], Ross Pollock[1], Robert Harrison[3], Shafik Diwan[1], Samyukta Ravisankar[1], Alfred Olugbenga[1], Irene Di Guilio[1], Peter Hodkinson[1]
[1]*Kings College London, London, United Kingdom;* [2]*Martin-Baker Aircraft Company Ltd., London, United Kingdom;* [3]*Cranfield University, Cranfield, United Kingdom*

(Original Research)

INTRODUCTION: Aircrew physiological monitoring (PHYSMON) is an area of increasing interest, but published research in general aviation related to this topic is limited. This study held two aims; to describe the heart rate (HR) response of inexperienced fliers to the general aviation environment and investigate the viability of two PHYSMON technologies to measure HR accurately and reliably in general aviation (including aerobatic flight). **METHODS:** 14 subjects with <5 hrs of light aircraft flight experience were passengers during a varied flight profile, including aerobatic manoeuvres, in a T67 Firefly with a flight instructor as pilot in command. Subjects HR was measured by two independent devices; a Garmin Fenix 6 Pro smartwatch utilising photoplethysmography (PPG) and Polar H10 chest strap using electrocardiography (ECG), the latter of which being treated as the reference device. The data was synchronised against cockpit video and analysed for agreement and variance in discrete phases of flight, categorised as either aerobatic or non-aerobatic. **RESULTS:** The two devices were largely in agreement during non-aerobatic flight (bias = 0.2031 with SD = 4.234, LoA -8.501 to 8.095). In aerobatic manoeuvres, the agreement between the two devices decreased (bias = 3.364 with SD = 5.371, LoA -7.163 to 13.89). Short (<10 seconds) duration increases in HR detected by the H10 were often not detected by the Garmin watch, reflected in a higher variance in HR from the H10 during these phases of flight. **DISCUSSION:** The agreement between the H10 and Fenix 6 suggests that PPG technologies work in the assessment of heart rate during non-aerobatic flight. The increasing disparity between chest-strap and smartwatch values for HR in the aerobatic phase suggests that ECG-based devices are more appropriate for use in aerobatic flight. This study highlights the need for PHYSMON devices to be validated in the flight setting to ensure the collected data reflects the physiological reality and suggests that PPG may be unreliable for use in the dynamic flight environment of aerobatics. Alternative technologies may exist for this role that pose novel solutions.

Learning Objectives

1. The audience will learn about the difference in performance between ECG and PPG-based physiological monitoring devices when used in the dynamic flight environment.
2. The audience will learn about the heart rate response to civilian aerobatics.

[82] INTERMITTENT MONITORING OF CARDIOVASCULAR HEALTH VIA INTELLIGENT & REMOTELY OPERATED ROBOTIC CARDIAC ULTRASOUND SYSTEM FOR SUPPORTING FLIGHT SURGEONS

Amanda Spilkin[1], Ehsan Zakeri[1], Hanae Elmekki[1], Ahmed Alagha[1], Hani Sami[1], Antonella Mariel Zanuttini[2], Lyes Kadem[1], Jamal Bentahar[1], Wen-Fang Xie[1], Phillippe Pibarot[2]
[1]*Concordia University, Montreal, QC, Canada;* [2]*Quebec Heart and Lung Institute, Quebec City, QC, Canada*

(Original Research)

INTRODUCTION: Human spaceflight is associated with numerous cardiovascular risk factors. Amongst them, prolonged exposure to microgravity reduces the workload imposed on the human heart and results in long-term structural changes. With space missions growing longer and more unchartered, and limitations on physician assignment in each mission, the use of a remotely operated robotic cardiac ultrasound system (RORCUS) provides an attractive solution for adaptable monitoring of crew cardiovascular health. **METHODS:** The RORCUS was tested to perform a full cardiac ultrasound (US) procedure, scanning four main cardiac windows upon a cardiac phantom torso. The system consists of a six degrees of freedom collaborative robotic arm equipped with force sensors and an ultrasound probe attached to the robot's end-effector. The robotic system was used to build a dataset of US images across the Parasternal Long-Axis, Parasternal Short-Axis, Subcostal, and Apical4Chamber views while maintaining safe physical coupling. The dataset images were graded according to a cardiologist-approved grading scheme. The RORCUS was trained on the labeled dataset using two deep learning models (based on ResNet-18); the first one classified images into one of

the cardiac views, while the second model estimated the quality of the image. The system aids the operator in performing the cardiac US by automatic characterization of cardiac windows and providing information on the quality of the scan. **RESULTS:** Performance in US recordings was evaluated upon the ability of the RORCUS to capture the required data upon the phantom. To assist the remote sonographer, the trained model took the US images in real-time and returned the category of the cardiac windows and the image quality percentage. The deep learning models for cardiac view classification and quality estimation demonstrated effectiveness in view classification and quality assessment according to the pre-defined grading scheme. **DISCUSSION:** The results obtained with the RORCUS demonstrates the ability for a robotic system to perform a full cardiac US examination with high quality images. Flight surgeons can obtain higher quality images and more consistent data from the crew during spaceflight, which in turn, can help in general health monitoring, diagnostics and pathology evolution.

Learning Objectives

1. The participant will learn how the use of an intelligent and remotely operated ultrasound robotic system for crew's cardiovascular imaging can provide flight surgeons with the ability to monitor health and long-term impact of spaceflight on the heart.
2. The participant will learn about a new cardiologist-approved cardiac image grading scheme that can be used for evaluating ultrasound image quality and accurate capture of cardiac windows.

[83] A SHOCKING EXPERIENCE - IMPLANTABLE CARDIAC DEFIBRILLATORS AND FLYING

Anthony Hochberg
Civil Aviation Safety Authority, Sydney, Australia

(Education - Case Study)

A private pilot in late July 2022, after flying then pulling the aircraft into a hangar and while washing it, became pre-syncopal then collapsed in cardiac arrest due to ventricular fibrillation (VF). This event would have been fatal if not for prompt resuscitation by an off-duty paramedic who administered 2 shocks from an automatic external defibrillator.

Subsequent cardiac investigation did not reveal a specific cause for VF – "idiopathic" VF. When a reversible cause of VF is not found, there is high probability of recurrence with unpredictable timing. Accordingly an ICD was implanted to enable continuous automatic detection of these heart rhythms and commit as required appropriate electricaltherapy of VF and ventricular tachycardia (VT) – secondary prevention of sudden cardiac death. That therapy is intended: 1. to treat VT with anti-tachycardia pacing (ATP), thus potentially avoiding the need for shock(s) from the ICD; should the ATP regime fail or reach its programmed time-out, shock(s) will proceed 2. to treat very fast VT or VF with shock(s) In an individual with an ICD, during VT the patient will develop symptoms of the arrhythmia itself or from ATP triggered by VT, ranging from distraction at minimum to pre-syncope or syncope. VF will be completely incapacitating, causing syncope and shock delivery (itself incapacitating), not necessarily in that order. The first appropriate shock may not be effective because of the probabilistic nature of defibrillation of VF. ICD therapy has its problems. Inappropriate therapy may occur because of:

- inappropriate programming
- limitation of software algorithms which discriminate VT or VF from non-ventricular rhythms, such as atrial fibrillation (AFIB) or atrial flutter (AFLT). Mr Cochrane is at higher risk of developing AFIB or AFLT because of his past history of hypertension, mitral valve disease and its associated surgery.
- ATP can accelerate VT into VF with resultant shock delivery
- Hardware failure, for example lead failure
- Environmental electromagnetic interference, detected by the ICD as VF

This presentation reviews the annual risk of incapacitation, risk of recurrent cardiac arrest, risk of defibrillation, impact of age on risk assessment and why it makes risks higher, the impact of ICD appropriate/inappropriate and failure to shock has on flying skills and recovery time, risk to any potential co-pilot of shock and global perspective of other authorities of ICD in pilots.

Learning Objectives

1. Annual risk of incapacitation with idiopathic VF, risk of recurrent cardiac arrest, risk of ICD defibrillation.
2. Limitations ICD therapy including impact of age on risk assessment.
3. Impact of ICD appropriate/inappropriate and failure to shock on flying skills and recovery time, risk to any potential co-pilot of shock and global perspective of other authorities of ICD in pilots.

Monday, 05/06/2024 ***4:00 PM***
Grand Ballroom CD South, EF

[S-17]: PANEL: SENSORIMOTOR STRATEGIES FOR EXPLORATION SUCCESS ACROSS DIFFERENT ARTEMIS MISSION PHASES

Chair: Scott Wood
Co-Chairs: Eric Groen

PANEL OVERVIEW: *Alterations in sensorimotor processing during spaceflight can lead to motion sickness, spatial disorientation, and decrements in postural control, locomotion, and fine motor control during and following G-transitions. These adaptive changes combined with other physiological changes can have functional impacts in critical mission tasks such as manual control, capsule egress and extravehicular activities (EVA). This panel will describe the sensorimotor research strategies to accommodate the needs of the crew and effectively leverage the human capabilities to ensure mission success during planned Artemis missions. The first presentation will provide an overview of the evidence for the sensorimotor risk and research roadmap. The second presentation will provide an overview of how ground-based analog for G-transitions can be used to prepare for the mission as training and research testbeds. The third presentation will describe how research conducted during International Space Station missions will be used to explore on-board training as a potential countermeasure for manual control of lunar landings. The fourth presentation will review the development of sensorimotor assessments of crew preparedness for early EVAs. The final presentation will describe countermeasures related to spatial disorientation and motion sickness to enable successful crew recovery following return to Earth. Each presentation will include lessons learned from Apollo that can be applied as we develop new strategies for success across the various Artemis mission phases.*

[84] CHARACTERIZING THE RISK: REVIEW OF SENSORIMOTOR EVIDENCE AND RESEARCH ROADMAP

Timothy Macaulay[1], Scott Wood[2]
[1]*KBR/NASA, Houston, TX, United States;* [2]*NASA, Houston, TX, United States*

(Education - Program/Process Review)

BACKGROUND: NASA's Artemis program will take astronauts back to the lunar surface for the first time in almost 50 years. Despite the successes of the previous Apollo program, the Artemis missions will differ in duration, vehicle characteristics, and landing tasks that may exacerbate the risks to crew health/safety and mission objectives. NASA's Human Research Program identifies the risk of altered sensorimotor/vestibular function impacting critical mission tasks as one of the top priority risks to lunar exploration missions. This session will review the existing evidence and remaining gaps in knowledge for the sensorimotor risk. **OVERVIEW:** Alterations in sensorimotor processing during spaceflight can lead to motion sickness, spatial disorientation, and decrements in postural control, locomotion, and fine motor control during and following gravity-transitions. The risk of impairment is greatest during and soon after gravity-transitions, when performance

decrements may have high operational impacts (e.g., manual landings, immediate egress following landing, and early extravehicular activities (EVAs)). Recent studies have specifically improved the risk characterization of changes in perception, motion sickness, postural and locomotor control, manual control, and fine-motor coordination. However, given the difficulty in obtaining measurements during and soon after gravity-transitions, evidence for initial decrements immediately following gravity-transitions remains limited. The most significant gaps in the risk include manual control ability around gravity-transitions, the ability to perform egress/EVAs soon after gravity-transition, and motion sickness during return to Earth. To address these gaps, current research roadmaps leverage both spaceflight studies and ground-based analogs for risk characterization and countermeasure development/validation. **DISCUSSION:** This panel will further describe the current sensorimotor research strategies with an emphasis on the operational scenarios of manual control, EVA, and crew egress. The goal of this research is to accommodate the needs of the crew and facilitate human capabilities to ensure lunar mission success. This work will prepare NASA for successful Artemis missions and enable the next giant leap, the exploration of Mars.

Learning Objectives

1. The audience will learn about the research evidence informing the risk of altered sensorimotor/vestibular function impacting critical mission tasks during lunar exploration missions.
2. The audience will understand how altered sensorimotor/vestibular function impacts the specific operational scenarios of manual vehicle control, extravehicular activities, and crew egress.

[85] THE PREPARATION: GROUND-BASED G-TRANSITION ANALOG FOR TRAINING AND RESEARCH

Eric Groen
TNO, Soesterberg, Netherlands

(Education - Program/Process Review)

BACKGROUND: During spaceflight astronauts undergo transitions between different gravity (G-) environments, e.g., the transition from 1g on Earth to 0g upon entry into weightlessness, or, vice versa, from 0g to 1g upon landing. It is known that such G-transitions may cause space motion sickness, spatial disorientation and postural imbalance: symptoms which are collectively designated 'Space Adaptation Syndrome' (SAS). We have previously shown that SAS can be simulated on Earth by means of prolonged exposure to hyper-gravity in a human centrifuge. This centrifuge paradigm may be a valuable testbed and training tool in preparing astronauts for G-transitions experienced during Artemis missions. **OVERVIEW:** In that previous research program we found that astronauts experience SAS-like symptoms after being exposed to a one-hour G-stimulus of 3g in a human centrifuge. The astronauts' individual susceptibility to this so-called "Sickness Induced by Centrifugation" (SIC) strongly correlated with their susceptibility to SAS in flight. In both cases, symptoms are aggravated by head movements, which trigger nausea, postural imbalance and illusory motion of the visual surroundings. This suggests a disturbance of the central processing of vestibular signals. To test this hypothesis we performed a series of vestibular tests before and after the centrifuge run, showing significant changes in orientation responses which depend on the sense of gravity. For example, the internal reference frame of reflexive eye movements showed reduced sensitivity to head tilt. Also, susceptible subjects showed an increased asymmetry between the otolith organs in the left and right inner ear, supporting a well-known theory on space motion sickness. **DISCUSSION:** Altogether the results indicate that the transition between 3g and 1g causes vestibular re-adaptation problems which are similar to the problems induced by G-transition during spaceflight. The centrifuge paradigm may thus be an adequate way to simulate G-transitions during Artemis missions, and can also be used as training tool that allows astronauts to experience their own response to G-transitions.

Learning Objectives

1. The audience will learn about vestibular problems associated with G-transitions during space missions.
2. The audience will understand how a centrifuge capability can be used as testbed and as training tool to prepare astronauts for Artemis missions.

[86] SAFE ARRIVAL: ISS RESEARCH FOR CHARACTERIZING RISK OF MANUAL CREW OVERRIDE DURING LUNAR LANDING

Kevin Duda
Draper Laboratory, Cambridge, MA, United States

(Education - Program/Process Review)

BACKGROUND: Alterations in vestibular sensory processing due to adaptation to a microgravity environment can lead to motion sickness, spatial disorientation, and sensorimotor impairment upon return to a gravitational environment that may impact manual control proficiency. As NASA prepares to send astronauts back to the moon as part of the Artemis Program, with a potential stop at the cis-lunar Gateway, astronauts may spend several weeks in microgravity prior to descending to the lunar surface. Addressing the risk associated with sensorimotor performance, and manual control of a piloted spacecraft, following long-duration exposure to microgravity is necessary for improving the safety and likelihood of successful lunar landings in NASA's Human Landing System (HLS). **DESCRIPTION:** NASA's Human Research Program (HRP) has funded a research study to quantify the effects of microgravity on simulated lunar landing manual control performance immediately following return to the gravitational environment of Earth, as well as the effect of "just-in-time" training while onboard the International Space Station (ISS). **DISCUSSION:** This presentation will describe how research conducted during ISS missions will be used to explore on-board training as a potential countermeasure for manual control of lunar landings.

Learning Objectives

1. The audience will learn about developing a high fidelity lunar landing simulation for test and evaluation.
2. The audience will learn about performance metrics and techniques for quantifying piloting performance during simulated lunar landing.

[87] SAFE EXPLORATION: SENSORIMOTOR ASSESSMENTS FOR EARLY EXTRAVEHICULAR ACTIVITIES

Sarah Moudy
NASA JSC, Aegis Aerospace, Houston, TX, United States

(Education - Program/Process Review)

BACKGROUND: Artemis missions will require a new level of crew autonomy around periods of gravitational transition, where sensorimotor disturbances are at their highest. There is a need to define performance thresholds for key sensorimotor assessments that indicate when performance in early extravehicular activities (EVAs) might be impacted or unsafe. This panel presentation will discuss the development of sensorimotor assessments for determining crew preparedness of early EVAs by utilizing a novel portable sensorimotor disorientation analog and other spaceflight analogs. **OVERVIEW:** The assessment tasks were defined based on lessons learned from Apollo and subject matter experts (e.g., flight surgeons) to include the following: 1) mimic body maneuvers such as reaching, bending over, etc. such that crew can self-assess their potential ability to complete operational tasks; 2) provide opportunities to develop strategies to recover from off-nominal body positions; and 3) aid in progressive adaptation to the novel gravitational environment. To define performance thresholds, we proposed to validate this set of sensorimotor assessment tasks under various spaceflight analogs. A Sensorimotor Disorientation Analog (SDA) was developed that could induce varying levels of disorientation through combined vestibular and

proprioceptive disruptions. The SDA was first pilot tested using subjective feedback from previously flown astronauts to determine the levels of disorientation that mimic motor performance immediately and +24hours postflight. A second study was performed using healthy non-astronaut ground subjects to validate the SDA levels by comparing to astronaut postflight data. The validated SDA was utilized in a third study to map performance in the proposed set of sensorimotor assessment tasks to performance on operationally relevant tasks such as capsule egress. This presentation will conclude with a discussion on future validation studies of the proposed assessment tasks using other spaceflight analogs such as centrifugation and gravity offload systems. **DISCUSSION:** Exploration class missions will require crew to be able to self-assess and treat their sensorimotor dysfunction after gravity transitions, and in off-nominal situations they may be required to perform provocative, challenging tasks soon after landing. This panel presentation will discuss current and ongoing research strategies to address the sensorimotor risk on safe exploration during Artemis missions.

Learning Objectives

1. The audience will understand the sensorimotor risk for early extravehicular activities.
2. The audience will learn about a proposed set of sensorimotor assessment tasks for crew self-assessment of abilities to perform operational tasks during missions.

[88] SAFE RETURN: MITIGATING MOTION SICKNESS FOR EARTH RE-ENTRY AND CREW EGRESS

Taylor Lonner, Aaron Allred, Aadhit Gopinath, Tori Mogheim, David Temple, Torin Clark
University of Colorado-Boulder, Boulder, CO, United States

(Education - Program/Process Review)

BACKGROUND: Following sustained exposure to microgravity, astronauts have an altered interpretation of sensory cues, particularly those from the vestibular system, which is maladaptive for re-entering Earth's gravity. This typically leads to motion sickness and sensorimotor impairment, which can negatively impact operational tasks such as crew egress. During water landings on Earth, such as planned during Artemis, the sea state passive motion with restricted views of external visual references prior to recovery can exacerbate motion sickness. Fundamentally, motion sickness is thought to be produced due to sustained "sensory conflict" or differences between sensory afferent measurements and the brain's expectation of sensory measurements. Means of reducing sensory conflict by helping the brain more accurately produce expectations of sensory measurements are likely to mitigate astronaut motion sickness during re-entry. **OVERVIEW:** Here, we present evidence supporting potential countermeasures for mitigating motion sickness and sensorimotor impairment relevant for Earth re-entry. We simulated the gravity transition associated with Earth re-entry using sustained Gx centrifugation followed by passive motions mimicking sea state motion. As compared to a control condition with a fixation point, we found providing a rich scene of motion-congruent, Earth-fixed visual cues in virtual reality significantly reduced the proportion of subjects who reached sustained "moderate" motion sickness (21% vs. 67%). In addition, we have tested how providing anticipatory cues of upcoming motion could help reduce motion sickness. Further, we explored two uses of galvanic vestibular stimulation (GVS). First, by using a novel computational model to quantify how the brain processes simultaneous vestibular stimulation from physical motion and GVS current, we aimed to reduce vestibular sensory conflict. Second, to improve vestibular sensory information transfer, we assessed using noisy galvanic vestibular stimulation (nGVS) to produce stochastic resonance. We found that applying nGVS improved translational vestibular perceptual thresholds (how small of a motion can be reliably sensed) by 28+/-9%. **DISCUSSION:** Mitigating motion sickness that is expected during Earth re-entry is critical to ensure astronaut well-being and adequate performance. Approaches which aim to reduce sensory conflict provide an avenue to reduce motion sickness and operational risks during crew egress.

Learning Objectives

1. Understand the concept of "sensory conflict" and how it leads to motion sickness.
2. Understand how visual and vestibular manipulations can be used to reduce motion sickness.

Monday, 05/06/2024 ***4:00 PM***
Grand Ballroom A

[S-18]: PANEL: PILOT-PHYSICIANS; A HISTORY OF PERFORMANCE, ENDEAVORS FOR THE FUTURE

Chair: Thomas Powell
Co-Chair: Sandra Salzman

PANEL OVERVIEW: *BACKGROUND: As mankind began to take flight through various ways, medical and physiological challenges had to be overcome to accomplish the flight safely and effectively. Ever since Dr. John Jefferies piloted the first hot air balloon across the English Channel in the 1700's, individuals with both aviation and medical expertise have been instrumental in overcoming the physiological and human factors challenges presented by the aerospace environment. Now known by the moniker "Pilot-Physicians", these dual-qualified individuals represent a small but eager community who continue to help solve modern aerospace medicine issues. OVERVIEW: Here we describe the various projects, proposals, and lessons learned by Pilot-Physicians. These presentations describe new problems, solutions, techniques, and procedures that individual Pilot-Physicians are involved with and helping their respective aviation communities to overcome. DISCUSSION: The various talks contained within this panel cover a spectrum of topics which range from operational to clinical to the areas in-between. As aircraft and their missions increase in complexity, these discussions will explain how these challenges are being overcome and the way forward for future endeavors. Many of these aerospace issues are cross-service as the Pilot-Physician community labors to improve human performance within the aerospace environment.*

[89] STABILITY OF VISION AT ALTITUDE AFTER SMILE CORNEAL REFRACTIVE SURGERY

Carter Tisdale[1], Timothy Soeken[2]
[1]*U.S. Air Force, San Antonio Uniformed Services Health Education Consortium, San Antonio, TX, United States;* [2]*U.S. Air Force, Wilford Hall Ambulatory Surgical Center, San Antonio, TX, United States*

(Original Research)

INTRODUCTION: Corneal refractive surgery (CRS) has revolutionized human visual performance in a variety of professional fields, environments, and activities by taking away the patient's need for spectacle correction to see well. Photorefractive keratectomy (PRK) and laser-assisted in situ keratomileusis (LASIK), the mainstay CRS procedures for triservice military personnel over the past one to two decades, have optimized the military's deployment capabilities and operability in austere suboptimal environments. Small incision lenticule extraction (SMILE) is the newest CRS procedure to have been approved for military personnel and aviators. Many studies and case reports were published in the 1990's and early 2000's about the visual instability of radial keratotomy (RK)–the oldest CRS procedure–at high altitude conditions. These findings led to high altitude studies of PRK and LASIK patients, all of which demonstrated stable vision at various altitudes. In our study, we sought to prove the vision and corneal stability of SMILE patients

in a hypobaric environment. **METHODS:** This was a non-randomized, unmasked, prospective study of 20 active-duty military volunteers who had undergone SMILE refractive surgery for correction of near-sightedness at least 1 month prior. High- and low-contrast visual acuity, automated refraction, corneal thickness, and corneal topography were each measured at ground level and at 10,000, 15,000, 18,000, and 22,500 ft simulated altitudes in a hypobaric chamber. Subjects were permitted to utilize artificial tear lubrication throughout the chamber flight. A portable slit lamp device was used to assess the cornea's appearance at ground level and at 22,500 ft simulated altitude in all subjects. Statistical significance of the comparison between the measured variables at ground level and at the respective altitudes was assessed using the ANOVA analysis tool. **RESULTS:** In the 20 study eyes tested there were no statistically significant changes in high- or low-contrast visual acuity, refraction, average corneal power, or corneal thickness among the subjects. **DISCUSSION:** Our study suggests that visual performance remains stable at altitudes up to 22,500 feet in patients who have undergone SMILE refractive surgery. This is especially applicable to military aviators who routinely perform their duties at altitude. Time at altitude was limited, so future research may include prolonged exposure at 22,500 ft or higher.

Learning Objectives

1. The audience will learn about the history of corneal refractive surgery (CRS) procedures and patients' vision stability in abnormal environments.
2. The participant will be able to understand how the cornea–and ultimately, vision–can physiologically be altered in a hypobaric environment.

[90] NVG HIGH-SPEED, LOW-LEVEL SIMULATION FLIGHT IN A TILT-ROTOR MODEL

Ian Curry[1], Steve Gaydos[2]
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(Original Research)

INTRODUCTION: The Future Long Range Assault Aircraft platform leverages tilt-rotor (TR) technology possessing significant advances in speed, maneuverability, and range. The expanded performance envelope and capabilities of these aircraft demand careful attention to the human operator including capacity, performance, communication, workload, fatigue, and safety. Future challenging environments within large-scale combat operations will drive maneuvering altitudes lower to include contour and low-level tactics. **METHODS:** A test was conducted in the vertical motion simulator at Ames Research Center, California to assess the ability of Army pilots to conduct high speed (HS), low-level (LL) and contour flight (CF) using a TR aircraft model. Six pilots conducted more than 300 test runs over flat, rolling, and mountainous terrain at airspeeds from 120-220 knots in both day and night vision goggle (NVG) conditions. Performance was judged by two primary metrics: Time spent above the doctrinally established threshold altitude as a percentage of total time for a test run and number of ground/obstacle strikes during each run. **DISCUSSION:** Within the limited scope of this test effort, it was determined that HS (up to 220 knots), LL flight was possible in all terrain types under both day and NVG conditions. HS CF was possible in flat terrain; however, HS CF in rolling or mountainous terrain was not possible without significant risk of ground/obstacle contact or significant time spent above contour altitude. In all cases, optimal NVG conditions (full moon illumination) produced essentially the same results as day conditions.

Learning Objectives

1. Participants will broadly recognize operational advantages and disadvantages of tilt-rotor aircraft.
2. Participants will appreciate maneuvering challenges associated with low-level and contour flight under various operational conditions.

[91] SILVER LINING STUDY: MISSILEER FATIGUE MITIGATION DURING 2020 CORONAVIRUS PANDEMIC

Sandra Salzman[1], Ashley Wiser[2], Jackson Prestwood[3], Tyler Wagner[4], Megan Morris[5]
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(Original Research)

INTRODUCTION: Since inception, ICBM Missileers operate consoles on 3-day cycles:min 24-hr alert-shift/24-hr travel/24-hr off-admin, leading to concerns that health, morale, and alertness are chronically impacted. 2020 Missileer Occupational Health Assessment (OHA) revealed 76% of missileers "struggle with being rested for duty" and 29% "never feel adequately rested for duty". The COVID pandemic increased operations tempo and crew fatigue. Scheduling of underground ICBM crews has similarities to space-based duty cycles. **METHODS:** All participants, Nuclear Missile Operations Officers, were continuously evaluated qualitatively and quantitatively to ensure nuclear safety. Interventions implemented and evaluated during the 9-mo period included: environmental modifications, scheduling changes, and crew education on fatigue management, nutrition, sleep hygiene, and fitness. 341st OG examined various 3-person and 4-person shift-length and alert duration schedules first in SAFTE-FAST scheduling software and if safe, on the mission console. Psychomotor Vigilance Testing (PVT) results validated crew safety and delta between pre- and post-shift measurements. AHLTA trends were analyzed for force-health awareness. Pre- and post-study OHA results were compared. Fatigue and health-related outcomes were collected from safety monitoring efforts during standard and COVID-19 operations at 341st Missile Wing. **RESULTS:** Max safe alert-duration is 7-days due to task fatigue onset between 8-10 days. Optimal schedule is a 3-week cycle:7-day alert/7-day recovery/7-day training-admin. PVT suggested traditional 4-member and new 3-member crew shifts are safe. On this schedule, short and long-duration Duties Not to Include Flight rates decreased by 74.6% and 79.2% respectively. Alerts/month missed decreased 86% from baseline. Anxiety and chronic pain visits fell by 57% and 18% respectively. 2021 Missileer OHA found a 7% decline in members seeking separation, and a complete absence of sleep, fatigue, and physical or mental health complaints. **DISCUSSION:** Implementation of reliable schedules emphasizing protected recovery and training time were associated with significant improvements in health and retention, compared to baseline. Trialing crew ideas, with medical support and analysis, improved trust of missileers, work-life balance, schedule stability, unit cohesion, and retention. Global Strike Missile Operations Groups adjusted scheduling practices to align with these findings.

Learning Objectives

1. Consider the value of recovery time in human factor analysis to mitigate fatigue, chronic complaints resulting from shift work disorder, and lack of work-life balance that may impact retention factors.
2. Understand climate factors in proposing and implementing change in risk averse organizations.
3. Military flight medicine involves evaluating airman that operate in non-standard conditions, including subterranean, air, and space. A deep understanding of the occupational requirements both on and off duty, can help providers give impactful, data driven recommendations to patients and commanders.

[92] CASE REPORT: TREATMENT WITH TRANSCRANIAL MAGNETIC STIMULATION IN A PILOT WITH LONG-COVID SYMPTOMS AND POSTURAL ORTHOSTATIC TACHYCARDIA SYNDROME

Benjy Park[1], Joe Zhang[2]
[1]*Joint Base Langley-Eustis, Hampton, VA, United States;* [2]*Edwards AFB, CA, United States*

(Original Research)

INTRODUCTION: The association between long COVID and Postural Orthostatic Tachycardia Syndrome (POTS) is increasingly recognized in the medical literature. Less defined is the association between POTS and COVID-19 vaccination. Transcranial magnetic stimulation (TMS) treatment strategies have been observed beneficial to alleviate some of the concerns related to long COVID, however there is a paucity of data to demonstrate any viability in treatment of POTS and more specifically, in long COVID related POTS. We describe a case that attempted to use TMS on such a patient. **METHODS:** A 32-year-old USAF pilot was suffering from symptoms of cognitive difficulties such as "brain fog" and orthostatic tachycardia for two years following COVID-19 vaccination and infection. He was evaluated with a battery of high-performance athletic training cognitive tests, then treated with 10 sessions of Electro-Magnetic Brain Pulse (EMBP®) which is a personalized TMS protocol guided by the patient's Electro Encephalograph (EEG). In addition, he also received rounds of peripheral magnetic nerve stimulation over the Vagus nerve. **RESULTS:** After treatment series, the high-performance athletic training cognitive tests demonstrated a 15% overall increase in his total score. The patient reported that his symptoms of "brain fogging" was subjectively improved by 50%. Post treatment EEG also showed an improved synchronized alpha wave pattern during the resting state. Unfortunately, the POTS symptoms did not respond to any of the treatments. **DISCUSSION:** Brain stimulation techniques appear to show early signs of success with long COVID cognitive symptoms. This is the first case describing use of TMS and peripheral magnetic nerve stimulation in an attempt to treat COVID related POTS. While some cognitive symptoms showed subjective improvement, tachycardia symptoms did not seem to respond and warrants further research. The human performance and cognitive measures may be especially important for combat aviators who have a much higher cognitive demand than the normal population.

Learning Objectives

1. Gain an understanding of the challenges quantifying Long COVID.
2. Gain an understanding of new developments in treating Long COVID.
3. Gain an understanding of new performance techniques to measure human performance.

[93] AIR FORCE SPECIAL OPERATIONS COMMAND SPECIAL OPERATIONS FLIGHT MEDICAL ELEMENT REORGANIZATION

Christopher Backus
Air Force Special Operations Command, Hurlburt Field, FL, United States

(Education - Program/Process Review)

BACKGROUND: Some United States Air Force (USAF) Flight Surgeons (FS) operated in teams called Squadron Medical Elements (SMEs), assigned to flying squadrons and commanded by aviators. Specially trained SMEs in Air Force Special Operations Command (AFSOC) were Special Operations Flight Medical Elements (SOFMEs). Since 2001, AFSOC adapted to counter terrorism. Afghanistan was a significant area of responsibility and withdrawal led to reevaluation of the resulting organization, within a setting of change throughout the US Military Health System (MHS) as the Defense Health Agency (DHA) centralized control and the USAF reorganized to support operational medicine. **OVERVIEW:** Prior to the withdrawal, SOFMEs were centralized in a Special Operations Support Squadron (SOSS). The senior FS scheduled training and deployments. A pool of SOFME flight surgeons rotated duties, shared information, and trained together. However, SOFMEs were not connected with a flying squadron nor commanded by individual squadron commanders, but by a SOSS commander. After withdrawal, command of SOFMEs was decentralized with one in each flying squadron. This allowed the SOFME to focus on the unique aeromedical challenges of each airframe and mission. However, decentralization created challenges with scheduling of training and deployments. Decentralization threatened the role of the senior SOFME FS. Meanwhile, centralization of control with the DHA threatened to disrupt the connection between the Wing Commander and the MTF Commander. This connection was traditionally a strength. So, an ideal solution to the problems of decentralizing SOFME flight surgeons would strengthen the connection between the Wing Commander and the MTF Commander. To address challenges, medical leaders created a new job, Special Operations Wing Surgeon (SOW/SG). Discussion of whether to appoint the MTF Commander as SOW/SG and task the senior FS as deputy or the reverse was pending, but the solution was designed to get benefits from decentralization while retaining benefits of centralized physician oversight, all while strengthening connection between Wing and MTF. **DISCUSSION:** Centralized vs decentralized control is a consistent theme and this case demonstrated one approach to gaining benefits of each while illustrating the unique organization of AFSOC flight medicine. Balance between line command and medical oversight was another common issue in military medicine demonstrated by this program review.

Learning Objectives

1. The participant will gain an overview of the USAF SME structure and the specialized AFSOC SOFME organization.
2. The audience will understand advantages and disadvantages to centralization vs decentralization of AFSOC SOFME teams.

Monday, 05/06/2024 ***4:00 PM***
Grand Ballroom B

[S-19]: PANEL: UPDATING ATTENTION-DEFICIT/ HYPERACTIVITY DISORDER MEDICAL CERTIFICATION POLICY

Chair: Randy Georgemiller

PANEL OVERVIEW: *Attention-Deficit/Hyperactivity Disorder (ADHD) is a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development. The nature of the neurocognitive and behavioral symptoms associated with ADHD are medically disqualifying and pose a significant aviation safety risk. Aviation fatalities have been associated with the condition (Laukkala, et al., 2017). Multiple factors have increased the burden for the FAA in making medical certification decisions for ADHD to include historically cursory diagnostic workups for the condition (Bruchmuller, et al., 2012), the surging number of cases in our society potentially tied to drug seeking for performance enhancement in occupational and academic settings, and the labor intensity of the review itself for FAA Medical Review Officers and specialists. Internal data also confirms the rise in the number of case reviews at the FAA. The FAA policy for ADHD entailed extensive neuropsychological evaluation for at least the last 10 years. A recent review of the literature related to ADHD, canvassing aviation medical policy from non-FAA agencies, and consultation with internal and external medical, behavioral health, and neurological professionals led to an updated ADHD policy consisting of dual tracks for those diagnosed with ADHD for which record review and interview would suffice in specified cases compared to those requiring neuropsychological assessment. The streamlined protocol was associated with delineating those ADHD applicants posing a lower versus higher aviation safety risk and apply an appropriate level of assessment and review. Details of the FAA ADHD Fast Track/Standard Track will be reviewed along with a Fast Track case example which does not require the administration of standardized neuropsychological measures.*

[94] UNDERSTANDING FAA ADHD POLICY CHANGES

Judith Frazier
FAA, Washington, DC, United States

(Education - Program/Process Review)

BACKGROUND: Policy changes in ADHD reflect knowledge, experience, disease pathology or change in standards of care. This presentation will inform aerospace medicine personnel on the history of ADHD policy changes and documentation tools for the new ADHD pathway. **OVERVIEW:** The ADHD working group identified what information was needed to evaluate a pilot/ATCS who reports ADHD or use of ADHD medication. The condition was stratified into risk "rows of severity". This approach identified subset of pilots/ATCS unlikely to be of aeromedical risk and may not require testing. The community provider is guided to answer specific questions related to safety and the AME or FAA review to make the certification decision. Policy documents were created to help external providers understand what the FAA requires. The tools also streamline the workflow within the FAA by putting the relevant questions in the same place and instructing the provider how we need the information displayed to make a certification/clearance decision. The policy progression is a result of expertise in the subject coupled with creation of tools useful for case processing. **DISCUSSION:** ADHD is a high-volume condition for the FAA. It is identified in students who have been on medication since childhood and adults taking medication as a performance enhancer. It appeared in the AME Guide in 2004 (listed as Attention Deficit Disorder) and required FAA Decision. The original ADHD/ADD Protocol (published in March, 2013) required a full neuropsychological battery on all pilots with ADHD. This protocol was revised in 2018 to allow for a shortened "core" test battery and supplemental battery when indicated. In either case, extensive review was required by AAM and testing was required by almost all applicants. The recent policy changes streamline the evaluation process to advance aerospace medicine by accurately testing those who need testing, not requiring testing from those who do not, and standardizing the way cases are reviewed for consistency.

Learning Objectives

1. The audience will be able to identify the changes made to the ADHD policy.
2. The audience will earn how the FAA uses the FAS TRACK FAA ADHD summary to review cases.
3. The audience will be able to identify the current AME actions.

[95] EXPANDED PATHWAYS FOR CLEARING ADHD CASES

Joyce Fowler
Fielding Graduate Institute (now University), Santa Barbara, CA, United States

(Education - Tutorial/Review)

INTRODUCTION: ADHD is a disqualifying diagnosis. The FAA ADHD workgroup, in consultation with external experts in the field, developed new AME Guidelines providing clearer guidance and expanded the pathways for ADHD evaluations. Informed by updated practices, the guidelines: leverage skill sets, improves review time, reduce cost & time for some applicants, adapts to the increasing number of cases, and expands the pool of initial evaluators. **TOPIC:** This presentation will delineate the two updated FAA ADHD Pathways and referral patterns for expedited processing. The Fast Track pathway assesses for the presence or absence of ADHD. The ADHD Standard Track meets FAA ADHD specifications for neuropsychological evaluation for more complex cases. **APPLICATION:** The new Fast Track pathway with an expanded pool of initial evaluators and virtual interview options saves time, money, and resources for a select group of airmen. Established criteria for airmen without symptoms, medication usage, other comorbid psychiatric conditions, and stable functioning allows for a more streamlined approach to assessment. A comprehensive airmen checklist provides explicit guidance empowering the airman to facilitate expediency. Referral patterns allow for more flexibility and increase access for airmen. A standardized protocol including review of required records and clinical interviews provides the bases for community-based assessments by psychologists and neuropsychologist with expertise in ADHD. Referrals for Standard Track assessments by FAA HIMS trained neuropsychologists for cases that do not meet established Fast Track criteria remains in place. **RESOURCES:** Federal Aviation Administration, Guide for Aviation Medical Examiners https://www.faa.gov/ame_guide/dec_cons/disease_prot/adhd

Learning Objectives

1. The participants will be able to delineate criteria for two pathways for evaluating for ADHD.
2. The participants will understand referral pathways to help expedite case processing.
3. The participants will understand records requirements for processing cases.

[96] INPUT FROM NON-FAA REGULATORY ENTITIES

Forest Pavel
University of Missouri-Kansas City, Kansas City, MO, United States

(Education - Program/Process Review)

EDUCATION: INPUT FROM NON-FAA REGULATORY ENTITIES

BACKGROUND: ADHD is a disqualifying diagnosis, yet it is increasingly diagnosed within the current aviation population, and among those seeking initial certification. The FAA ADHD workgroup, in consultation with external experts in the field, developed new AME Guidelines providing clearer guidance and expanded the pathways for ADHD evaluations. As part of the decision-making process, the FAA ADHD workgroup reviewed guidelines from multiple non-FAA entities, both military and civilian, as part of their decision-making process. **OVERVIEW:** This presentation will examine the differences and similarities between multiple non-FAA regulatory entities. Current aeromedical guidelines from the United States Army (Aeromedical Policy Letters), Navy (Aeromedical Reference and Waiver Guide), Air Force (Aerospace Medicine Waiver Guide/Air Force Waiver Guide), and Australian Civil Aviation Safety Authority (CASA) Clinical Practice Guidelines will be explained. Information regarding how those entities view ADHD from an aerospace safety perspective will be highlighted. Clinical evaluation and waiver processes from those entities will also be reviewed to ascertain how they differ from current FAA guidelines. **DISCUSSION:** When engaging in a regulatory change process, informed decision-making is key when working from an aeromedical safety perspective. As airspace is a shared environment it is important to review, compare, and contrast the policies of those who operate within it. Aviators in both the military and civilian sectors operate within the same National Airspace, yet among four separate regulatory bodies each treat evaluation and decision-making for waiver/special issuance for ADHD differently. The Australian CASA regulations were also reviewed in order to examine how a comparable civilian agency evaluates ADHD amongst its aviator population. Information gleaned factored into the creation of a new standardized FAA protocol which seeks to streamline the process for a select group of airmen who qualify for the ADHD Fast Track pathway.

Learning Objectives

1. The participant will recognize that aviation regulatory agencies apply medical standards differently among their aviators despite sharing the same airspace, leading to individuals being variously medically eligible or ineligible dependent upon which regulatory body they fall under.
2. The participant will be able to understand differing standards for ADHD evaluation within US militaries and Australian Civil Aviation Safety Authority.

[97] ADHD AS A MEDICALLY DISQUALIFYING CONDITION

Randy Georgemiller
FAA, Washington, DC, United States

(Education - Program/Process Review)

BACKGROUND: For more than two decades the FAA has deferred medical certification for the presence of Attention Deficit Disorder now categorized as Attention-Deficit/Hyperactivity Disorder (ADHD). When the presence of the condition is confirmed, it is medically disqualifying. **DESCRIPTION**: ADHD is a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development. A disorder typically diagnosed in childhood, symptoms may persist into adulthood and adversely affect social, academic, and occupational functioning. Associated neuropsychological symptoms impact a broad range of cognitive domains, all of which pose potential risks to aviation safety. While causation cannot be assumed, nonetheless, ADHD associated aviation fatalities have been documented based on case study and analyses of National Transportation and Safety Board (NTSB) data. **DISCUSSION**: Multiple factors associated with ADHD present significant challenges for aviation medical certification decisions. The limited diagnostic workup of many ADHD cases poses a challenge for medical review officers who are tasked with determining the authenticity of the diagnosis based on record review. Given the short-term performance enhancement which can be realized in occupational and academic settings with the use of psychostimulants, the diagnosis has been inappropriately applied to those driven by medication seeking. Medical certification decisions are further complicated by the frequent comorbidity of ADHD with other mental conditions which are potentially disqualifying. Given symptom overlap with other developmental disorders such as Autism Spectrum Disorder and Specific Learning Disorders, determining aviation safety risk is particularly challenging. Chronologically, FAA ADHD-related applications showed an approximately 33% increase over a five-year period and in 2023 the estimated number of cases is just under 2,500. Given the above factors, case review for medical certification is labor intensive relying on the expertise of FAA Medical Review Officers, Neuropsychologists, Psychiatrists, and Neurologists.

Learning Objectives

1. The participant will be able to describe three ADHD symptoms that pose an aviation safety risk.
2. The participant will be able to list ADHD comorbid conditions which are aeromedically disqualifying.
3. The participant will be able to identify factors that limit the ability to accurately identify a history of ADHD.

[98] ADHD DIAGNOSED IN AN ADULT AND RELEVANCE TO THE FAST TRACK PATHWAY

Robert Mapou
Oceanside Neuropsychology, Rehoboth Beach, DE, United States

(Education - Case Study)

INTRODUCTION: This case study illustrates an incorrect adult ADHD diagnosis due to inadequate record review and not considering contributing stressors. **BACKGROUND:** Proper adult ADHD diagnosis requires interviews; a detailed developmental history based on interviews and record review, review of symptom onset and possible contributing factors, and ratings of current symptoms (e.g., Barkley et al., 2008; Mapou, 2023). Until recently, FAA applicants with ADHD required neurocognitive screening, with additional testing for deficits identified on screening. For the Fast Track pathway, an interview and record review may suffice. **CASE PRESENTATION:** A 52-year-old former USAF enlisted officer was diagnosed with ADHD at age 40. However, evaluations by a psychiatric nurse practitioner, a psychologist a psychiatrist, and a PCP relied on self-report only. While the nurse practitioner and psychologist noted stresses related to deployment, anxiety, sleep deprivation, and promotion to a position with more responsibility, ADHD was diagnosed as the cause of the patient's attention problems. He was treated with medication but experienced side effects after being switched from bupropion to psychostimulant medication. He continued treatment as a civilian. Medical records confirmed the cursory evaluations. The psychiatrist had written "No h/o developmental problems." consistent with current self-report. Academic records from several colleges showed strong grades before and during treatment. The patient had advanced quickly before being treated. Performance ratings and commendations showed no problems both before and during treatment. Rating scales completed by the patient and his wife showed a few symptoms of ADHD but not enough to diagnose ADHD. The summary CogScreen score was outside the normal range, due to three Low Average scores and one Below Average score. The profile showed a tradeoff of speed for accuracy. Neuropsychological screening with supplementary measures of mental math and visuospatial skills, however, showed strong skills. Personality testing showed no concerns. **DISCUSSION:** This case, judged appropriate for the Fast Track Pathway, illustrates the importance of never considering self-report alone when diagnosing ADHD, reviewing records that provide objective information, and thoroughly considering other causes of new-onset attention symptoms in an adult.

Learning Objectives

1. Understand how ADHD may be incorrectly diagnosed based on self-report only.
2. Understand how the FAA Fast Track Pathway provides a way to determine medical certification eligbility based on a record review and interview.

Monday, 05/06/2024 ***4:00 PM***
Grand Hall J

[S-20]: SLIDES: RETURNING TO FLIGHT DUTY

Chair: Tarek Sardana
Co-Chair: Denise Baisden

[99] RETURN TO OPERATIONAL SEARCH AND RESCUE DUTIES POST TOTAL HIP ARTHROPLASTY

Maj Melissa Gear[1], Col Max Talbot[2]
[1]*Canadian Armed Forces, Winnipeg, MB, Canada;* [2]*Canadian Armed Forces, Montreal, QC, Canada*

(Education - Case Study)

INTRODUCTION: This case report describes a military Search and Rescue Technician (SAR Tech) who required a total hip arthroplasty (THA) and the following risk assessment to allow return to operational duties. **BACKGROUND:** Royal Canadian Air Force aircrew occasionally return to aircrew duties following a total hip arthroplasty, but a structured approach to evaluate the operational risk of post-procedure periprosthetic fractures and hip dislocations has not been well established. Newly available nomograms, which can provide individualized 5-year risk forecasts, combined with aeromedical risk matrices provide a better starting point to evaluate individual aircrew risk. SAR Techs are a subset of aircrew who are required to preform a variety of demanding physical tasks which requires a detailed assessment of risk for return to operational activities. **CASE PRESENTATION:** The subject was a > 40-year-old experienced Royal Canadian Air Force Search and Rescue Technician with > 2200 total flying hours over multiple platforms, and 88 total dive hours who suffered hip injury from a fall from height in 2016. Despite rapid development of post-traumatic arthritis, they managed to continue operational SAR duties with conservative treatment until their function had deteriorated with increase pain and frequent locking episodes in 2018. After excellent response to corticosteroid injection, they had a brief return to operations until an eventual THA (uncemented porcelain on polyethylene via posterolateral approach) in 2020. After 18 months of rehab and excellent recovery, the member was cleared to gradually return to training duties which were well tolerated. Two full

years post procedure, the SAR Tech was cleared to return to operational duties with the exception of operational parachuting. **DISCUSSION:** It is not advised to return to full military aircrew duties in the year following a THA as this period has the highest rate of complications, and aircrew are required to rehabilitate back to a level of fitness required for operational standards. Combining nomograms with aeromedical risk matrices provides solid assessment foundation, but this case highlights the limitations in deducing operational risk in complex cases or operational environments.

Learning Objectives

1. The audience will understand ways to combine available clinical nomograms with aeromedical risk matrices to more precisely determine operational risk in return to duty after joint arthroplasty.
2. The audience will explore the limitations in application of calculated risk assessments to complex aircrew tasks or environments.

[100] FROM GROUND TO CLOUD: STREAMLINING AEROMEDICAL EVALUATIONS WITH CLINICAL DECISION SUPPORT INNOVATIONS

Barrett Campbell
U.S. Army Medical Center of Excellence, Fort Novosel, AL, United States

(Education - Program/Process Review)

BACKGROUND: Flight physicals are essential to ensure the health and safety of pilots and crew, providing a comprehensive evaluation of an individual's fitness to fly. With the rapid advancements in medical technology and the increasing complexity of aerospace medicine, there is a growing need for a standardized, evidence-based approach to conducting flight physicals and analyzing the population data they contain. AsMA attendees will benefit from understanding the importance of implementing clinical decision support (CDS) systems in this context, especially as the demand for streamlined and accurate flight physical evaluations continues to rise. **OVERVIEW:** Clinical decision support systems offer a robust solution to enhance the quality and consistency of flight physicals. Implementing CDS tools for flight physical evaluations involves integrating electronic health records with real-time, evidence-based guidelines and recommendations specific to aerospace medicine. This presentation will discuss the development of a CDS framework tailored for flight physicals, detailing its design, functionalities, and the challenges faced during its implementation. The system's primary aim is to assist medical professionals in making informed decisions by providing them with relevant data, predictive analytics, and best practice guidelines during the evaluation process. **DISCUSSION:** Understanding the current state of electronic health record technology allows accurate and complete gap assessments. Implementing CDS can revolutionize the approach of aerospace medical professionals. By providing consistent and up-to-date information, system implementation ensures that evaluations are thorough, accurate, and aligned with the latest medical research. The integration of CDS not only streamlines the process but also elevates the standard of care in aeromedicine. By relying on evidence-based recommendations, medical professionals can make better-informed decisions directly impacting human performance. A unified CDS framework for flight physicals leverages medical ontology for versatile and adaptable implementation across various international, military, and civilian sectors. Its universal design promotes collaboration and knowledge sharing, fostering a more unified approach to aerospace medicine worldwide. Further, CDS implementation facilitates a structured approach to data analysis, adjusting medical practice to provide a balanced risk approach.

Learning Objectives

1. Recognize the significance of standardized, evidence-based flight physicals and the role of clinical decision support (CDS) systems in enhancing the quality and consistency of evaluations in aerospace medicine.
2. Appreciate the potential of a unified CDS framework in promoting collaboration, knowledge-sharing, and a balanced risk approach in aeromedicine across international, military, and civilian sectors.

[101] REVISITING MIGRAINE

Sarita Dara, Claude Preitner, Sprott Tim
Civil Aviation Authority of New Zealand, Wellington, New Zealand

(Education - Program/Process Review)

BACKGROUND: Migraine is a common medical condition in applicants for initial pilot medical certification. In view of the unpredictability of its occurrence and potential for incapacitation, it is assessed as a condition of aeromedical significance. Civil Aviation Authority New Zealand (CAA NZ) medical standards have considered the various factors such as nature of migraine and aura, medications use as well as recurrence free interval for certification of initial class 1 and 2 applicants. However, it is noted that policy from other regulators such as US Federal Aviaiton Authority (FAA) and Civil Aviaiton Authority United Kingdom (CAA UK) show a variation in the approach and variable recurrence free interval for migraine prior to certification. **OVERVIEW:** A literature review was undertaken to review the current evidence base, aeromedical certification approach and consideration for cases of headaches and migraine in various countries. Also, a review of cases of headache and migraine in the CAA NZ medical database over a two-year period of time was undertaken. Only cases processed through the flexibility pathway at the central medical unit were included in the final analysis. Certification approach and considerations were compared and analyzed. Analysis of NZ CAA certification data helped to understand the considerations for certification in the local context and enabled a review of the migraine free observation period for certification. An algorithm for assessment of headache is proposed for aeromedical certification of applicants with migraine/migraine like conditions. **DISCUSSION:** A history of headaches that is diagnosed as migraine either by treating general practitioner or by specialist physician is relevant for pilot applicants, in view of the potential implications for flight safety. Migraine assessment involves a multidimensional review of the various symptoms, signs as well as treatment. The proposed algorithm includes the relevant factors that will aid aeromedical decision making for both Medical Examiners and Regulators.

Learning Objectives

1. Learn about Migraine and comparative analysis of aeromedical standards in different countries for headaches/migraine.
2. Learn about the factors influencing certification decision for migraine in CAA NZ.

[102] CHOROIDAL OSTEOMA IN A COMMERCIAL AVIATION PILOT: CASE REPORT

Daniela Castro Quiroga[1], Miguel Fernando Caro Sepulveda[1], Armando Rafael Martinez Medrano[1], Alexandra Mejía Delgado[2], Johana Giraldo Alzate[2], Diego García Morales[1]
[1]*Universidad Nacional de Colombia, Bogota, Colombia;* [2]*Colombian Civil Aviation Authority, Bogota, Colombia*

(Education - Case Study)

INTRODUCTION: This case describes the pathway of an active commercial airline pilot to get a special issuance, due to a progressive visual field deterioration in his left eye caused by a choroidal osteoma. **BACKGROUND:** Choroidal osteoma (CO) is a benign tumor of the choroid with calcifying characteristics, caused by thinning of the retinal pigment epithelium. It produces progressive deterioration in the visual acuity, leading to monocularity. Although monocularity could compromise the capacity of the pilot to maneuver an aircraft as stereopsis and a portion of the visual field are lost, there are monocular cues and other operational techniques that can be learned to enhance depthness perception and visual scanning to ensure safe operations.**CASE PRESENTATION:** This is a 48 years old pilot, with dyslipidemia treated with atorvastatin, bladder biopsy negative for malignancy and family history of acute myocardial infarction and dyslipidemia. He flies an Airbus A320 and has 25 years of experience. Since 2016, he has been facing gradual deterioration in his left eye visual field. CO was diagnosed via ocular ultrasound. Later, in 2018, choroidal neovascularization was detected with an optical coherence tomography,

which has been treated with intravitreal anti-vascular agents (30 doses so far). He continued his duty as a pilot until 2022 when his medical certification was postponed to be evaluated by the Colombian Aviation Authority (CAA) due to low vision and central field alteration. **DISCUSSION:** CO causes progressive reduction in visual acuity and field, but a special issuance is possible with certain restrictions. The visual system gives up to 80% of the flight-related information. Stereopsis is the primary binocular cue, so monocular pilots need a minimum of 6 months of training to perform safe flight operations. Also, visual acuity and remaining visual field of the unaffected eye are important for aeromedical decision-making, which should be accompanied by performance evaluations such as a medical flight test. To our knowledge this is the first report of a commercial aviation pilot with CO receiving a special issuance. We provide a comprehensive performance-based approach informed by clinical assessment of a pilot with monocular low vision toward aeromedical certification.

Learning Objectives

1. The audience will learn what the CAA considered regarding clinical conditions and operational experience in a case of a pilot with choroidal osteoma with gradual vision loss and his return to flight duties.
2. Provide a comprehensive performance-based approach informed by clinical assessment of a pilot with monocular low vision toward aeromedical certification.
3. The audience will learn how a medical flight test was carried out in a flight simulator in order to evaluate his visual capacities.

[103] EDUCATION CASE STUDY: STROKE IN A FIGHTER AND AIRLINE TRANSPORT PILOT

Joseph Connolly
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Case Study)

INTRODUCTION: This case report describes a pilot who experienced a posterior circulation ischemic stroke. **BACKGROUND:** Ischemic stroke (IS) risk factors of hypertension, diabetes, smoking, dyslipidemia, and obesity are not typically present in USAF aircrew who have IS. Cryptogenic stroke and embolic stroke of undetermined source (ESUS) are the frequent diagnoses after stroke workup. Undiagnosed atrial fibrillation is a concern with cryptogenic stoke or ESUS. Patient foramen ovale (PFO) and cervical artery dissection (carotid/vertebral) are commonly identified causes of IS and TIA in USAF aviators. PFO closure has atrial fibrillation as the most common complication. **CASE PRESENTATION:** A 49 y/o pilot after an 8-hour drive, became dysarthric while eating pizza with their family. The pilot was rushed by their family to the ER, where they were able to walk in. The pilot was noted to have acute dizziness, dysarthria, dysphagia, diaphoresis, and a left facial droop. CT imaging demonstrated a perfusion deficit/occlusion of the proximal P2 segment of the right posterior cerebral artery, right occipital lobe ischemia, and occlusion of the right superior cerebellar artery. Fifty minutes after the onset of dysarthria they received tPA. The stroke work up included CTA head and neck, rhythm monitoring, hypercoagulable work-up, and echocardiogram revealed a right to left intra-atrial shunt at rest. Five months post-stroke the PFO was closed, one month later they had syncope and atrial flutter, 7 months later they had radiofrequency catheter ablation of the caco-tricuspid isthmus, 10 & 11 months later they had episodes of symptomatic atrial fibrillation, 5 months later they were treated with radiofrequency catheter ablation of pulmonary veins (PVAI) and posterior left atrial wall. **DISCUSSION:** This case highlights appropriate work-up for stroke in the young (SITY). RoPE and CHA_2DS_2VASc Scores will be discussed. This case demonstrates complications of PFO closure and etiological diagnostic ambiguity. Finally, USAF Aeromedical waiver recommendation utilizing the USAFSAM AMRAAM will be discussed, and outcome of FAA medical certification will be mentioned.

Learning Objectives

1. The participant will learn about the appropriate work of Stroke in the Young (SITY) in a patient without the usual cerebrovascular risk factors.
2. The participant will know the most common adverse effect of PFO closure.
3. The participant will consider the aeromedical issues in an aviator who has recovered from a stroke, who has a PFO, who has undergone a PFO closure, who had atrial arrhythmias, and has undergone treatment of atrial arrhythmias.

[104] ASTHMA WAIVER POLICY OF THE ISRAELI AIR FORCE

Mor Rittblat, Oded Ben-Ari, Aya Ekshtein, Amir Bar Shai
Israel Air Force Aero Medical Center, Tel Hasomer, Israel

(Original Research)

INTRODUCTION: In the Israeli Air Force (IAF), as in many air forces around the world, individuals with asthma are not eligible for flight academy. However, waiver is considered when asthma onset manifests during or subsequent to the successful completion of flight academy training. The potential risks associated with asthma among aircrew hinge on the assumption that asthma compromises pulmonary function and may lead to sudden incapacitation under extreme conditions, such as high acceleration (G) and hypoxia. The aim of this study was to collect long term data from asthmatic aircrew and to inspect the validity of the current IAF asthma waiver policy. **METHODS:** This was a retrospective cohort study analyzing data from medical records of all active and reserve asthmatic aircrew, who underwent annual medical screening in the IAF Aero Medical Center (AMC) between 2008 and 2022. Data collected included demographic characteristics, flight platform, role in the aircraft, age at onset, treatment, and pulmonary function tests (PFT). **RESULTS:** A total of 30 subjects with a diagnosis of asthma met the inclusion criteria. There was a male predominance (90%). Average age at diagnosis was 32.39±7.66 years. Maximal follow up period was 14 years. High performance (jet) aircrew accounted for almost half (46.66%) of the subject. The majority (66.66%) were treated with inhaled bronchodilators. The average ratio of the forced expiratory volume in the first one second to the forced vital capacity of the lungs (FEV1/FVC) was 74.02% with a minimum of 65%. **DISCUSSION:** Albeit a limited cohort, the results of this study suggest that asthmatic aircrew present stable PFT's over a long follow up period with no medical or flight safety issues. Hence, the current asthma waiver policy of the IAF, which permits jet pilots to fly under chronic inhaled bronchodilators treatment, seems reasonable.

Learning Objectives

1. Pulmonary function tests of asthmatic aircrew remain stable over a long follow up period.
2. Jet pilots under chronic treatment of inhaled bronchodilators perform well with no documented safety events.

Monday, 05/06/2024 ***4:00 PM***
Grand Hall K

[S-21]: SLIDES: BIOMETRICS AND DATABASES FOR SPACE FLIGHT

Chair: Jennifer Fogarty
Co-Chair: Mary Van Baalen

[105] THE NASA OPEN SCIENCE DATA REPOSITORY: BIOMEDICAL DATA, ANALYSIS TOOLS, AND INFORMATIC COLLABORATIONS

Ryan T. Scott[1], Danielle K. Lopez[1], Amanda Saravia-Butler[1], Lauren M. Sanders[2], Samrawit G. Gebre[3], Sylvain V. Costes[3]
[1]*NASA Ames, Space Biosciences Division; KBR, Moffett Field, CA, United States;* [2]*NASA Ames, Space Biosciences Division; BMSIS, Moffett Field, CA, United States;* [3]*NASA Ames, Space Biosciences Division, Moffett Field, CA, United States*

WITHDRAWN

[106] CHANGES IN BLOOD GLUCOSE USING A CONTINUOUS GLUCOSE MONITOR AND BIOMONITORING PARAMETERS OVER THE COURSE OF PARABOLIC AND SUBORBITAL FLIGHT

Dr. Shawna Pandya[1], Yvette Gonzalez[2], Aaron Persad[3], Dr. Jason Reimuller[4], Kellie Gerardi[5]
[1]*International Institute for Astronautical Sciences, Sherwood Park, AB, Canada;* [2]*International Institute for Astronautical Sciences, Berlin, Germany;* [3]*International Institute for Astronautical Sciences, Princess Ann, MD, United States;* [4]*International Institute for Astronautical Sciences, Boulder, CO, United States;* [5]*International Institute for Astronautical Sciences, Jupiter, FL, United States*

WITHDRAWN

[107] MAPPING THE UTILITY OF RADIOGRAPHY AND ULTRASOUND FOR THE NASA IMPACT CONDITIONS LIST

Michael Pohlen[1], Michael Boyle[2], Prashant Parmar[3], Kris Lehnhardt[4], Benjamin Easter[4]
[1]*Stanford University, Palo Alto, CA, United States;* [2]*N/A, San Francisco, CA, United States;* [3]*UTMB, Galveston, TX, United States;* [4]*IPA - NASA JSC, Houston, TX, United States*

(Original Research)

INTRODUCTION: Imaging is central to modern diagnostics, yet to date only ultrasound has been utilized in spaceflight. Advancing the level of care on exploration-class missions and permanent off-world habitats will likely require advanced imaging capabilities to reduce medical risk. The NASA IMPACT tool suite was designed for exploration-class mission probabilistic risk assessment and trade space analysis. Its associated IMPACT Condition List (ICL) includes 120 inflight medical conditions of high concern as established by flight and terrestrial data as well as expert opinion. This study evaluated the clinical utility of ultrasound (US) and radiography (XR) for the diagnosis and management of each of the ICL conditions to identify the conditions for which XR would add value. **METHODS:** For each condition, two reviewers performed a rapid systematic literature review of professional society guidelines and applied subject matter expertise and clinical experience to semi-quantitatively score the utility of US and XR for both diagnosis and management. Diagnostic utility of a modality for a condition was evaluated for the most common clinical presentation(s) of said condition as well as the worst-case scenario and its sequelae as defined by the ICL. Evidence tracing and quality of evidence scores were also recorded. **RESULTS:** Of the 120 ICL conditions, XR diagnostic utility surpasses that of US for 14 (12%) and provides complementary capabilities for an additional 29 conditions (24%). For condition management, XR utility surpasses US for 13 conditions (13%) and provides complementary capabilities for an additional 16 conditions (13%). **DISCUSSION:** Radiography provides diagnostic and management capabilities that surpass or complement ultrasound for over one third of medical conditions of greatest concern on exploration class missions. Specifically, XR provides superior diagnostic ability for conditions involving bony injuries, particularly to the axial skeleton, dental conditions, and certain diseases of the lung parenchyma, among others. It provides superior capability for management of conditions requiring orthopedic reductions, endotracheal tube placement, and drain placement confirmation. This analysis suggests future exploration class missions may consider augmenting the medical system with portable radiography if resource constraints allow, and future work should attempt to quantify the risk reduction provided by this capability.

Learning Objectives

1. Understand the overall degree of utility of imaging in diagnosis and management of the conditions on the IMPACT conditions list.
2. Understand the medical conditions of highest concern on exploration class missions for which radiography provides complementary or superior capabilities compared to ultrasound.

[108] AN ORION MEDICAL KIT SYSTEM OVERVIEW: STARTING POINT TO THE ARTEMIS MISSIONS

Christopher Haas
NASA, Houston, TX, United States

(Education - Program/Process Review)

BACKGROUND: The Orion Medical Kit System has been designed to provide the base medical functionality for the multi-purpose crew vehicle for up to a 21-day orbital mission. The medical system design was derived from a combination of probabilistic risk assessment tool analysis, NASA subject matter expert review, application of the NASA Spaceflight Human System Standard for Crew Health, and an understanding of the initial mission sets for the Artemis Missions. The ultimate design of the Orion Medical System was also strongly influenced by mass and volume considerations. Thus, the selection of diagnostic capabilities was also driven by the mass and volume footprint of available devices and whether they could be integrated into the vehicle data systems. In this presentation, a high-level description of the selected medical diagnostic and treatment capabilities will be reviewed. Lessons learned from designing the system will be highlighted along with considerations for how the Orion Medical Kit System will need to evolve for Gateway and the lunar exploration components of Artemis. Finally, considerations for future exploration vehicle medical system design and integration will be highlighted.

Learning Objectives

1. The participant will be able to describe the main factors that went into the design of the Orion Medical Kit System.
2. The participant will learn the major components as well as high-level diagnostic and treatment capabilities of the Orion Medical Kit System.
3. The participant will be able to identify challenges to spacecraft medical system design and possible methods for addressing these challenges early on in program development.

[109] SEVEN DAYS OF WHOLE-BODY UNLOADING USING A MG ANALOGUE INDUCES MUSCLE LOSS AS WELL AS REDUCTIONS IN BOTH MUSCLE PROTEIN SYNTHESIS AND BREAKDOWN

Stephen Harridge[1], Tess Morris-Paterson[1], Eleanor Jones[2], Owen Carmichael[3], David Green[4], Zudin Puthucheary[5], Jess Cegeilski[6], Dan Wilkinson[6], Ken Smith[6], Ivana Rosenzweig[1], Atherton Philip[6]
[1]*King's College London, London, United Kingdom;* [2]*University of Nottingham, Nottingham, United Kingdom;* [3]*Pennington Biomedical Research Center, Baton Rouge, LA, United States;* [4]*European Space Agency, Cologne, Germany;* [5]*Queen Mary's University London, London, United Kingdom;* [6]*University of Nottingham, Nottingham, United Kingdom*

(Original Research)

INTRODUCTION: Muscle mass is maintained through a balance between muscle protein synthesis (MPS) and breakdown (MPB). The loss of skeletal mass is one of the major challenges of prolonged exposure to micro-gravity (μG). The present study utilised two tracer approaches with the aim of investigating the effects of 7-days of whole body unloading using a novel ground-based μG analogue on muscle loss and rates of MPS and MPB in young healthy males. **METHODS:** Twelve healthy male subjects (27.3±4.2 years) completed the study. Six weeks prior to unloading each subject underwent a one-week control period. For the unloading intervention period the subjects were asked to lie supine on a hyper buoyancy floatation bed (HBF) for 7 days. For a maximum of 15 mins per day, they were off the HBF (for personal hygiene etc) and were fed a controlled diet during both the control and intervention periods. The deuterium oxide (D_2O) tracer technique with analysis of muscle biopsies taken from the quadriceps was used to study changes in MPS (n=10) over the control and unloading periods. The 3-methylhistidine (3-MH) technique was used to measure MPB (n=12) across the whole body and changes in muscle mass of the upper part of the lower limb were measured using Magnetic Resonance Imaging (n=12). **RESULTS:** Muscle mass of the upper leg was reduced by 3.4% (10.4±1.8 vs 10.0±1.8 kg; p<0.01,

mean±SD; paired t-test) after the unloading period. MPS (expressed as myofibrillar fractional synthetic rate) was significantly lower after the unloading compared to the control period (1.21±0.18 vs1.41±0.21%•d^{-1}; $p<0.01$). The rate of MPB was also significantly lower for the unloading period compared to the control period (0.043±0.031 vs 0.062±0.23 h^{-1}; $p<0.05$). **DISCUSSION:** The finding that unloading induced a reduction in muscle mass and MPS is not unexpected in the light of results from previous studies. However, the observation that MPB was also reduced is a novel observation which provides new insights into the processes driving unloading-induced muscle atrophy in healthy humans.

Learning Objectives

1. The audience will learn about the effects of micro gravity and unloading on human skeletal muscle mass.
2. The audience will learn about the use of tracer techniques to measure rates of muscle protein synthesis and breakdown in humans.
3. The audience will learn that 7 days of whole body unloading, which induces a loss of muscle mass, is accompanied by a reduction in muscle protein synthesis and also, somewhat surprisingly, by a reduction in muscle protein breakdown.

[110] THE EFFECT OF 60-MINUTE HEAD-DOWN TILT ON THE CROSS-SECTIONAL AREA OF THE INTERNAL JUGULAR VEIN

Syeda Yasmin Zaman[1], Matteo Fois[2], Stefania Scarsoglio[2], Luca Ridolfi[2], Ana Diaz-Artiles[1]

[1]*Texas A&M University, College Station, TX, United States;* [2]*Politecnico di Torino, Turin, Italy*

(Original Research)

INTRODUCTION: Exposure to weightlessness causes a headward fluid shift that may alter venous hemodynamics, compromising internal jugular vein (IJV) flow and possibly leading to partial or complete thrombosis. To better understand the early response of the IJV to headward fluid shift, this study aims to characterize the cross-sectional area of the IJV (A_{IJV}) during 60 minutes of exposure to 6° head-down tilt (HDT). **METHODS:** Twelve subjects (6F/6M, 25.8 ± 3.8 years old) were exposed to 60 minutes of 6° HDT using a tilt table. Measurements of the A_{IJV} (left and right side) were collected using ultrasound at the start (i.e., 5 minutes into) and end of exposure. In addition, mean arterial pressure (MAP), heart rate (HR), and cardiac output (CO) were also collected using Finapres NOVA (MAP and HR) and Innocor (CO) devices. Immediately before the tilt test, baseline data were also collected at 80° head-up tilt (HUT). Data at the start and end of the tilt test were analyzed using a paired t-test (one-sided). Data are presented as mean ± standard deviation. **RESULTS**: At 80° HUT, A_{IJV} = 4.5 ± 6.1 mm^2 (left and right side averaged), MAP = 82.4 ± 13.4 mmHg, CO = 3.7 ± 1.1 l/min, and HR = 100.8 ± 14.3 bpm. During the 60 minutes of 6° HDT, the A_{IJV} significantly increased from 57.7 ± 31.5 to 83.6 ± 33.1 mm^2 ($t(11)=5.5$, $p<0.001$), MAP significantly increased from 74.3 ± 12.1 to 81.9 ± 11.6 mmHg ($t(11)=4.7$, $p<0.001$), and CO significantly increased from 4.8 ± 1.4 to 5.7 ± 1.2 l/min ($t(11)=2.1$, $p=0.028$). HR did not significantly change ($HR_{initial}$ = 74.8 ± 14.0 bpm, HR_{end} = 73.4 ± 10.3 bpm, $p=0.23$). **DISCUSSION:** The responses of the A_{IJV} were characterized during early exposure to headward fluid shift, showing a steady increase during this time frame. MAP and CO were found to increase while HR remained stable. As commercial spaceflight operates within similar short-term timelines, these results provide a better understanding of early hemodynamic responses and contribute towards the protection of humans in these microgravity environments. These results can also inform the development of future countermeasures.

Learning Objectives

1. The audience will learn about headward fluid shift and how it affects the internal jugular vein.
2. The audience will learn about how acute exposures to ground-based analogues of weightlessness elicit hemodynamic responses.

Monday, 05/06/2024 ***4:00 PM***
Grand Hall GH

[S-22]: PANEL: UPDATES IN OPERATIONAL VISION RESEARCH

Chair: Adam Preston
Co-Chair: Micah Kinney

PANEL OVERVIEW: *Aircrew rely heavily on their visual system to maintain situational awareness and aircraft control during critical phases of flight and operational events. This panel will discuss updates in a range of operational vision research topics to include aviator eye tracking and machine learning, color vision, and the development of a virtual-reality (VR) based laser dazzle training. Presentation (1) will open with a discussion on the development of a deep learning eye tracking model capable of identifying suboptimal scan patterns in real time in pilots flying a Texan T6A flight simulator. Presentation (2) will discuss findings that suggest clinical electrodiagnostic measures suggest adaptive changes in color vision performance with color-correcting lens wear. Presentation (3) will discuss color vision impacts of a recently available FAA-approved commercial laser eye protection spectacle developed in partnership with the Department of Defense. Presentation (4) will discuss color vision discrimination modeling based on psychophysical research on aircrew laser eye protection and clinical color vision tests. Presentation (5) will discuss the development of a VR-based laser dazzle and aftereffects simulator that can be incorporated into existing and future flight simulators for training, education, and response development.*

[111] REAL-TIME DETECTION OF SUBOPTIMAL SCAN PATTERNS USING DEEP LEARNING

Lucas Haberkamp, Roy Allen Hoffman, Michael Reddix, Stephanie Warner

Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States

(Original Research)

INTRODUCTION: A growing body of research focused on aviator scan patterns suggests that 'normal' scanning behavior is context dependent. Scanning strategies are influenced by the phase of flight, environmental conditions, and individual variability. Suboptimal visual scanning can negatively impact an aviator's situational awareness and pose risks to flight safety. To address this concern, we present a cutting-edge solution: a deep learning model that considers the broader flight context to detect suboptimal scan patterns. **METHODS:** Fourteen aviators completed two flights in visual meteorological conditions using a Texan T6A flight simulator. The flight phases included takeoff, heading and altitude changes, constant rate turns, and landing. We simultaneously collected flight state variables and eye-tracking data to extract gaze transition entropy (GTE), fixation rate, and out-of-the cockpit proportional dwell time. We pretrained a recurrent neural network to generate predictions for gaze metrics and flight state variables conditioned on 25 seconds of historical data. After manual annotations of normal versus anomalous scanning, we fine-tuned our model to classify anomalous gaze behavior using each aviator's first flight for training and the second flight for validation. We analyzed the performance of our deep learning model using precision and recall, common classification metrics for evaluating false positives and negatives. **RESULTS:** Precision was 1.0 and recall was 0.96 for both GTE and fixation rate. For out-the-cockpit proportional dwell time, the precision was 0.98 and recall was 0.94. The model demonstrated contextual awareness. For example, low GTE (predictable scanning) while on glide slope were correctly flagged as anomalous compared to similar GTE values that were deemed 'normal' during final approach. **DISCUSSION:** Our results underscore the deep learning model's ability to discern flight scenario-specific norms. A limitation of our study was the small dataset.

Utilizing a larger dataset has the potential to boost classification performance further. Future research exploring alternative neural network architectures and data streams may yield improved results and enable monitoring of additional physiological responses. Overall, our deep learning approach provides a framework for automatically detecting suboptimal scanning behavior and holds the potential for enhancing aviator training techniques and in-flight physiological monitoring systems.

Learning Objectives

1. Discuss a novel deep learning framework for detecting suboptimal scanning behavior.
2. Provide insights into how aviator training techniques and in-flight physiological monitoring systems can benefit from incorporating deep learning.

[112] VEP METRICS OF COLOR CORRECTING LENSES (CCL): A RANDOMIZED CLINICAL TRIAL

Erica Poole, Jeff Rabin
University of the Incarnate Word, San Antonio, TX, United States

(Original Research)

INTRODUCTION: Color vision deficiency (CVD) can reduce performance and delay response time in cue-limited settings. Hereditary congenital CVD is regarded as non-progressive and predicated on a shift in red (L) or green (M) cone sensitivity or the absence of either cone. Our purpose is to describe objective improvement in CVD performance wearing CCLs (www.enchroma.com) as well as potential for neuro-adaptive change. **METHODS:** 20 CVDs (3 female, 17 male, 8 protan, 12 deutan) provided written informed consent in accord with our IRB-approved protocol (randomized, double-blind, placebo-controlled crossover clinical trial, clinicaltrials.gov/study/NCT05463016). CVD was confirmed by Ishihara and anomaloscope testing. Subjects wore either CCLs or neutral lenses (same luminance transmission equally across spectrum, ND) for 7 days, tracking daily indoor and outdoor wearing time and then crossed over to the lenses not worn in the first session. Cone-specific visual evoked potentials (VEP) were recorded on the first and last days of each 7-day session with and without the assigned filter (4 data sets per subject). Data were distributed normally. Repeated-measures ANOVA with post-hoc t-tests were used for analyses (Bonferroni correction). **RESULTS:** On day 1 mean VEP amplitude for the defective cone type (DC) was significantly higher with CCLs (7.4 μV) vs. without CCLs (4.5 μV; mean improvement 2.9 μV or 65%, 95% CI 1.2 - 4.5, $P = 0.003$, n=19). Mean DC VEP latency was shorter with CCLs (40.6 msec.) vs. without (47.5) but neither this immediate effect nor VEP changes (on day 1 vs. day 7 of CCL wear) achieved significance. In contrast to CCL wear, there were no immediate or 7-day effects of ND lenses on VEP amplitude or latency ($P > .65$). **DISCUSSION:** Initial results from the first randomized clinical trial of CCLs showed 65% improvement in cone-specific VEP amplitude with a latency trend but no definitive evidence of neuro-adaptive change over a 7-day period. Since the CCLs were prototypes that have since been improved offering greater light transmission and enhanced CVD performance based on initial testing, it is conceivable that the new lenses, and further analysis of the myriad data collected in our clinical trial, will reveal both immediate and longer-term neuro-adaptive improvements in CVD.

Learning Objectives

1. The audience will learn about Visually Evoked Potentials and how they differ in Color Vision Deficient vice Color Normal subjects.
2. The participants will be able to understand the importance of cone-specific testing for indentifying type and severity of Color Vision Deficiency.

[113] HUMAN FACTORS EVALUATION OF LASER EYE PROTECTION SPECTACLES FOR CIVIL AVIATION

David Newton[1], Ted Mofle[2], Peter Hu[2]
[1]*FAA, Oklahoma City, OK, United States;*
[2]*Cherokee Nation 3-S, Oklahoma City, OK, United States*

(Original Research)

INTRODUCTION: Laser strikes pose a direct threat to aviation safety and air traffic coordination. They can cause a variety of negative physiological and psychological effects on pilots, including glare, flash blindness, afterimages, and startle. Laser eye protection (LEP) spectacles are designed to mitigate these effects by attenuating the light emitted by handheld lasers. While LEP spectacles are effective in mitigating the impacts of laser strikes on pilots, psychophysical assessments reveal that the attenuating properties of the lenses can alter color perception. As such, wearing the LEP spectacles may impact pilots' ability to use color-coded information and maintain awareness of critical visual information during flight. **METHODS:** Fourteen Instrument-Rated pilots with normal color vision completed flights with LEP spectacles in a variety of flight environments in a fixed-base flight simulator. During the flights, objective measures of pilot performance were taken and compared to baseline flights where LEP spectacles were not worn. Additionally, participants completed questionnaires and interviews to provide subjective feedback on use of the LEP spectacles. **RESULTS:** Wearing LEP spectacles largely did not affect pilots' ability to follow navigational and flight guidance information, perceive and comprehend color-coded alphanumeric information during flight, or detect and respond to system malfunctions. Questionnaire and interview responses from pilot participants revealed that the LEP spectacles were compatible with displays, controls, and instruments inside the aircraft, and do not substantially hinder visibility of environmental features such as airfield lighting. **DISCUSSION:** LEP spectacles—a promising tool for reducing the risks associated with laser strikes—are likely compatible with the civil aviation flight deck and associated pilot duties. Yet, there are opportunities to increase awareness of LEP technology among the pilot community and develop recommendations for their use during flight. Increased use and acceptance of LEP spectacles, combined with an established framework for their use, could potentially reduce the risks of laser strikes to flight safety.

Learning Objectives

1. The perceptual effects of wearing LEP spectacles likely does not translate to operationally-significant effects on performance for pilots with normal color vision.
2. It is likely that pilots' ability to perform normal pilot duties is not negatively impacted when wearing LEP spectacles.

[114] A METHOD FOR MODELING FM-100 HUE DATA THAT ENABLES CLINICAL AND APPLIED LABORATORIES TO ESTMATE CLASSIC WAVELENGTH DISCRIMINATION

Vincent Billock[1], Adam Preston[2], Michael Reddix[2]
[1]*Leidos, Inc. at Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States;* [2]*Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States*

(Original Research)

INTRODUCTION: Although rigorous studies of color discrimination are based on bipartite monochromatic stimuli, few laboratories are so equipped. Most clinical and applied laboratories employ the Farnsworth-Munsell 100 hue test, a cap arrangement task that uses many pigmented broad-spectral desaturated stimuli. Our laboratory – which employs the FM-100 to study color vision of subjects wearing laser eye protection – sought to bridge this gap between monochromatic and broadband wavelength discrimination. **METHODS:** Experimental work was approved by the NAMRU-D IRB. 20 color normal subjects were measured using the FM-100 hue arrangement test, which uses pigments of roughly equal

subjective desaturation. The cap dominant wavelengths are known and colorimetric purity was computed from the dominant wavelength and CIE coordinates of each cap. The FM-100 hue data were transformed into an equivalent wavelength discrimination function (spanning 445-633 nm) by compensating for the known (Tyndall) effects of colorimetric purity on discrimination. We averaged the results for the 20 normal observers and fit the data with the Boynton (1979) model for wavelength discrimination. For comparison we generated an average observer for monochromatic stimuli by averaging 9 observers from 4 laboratories that used monochromatic stimuli. **RESULTS:** After compensating for the Tyndall effect, the FM-100 hue test is capable of resolving wavelength discriminations equivalent to those produced for monochromatic stimuli. Moreover, the average purity-compensated FM-100 hue wavelength discrimination function closely resembles the average observer wavelength discrimination function that we curated from the literature. **DISCUSSION:** The purity-compensated FM-100 hue wavelength discrimination function allows any clinical or applied laboratory to study wavelength discrimination in its original context and to use the models developed for classic wavelength discrimination. The next step for our laboratory will be to apply this to wavelength discrimination for normal and anomalous trichromats wearing laser eye protection.

Learning Objectives

1. Understand that desirable but difficult to measure experimental data (wavelength discrimination) can be obtained from a widely available test (FM 100 Hue), by incorporating an additional experimental finding (he Tyndall effect).
2. Understand that transforming FM 100 hue results into wavelength discrimination makes it possible for clinical and applied laboratories to use models of wavelength discrimination developed for monochromatic data and to compare data taken by different means.

[115] SIMULATION OF LASER DAZZLE AND LASER EYE PROTECTION EFFECTS IN VIRTUAL REALITY

Wesley Kinerk, Julie Lovell, Lyndsey Ferris
Air Force Research Laboratory, Joint Base San Antonio-Fort Sam, Houston, TX, United States

(Original Research)

INTRODUCTION: The widespread availability and increasing power of hand-held lasers has driven a rise in the threat of vision effects, including temporary effects such dazzle (i.e. glare) and afterimages. For example, there were 9,457 aircraft illumination events reported to the U.S. Federal Aviation Agency in 2022. The 711th Human Performance Wing's Bioeffects Division has created a simulation of transitory laser effects on vision in virtual reality (VR), to include dazzle and afterimages and is also simulating laser eye protection (LEP) effects such as shifts in color vision perception (both before and after adaptation by the human visual system) and the mitigation of dazzle effects when viewed through appropriate LEP. **METHODS:** An experiment with 16 participants was performed under Air Force Research Laboratory Institutional Review Board protocol FWR 20230100H comparing the outcomes of an orientation discrimination task (Landolt Cs) conducted in VR with the results of a similar task performed in the presence of real laser dazzle with a 532 nm (green) wavelength. The independent variables included laser irradiance at the observer, background luminance, and eccentricity of the target relative to the laser source. **RESULTS:** The technical limitations of currently available VR headsets make it necessary to create image adjustments to compensate for the headset's inability to replicate high irradiance and high background luminance levels. After making those adjustments, the extent of the visual field obscured by the VR laser dazzle effect generally correlated well with that obscured by real laser dazzle with the highest amount of variation in data explained at the 6 cd/m^2 background luminance (r^2=0.99), followed by the 100 cd/m^2 background (r^2=0.90), and the 1000 cd/m^2 background (r^2=0.76). **DISCUSSION:** The overall goal of this effort is to create validated laser dazzle and LEP effects packages that can be incorporated into existing and future VR flight simulators. These implementations will enable training, education, and development of tactics in response to laser exposures that are difficult or impractical to accomplish with physical lasers and live training.

Learning Objectives

1. The audience will learn about the potential applications of simulating realistic laser dazzle in extended reality training and education environments.
2. The audience will learn about the technological challenges and limitations of simulating laser dazzle as well as possible future directions for this area of investigation.

Monday, 05/06/2024 ***4:00 PM***
Grand Hall I

[S-23]: PANEL: INTERNATIONAL COOPERATIVE ENGAGEMENT – PROGRAM FOR POLAR RESEARCH HUMAN PERFORMANCE WORKING GROUP OVERVIEW

Chair: Bethany Shivers

PANEL OVERVIEW: *BODY: This panel provides an overview of the International Cooperative Engagement – Program for Polar Research (ICE-PPR) Human Performance Working Group (HPWG). The ICE-PPR is a multi-national program, led by the U.S. Chief of Naval Research, established to provide a forum for collaborative polar research and resource sharing. There are four working groups within the ICE-PPR construct (Environmental, Human Performance, Platforms, and Situational Awareness). The first presentation, from the Office of Naval Research, will provide an overview of ICE-PPR construct. The second presentation, from the Naval Health Research Center, will discuss nutrition and hydration needs for optimal Warfighter performance in polar environments. The third presentation, from the Naval Medical Research Unit – San Antonio, will provide an overview of the sub-working group on Polar Medicine and research related to combat casualty care in polar environments. The fourth presentation from the Naval Clothing and Textile Research Facility, will discuss protective clothing capability gaps and developmental programs. Finally, the fifth presentation, from the Air Force Research Laboratory, will provide an overview of the Cognitive Performance sub-working group and polar environmental effects on instrumentation.*

[118] ICE PPR OVERVIEW

Patrick Mason
Office of Naval Research, Arlington, VA, United States

(Original Research)

BACKGROUND: Future military operations are expected to push further into arctic environments. This will require militaries to identify and address knowledge and capability gaps pertaining to optimizing and sustaining human performace and medical care in extreme cold and austere conditions. **OVERVIEW**: Led by U.S. Chief of Naval Research, the International Cooperative Engagement Program for Polar Research (ICE PPR) was established in November 2020 and pertains to research, development, testing, and evaluation (RDT&E) to improved capabilities for successful and safe operations in Polar areas. The seven participating nations are: Canada, Denmark, Norway, Sweden, Finland, New Zealand, and United States. All Services and Government Agencies in these nations are invited to participate. ICE PPR creates a collaborative forum to initiate, conduct, and manage polar RDT&E projects, as well as exchange information (up to SECRET) in order to harmonize defense and national security requirements. There are four ICE PPR Working Groups (Environmental, Human Performance, Platforms, and Situational Awarenness). **DISCUSSION**: ICE PPR provides a platform for participating nations to conduct collaborative research, share resources, and leverage capabilities in order to optimize

warfighter performance, safety,medical care, and mission success in polar environments.

Learning Objectives

1. Audience will learn how seven nations are preparing warfighters for military operations in polar environments.
2. Audience will learn what are current limitations in human performance and medical care in extreme cold and/or austere environments.

[116] IMPACT OF EXTREME COLD ON COMBAT CASUALTY CARE

Bill D'angelo
Naval Medical Research Unit, San Antonio, TX, United States

WITHDRAWN

[117] EQUIPMENT AND INSTRUMENTATION TESTING FOR POLAR ENVIRONMENTS

Jorge Chavez Benavides
Air Force Research Laboratory, Dayton, OH, United States

WITHDRAWN

[119] THE LINK BETWEEN FOOD, GUT, AND WARFIGHTER PERFORMANCE

Lynn Cialdella-Kam
Naval Health Research Center, San Diego, CA, United States

(Education - Tutorial/Review)

Meals, Ready to Eat have been optimized to provide energy and nutrient needs to support warfighter performance during cold weather operations (CWOs). Warfighters, however, are often in caloric and nutrient deficit during CWOs due to such factors as time or situational limits, lack of appetite, and fatigue. Thus, nutrition interventions targeted to optimize the health and well-being of warfighters prior to CWOs may be ideal. The goals of this presentation are to (1) provide a brief overview of energy and nutrient deficit research, (2) summarize the link between food and gut health, and (3) explore the implications for warfighter performance. Specifically, foods high in polyphenols (i.e., natural food components that confer health benefits) and other nutrients (e.g., vitamin D, magnesium, and calcium) will be linked to musculoskeletal and immune health. In addition, evidence of the link between nutrients and mood will be described. Lastly, the presentation will conclude with potential nutrition strategies to prepare warfighters prior to CWOs.

Learning Objectives

1. Understand the energy and nutrient deficit during cold weather operations.
2. Identify the link between polyphenols, gut health, and inflammation and oxidative stress.
3. Understand the implications of nutrition aspects for warfighter performance during cold weather operations.

[120] ICE-PPR HUMAN PERFORMANCE – ARCTIC AND COLD WEATHER CLOTHING OVERVIEW

Chris Diaz
Navy Clothing and Textile Research Facility, Natick, MA, United States

(Education - Program/Process Review)

BACKGROUND: As the Polar environments change, commercial, scientific, and national security operations in the Arctic will continue to increase. Proper clothing selection is a critical factor in human performance and survivability, especially when operating in extreme environments. This presentation will provide an overview of US military efforts to address cold weather clothing capability gaps. **OVERVIEW:** The International Cooperative Engagement – Program for Polar Research (ICE-PPR) Human Performance – Clothing sub-working group members are collaborating to improve cold weather protective clothing capabilities for safe operations in polar environments. This presentation will focus primarily on US military services' cold weather clothing research, development, testing and evaluation efforts, including the use of instrumented thermal manikins to assess the thermoregulatory performance of clothing ensembles. Existing operational decision aids have gaps in thermal protection performance of clothing when fully and partially wet in cold water and cold air environments. Further, there are opportunities to improve operational decision aids to better predict performance of protective clothing for women. Additionally, there are research and evaluation efforts exploring plant and animal bio-based alternatives to synthetic polymeric fibers to address future material availability gaps resulting from supply chain limitations and microplastic pollution reduction. **DISCUSSION:** Operational decision aids utilizing predictive models for survivability are tools for military commanding and aeromedical officers to use to make data-informed protective clothing selection decision for those in their charge to reduce cold and heat stress injury risk. The clothing protection data library and decision aid tools have applications beyond the military, including for search and rescue operations.

Learning Objectives

1. The audience will understand military considerations for cold weather protective clothing.
2. The audience will understand the usage of laboratory-based clothing ensemble assessments for military operational decision aid tools.

TUESDAY, MAY 07, 2024

Tuesday, 05/07/2024 ***10:30 AM***
Grand Ballroom CD South, EF

[S-24]: PANEL: IDENTIFYING NEEDS AND RECOMMENDATIONS FOR MEDICAL SCREENING PERSONNEL PROVIDING PREFLIGHT EVALUATION OF COMMERCIAL SPACEFLIGHT PARTICIPANTS

Chair: Andrea Hanson
Co-Chair: Alejandro Garbino

PANEL OVERVIEW: *This panel will explore the growing demands on Aerospace Medical Examination needs, current policy, and shaping strategic growth to support the emergent commercial spaceflight participant community. The panel will explore the current metrics related to AME Certified Professionals and demand for examinations, look at the anticipated growth in commercial spaceflight participants in the next 5-20 years, and encourage commentary and discussion regarding future policy and regulation required to ensure the safety of commercial spaceflight participants. The driver for this discussion is twofold: 1) The rise in commercial human spaceflight opportunities for civilians, and 2) impending expiration of FAA moratorium on medical screening standards/requirements for spaceflight flight participants. The panel will include international government and civil aerospace medicine perspectives, as well as insight from related extreme environment communities such as the global diving and wilderness medicine communities. A primary focus will be to collect a summation of best practices in medical examination and care from established communities and share lessons learned to support the growing commercial spaceflight sector. The panel will seek to identify the current major players in civilian spaceflight and potential benefits of more formally shaping standards and regulations to support both AMEs and spaceflight participants. The panel will share comments and positions collected by*

the Space Medicine Association and aim to form a consensus representative of related communities in an effort to provide guidance to regulatory agencies from this highly specialized field of experts.

[121] WHO SCREENS THE SCREENERS? PERSONNEL CONSIDERATIONS FOR PREFLIGHT MEDICAL EVALUATION OF COMMERCIAL SPACEFLIGHT PARTICIPANTS

Jennifer Law
UTMB, Galveston, TX, United States

(Education - Program/Process Review)

BACKGROUND: The number of commercial spaceflight participants (SFPs) has increased dramatically in recent years and will continue to rise. To date, under a Congressional moratorium barring the Federal Aviation Administration (FAA) from regulating the nascent commercial spaceflight industry, companies have approached preflight medical evaluation in diverse ways. Once this "learning period" expires, the FAA may establish regulations or continue to allow industry to develop consensus standards. This presentation will provide a commercial flight surgeon's perspective on personnel considerations for preflight medical evaluation of commercial SFPs. **OVERVIEW:** Commercial human spaceflight presents a shift from the traditional, government-funded paradigm in astronaut selection, medical certification, and operational support. In the setting of business-driven decisions, companies tend to employ few medical personnel, who must design and then implement new processes, typically with limited guidance and support. Additional challenges include geographically diverse clientele, pressure to "medically clear" as many customers as possible, and medicolegal liability. A distinction between medical screening and clearance will be made. Illustrative examples will lead to recommendations for the qualifications of medical personnel for commercial spaceflight, which include an understanding of the aerospace environment and operational space medicine experience. Both physical and psychological issues should be considered in preflight medical evaluations. **DISCUSSION:** Whether by government regulation or industry consensus, preflight evaluation of commercial spaceflight participants should ideally meet minimum medical standards out of best practice, transparency, and fairness. Concurrently, standardization of personnel qualifications would ensure aerospace medical practices incorporate knowledge built on over 60 years of supporting human spaceflight while helping to reduce medicolegal liability, not only for the physicians but also for the whole industry. This discussion should be of interest to companies, current and future flight surgeons in commercial spaceflight, and regulators.

Learning Objectives

1. [The audience will learn about…] the challenges associated with preflight medical evaluation of commercial spaceflight participants.
2. [The audience will learn about…] the recommended qualifications of medical personnel for preflight medical evaluation of commercial spaceflight participants.

[122] WHAT KEEPS US UP AT NIGHT? BLACK SWANS IN SPACE

Jay Lemery, Alex Garbino, Andrea Hanson
NASA, Houston, TX, United States

(Education - Program/Process Review)

BACKGROUND: The rise in commercial human spaceflight opportunities for civilians and varying medical screening standards for commercial spaceflight flight participants will result in increased risk of medical event 'outliers' in spaceflight. We illustrate an analogue case from polar medicine to discuss unpredictability in risk models, as well as the need for novel medical systems to better embed flexibility and resilience for long duration missions. **OVERVIEW:** At 5:30 A.M. on June 14th 2018, a polar bear walked into Summit Station—the NSF's research station in remote Greenland– nearly 300 m from individuals sleeping in arctic tents. Summit Station possessed no bear deterrents other than heavy machinery. Over 40 Station residents were required to shelter in the two hard-sided buildings for 36 hours. Having little recourse to relocated the animal, ultimately hunters were flown to Summit Station and euthanized the bear. The epilogue of this encounter was a cascade of mental health complaints amongst the camp denizens, with reactions that included fear, anger, indifference, anxiety, grief and guilt stemming from the loss of autonomy, experiencing or witnessing a life-threatening encounter and the bear's death. The US-based medical team in support of Summit Station quickly mobilized psychiatric first aid support for the camp, in an effort to normalize reactions, explain coping mechanisms and re-establish a group connection (1). **DISCUSSION:** When considering medical risk assessment for extreme and/or remote missions, this encounter epitomizes a 'black swan' event– beyond any historic predictive data and characterized by unpredictability; has a potentially massive impact to the mission; and post-hoc predictability, with a sentiment that this encounter was less random and more predictable than it actually was, often saying it was "bound to happen."(2) As NASA endeavors to create evidence-based risk databases and predictive analytics for long duration missions, the 'black swan effect' reminds us that unforeseen outliers demonstrate the fragility of systems based on prediction and standard deviation; the dangers of placing too much confidence in a narrowly-focused expertise; and how rare and unpredictable events have a much greater impact than regular occurrences. This Arctic event speaks to the importance of resilient progressively earth independent medical systems that include redundant characteristics and improvisational skillsets.

Learning Objectives

1. The participants will understand the the fragility of systems based on prediction and standard deviation.
2. Participants will comprehend the dangers of placing too much confidence in a narrowly-focused expertise.
3. Participants will discern in large systems how rare and unpredictable events have a much greater impact than regular occurrences.

[123] EXPLORING THE NEED FOR AN EVIDENCE-BASED AND COLLABORATIVE APPROACH TO DEVELOPING REGULATORY MEDICAL STANDARDS FOR SUBORBITAL SPACEFLIGHT PARTICIPANTS

Ryan Anderton
UK Civil Aviation Authority, London, United Kingdom

(Education - Program/Process Review)

BACKGROUND: The UK Civil Aviation Authority (CAA) became the regulator for UK space activities in 2021, with the responsibility of developing medical standards for spaceflight particpants and providing guidance relating to the standards/training requirements for AMEs undertaking particpant/crew medicals. This presentation will discuss the importance of an evidence-based approach in developing standards for a very different risk profile compared to other aviation activities. **OVERVIEW:** The regulations that currently govern human spaceflight participation are broad and have been intended to prevent restricting the development of emerging operators during this 'learning period', an approach adopted by the FAA. Section 17 of the UK Space Industry Act and The UK Space Industry Regulations 2021 set out the requirements for launch operators, including the requirement for informed consent of their crew and participants to undertake spaceflight activities. There is currently limited medical experience and knowledge on individuals with significant medical history who have flown in space. Most of the physiological and medical data collected to date is from generally healthy individuals, such as career astronauts who are selected in part based on physical fitness and the absence of disease. With the advent of commercial spaceflight operators, space is becoming increasingly accessible to the public, many of whom would have been excluded from astronaut selection based on medical history alone. Whilst considerable data exist regarding the effects of gravitational (G) forces on human physiology, the effects on suborbital spaceflight participants, particularly in those with

pathology, is minimal. Although short in duration, such flights involve considerable G-forces that may either impair the experience or pose a direct risk to health. **DISCUSSION:** Research currently being funded by the UK CAA includes centrifuge-based acceleration studies as well as computational fluid dynamic modelling to predict the effects of suborbital spaceflight on several medical conditions aiming to address the need for evidence-based policy. As we move closer to potential operators launching from UK soil, the UK CAA is looking to collaborate with the international aerospace medicine community in the development and evolution of medical standards and AME training guidance to provide greater assurance to the public.

Learning Objectives

1. The audience will learn about the current, and potential future regulatory requirements for operators, designed to safeguard human spaceflight participants.
2. The audience will gain an understanding of how research can contribute to the development of evidence-based spaceflight participant medical standards.

[124] NAVIGATING LEGAL AND ADMINISTRATIVE CHALLENGES IN HIGH-ALTITUDE AND NEAR-SPACE PROJECTS

Giugi Carminati
C2Space Tech LLC, Aurora, CO, United States

(Education - Program/Process Review)

BACKGROUND: High-altitude and near-space projects have emerged as cutting-edge endeavors that push boundaries while providing a test bed for technologies, methods, and approaches. However, these ventures also introduce novel legal & administrative challenges that demand careful consideration and planning. **OVERVIEW:** This presentation explores the multifaceted aspects of administering personnel, obtaining insurance coverage, and addressing liability waivers for high-altitude and near-space projects. By carefully addressing project management, insurance, and waivers, legal & ops personnel can enhance mission efficiencies while minimizing legal risks. This presentation serves to arm physicians and operators with an organizational framework. **DISCUSSION:** Administration is a critical aspect of these projects, involving the coordination of entities and individuals across disciplines, states, and operational roles. Understanding the distinction between medical consulting and medical support, for instance, is essential, as is ensuring compliance with state laws, licensing obligations, and appropriate insurance coverage. In addition, effective project management and payroll classification are unseen yet necessary components of proper execution. In addition, because of the nature of the work (sporadic with uncertain timelines and dynamic shifts in personnel needs), having team redundancy is both challenging and paramount. Insurance is another dimension, with projects needing to assess whether they require various types of insurance, as as General Commercial Liability, medical malpractice insurance, Errors and Omissions, Umbrella policies, and/or vehicle liability insurance. This evaluation safeguards the project and mitigates risk. Finally, the legal landscape for high-altitude and near-space activities is complex, in part due to the United States federalist structure and the absence of federal tort laws. This situation leaves uncertainty and inconsistencies at the state level. Navigating this legal terrain is paramount to project success and compliance. This presentation introduces the specific challenges of liability waivers for high-altitude and near-space projects. These challenges include the selection of state laws and ensuring adequate protections under those laws. In conclusion, high-altitude and near-space projects present a dynamic environment that requires a comprehensive understanding of the legal, administrative, and operational intricacies.

Learning Objectives

1. Understand the operational complexities of high-altitude and near-space projects, including the coordination of personnel, compliance with state laws, and the distinction between medical consulting and medical support.
2. Identify the various insurance considerations for high-altitude and near-space projects, such as General Commercial Liability, medical malpractice insurance, Errors and Omissions, Umbrella policies, and vehicle liability insurance, and assess their importance in mitigating project risks.
3. Gain insights into the legal challenges and complexities involved in high-altitude and near-space projects, including the selection of state laws and the creation of liability waivers, to ensure project success and compliance in this dynamic environment.

[125] SAFETY AND MEDICAL SUPPORT FOR SPACEFLIGHT EXPERIENCES: BEYOND CERTIFICATION

Jonathan Clark
C2Space, Houston, United States

(Education - Tutorial/Review)

In traditional aerospace activities, medical certification of crew is a key regulatory step. However, in the high-stakes realm of high-altitude and near-space activities, certification is often non-existent. Furthermore, the teams conducting operations are often much smaller, and have more cross-training than traditional commercial aerospace activities; are often in remote environments, and rarely have an established occupational medicine support program, Furthermore, the lines between 'medical' and 'safety' are often blurred, with a complex interplay of medical support, safety, and communication during these missions. Aerospace medical support teams can fill the multifaceted role of ensuring the well-being and safety of extreme environment events in an interdisciplinary fashion, creating communication between operational, engineering, and medical teams. To do so includes providing vital medical support before, during, and after the mission, from training through recovery. For a truly successful strategy, it requires going beyond establishing crucial links with trauma centers, EMS teams, and specialized recovery units; but also extends to fostering a safety-conscious culture, and implementing progressive testing strategies, The emphasis is on a crawl-walk-run approach that avoids unnecessary risks. This presentation will underscore the critical role of safety and medical officer(s), who operate at the nexus of project leaders and crew members. The tension that often arises between them serves as an indicator of the delicate balance required for pushing the boundaries of extreme environment exploration safely. Leveraging lessons learned from multiple stratospheric, hot air balloon, flight operations and clinical medicine, the speaker will normalize the existence of this tension, clarifying that it is not an obstacle but rather a barometer of mission preparedness and safety diligence. Furthermore, the panel will emphasize the significance of proactive risk assessment and communication as a means to mitigate potential dangers, thereby reducing the reliance on near misses or "tasting blood" moments as catalysts for change. By reviewing medical support plans, safety protocols, and communication strategies that have (and have not) been successful, we will impart valuable insights into how to balance innovation with safety in the challenging and dynamic field of spaceflight and other extreme environment missions.

Learning Objectives

1. The audience will be able to to describe the different roles of the medical/support team.
2. Participants will gain insight into the diverse responsibilities of medical support, extending beyond crew certification, to ensure the well-being and safety of extreme environment pilots and crew.
3. The panel discussion will provide a deeper understanding of the delicate balance between innovation and safety in extreme environment missions, demonstrating the importance of proactive risk assessment and effective communication to reduce reliance on near misses as drivers for change.

Tuesday, 05/07/2024 ***10:30 AM***
Grand Ballroom A

[S-25]: PANEL: CONNECTING PHYSIOLOGY TO ACCELERATION TOLERANCE

Sponsored by Aerospace Physiology Society

Chair: John Harrell
Co-Chair: Ross Pollock

PANEL OVERVIEW: *This panel will present research that explores physiological factors that may contribute to an individual's +Gz tolerance (head-to-foot acceleration). Presentations are focused on topics that probe the physiological mechanisms underlying +Gz tolerance and potential strategies to increase head-level blood pressure, increase cerebral blood flow, and improve +Gz tolerance. The first presentation will describe an effort conducted by personnel at the US Air Force's 711th Human Performance Wing into whether physiological metrics can predict +Gz tolerance. Presentations 2 and 3, also from the 711th Human Performance Wing, will disseminate research on the extent to which arterial and venous characteristics contribute to +Gz tolerance, respectively. In the fourth presentation, researchers from the Royal Air Force Centre of Aviation Medicine will present an assessment of the differing cardiovascular and blood volume responses associated with three distinct levels of G-protection. The final presentation will communicate a collaborative effort between King's College London and the 711th Human Performance Wing investigating the impact of breathing elevated levels of carbon dioxide on cardiovascular and cerebrovascular responses to lower body negative pressure, an analog of hypergravity. This panel is sponsored by the Aerospace Physiology Society.*

[126] PHYSIOLOGICAL PREDICTORS OF HIGH G TOLERANCE

Justin Reed[1], Hannah Graves[1], Derek Haas[2], Andrew van der Merwe[3], Sarah Pfahler[4], Alex Kasak[5], John Harrell[5], Molly Wade[5]
[1]*KBR, Air Force Research Labs, Wright-Patterson AFB, OH, United States;* [2]*JYG Innovations, Air Force Research Labs, Wright-Patterson AFB, OH, United States;* [3]*Royal Air Force Exchange Flight Surgeon, Air Force Research Labs, Wright-Patterson AFB, OH, United States;* [4]*UES Inc., Air Force Research Labs, Wright-Patterson AFB, OH, United States;* [5]*Air Force Research Labs, Wright-Patterson AFB, OH, United States*

(Original Research)

INTRODUCTION: Exposure to high +Gz puts aircrew at risk for physical and cognitive declination which could lead to fatigue or injury, and ultimately risk mission failures or aviation mishaps. It is important to understand physiological traits associated with G-tolerance to mitigate this risk. Currently, limited associations with G-tolerance have been found and include, age, various anthropometric traits, and some vascular measures. There is a need for more robust test battery to elucidate which traits are associated with +Gz tolerance. **METHODS:** Baseline physiological assessments of human subject panel (HSP) for centrifuge research participants will be conducted (n=100). Measurements include anthropometrics, vascular characteristics, muscular and cardiovascular fitness, training habits, biomarkers and transcriptomics, and HSP training performance. The latter is a phased progression that systematically progresses trainees to full qualification of +9Gz and the ability to conduct simulated aerial combat maneuvers (SACM). Generally, training phases are, +7Gz for 15 seconds (s) reclined seat(R), +9Gz for 15s(R), +7Gz for 15s upright seat(U), +9Gz for 15s (U), +9Gz for 15s(U) plus a SACM in full combat edge. Physiological measurements will be merged with HSP training performance to model physiological associations with G-performance. This study was approved by the Air Force Research Lab institutional review board, protocol: FWR2020048H. **RESULTS:** Analysis of 46 subjects (fully qualified; 22-males, 4-females; did not qualify (DNQ) 17-males, 3-females) has been conducted. Three (3-males) DNQ at +7Gz for 15s(R), significant association; change in systolic blood pressure (SBP) post activity (p=0.033). Ten (9-males, 1-female) DNQ at +9Gz for 15s(R), significant associations; torso length (p=0.041) and height (p=0.045). Six (4-males, 2-females) DNQ at +7Gz for 15s(U), significant associations; resting SBP (p=0.047 and 0.041 for standing and seated respectively), resting diastolic BP (p=0.011 and 0.001 for standing and seated respectively), weight (p=0.014), and hip girth (p=0.012). One male DNQ on the SACM phase, no analysis. **DISCUSSION:** Preliminary analysis suggests there are physiological associations with +Gz tolerance. Once complete, full analyses will be conducted to determine physiological traits separating those successful in HSP training from unsuccessful candidates. Additional analyses will determine traits related to training phase completed.

Learning Objectives

1. Participants will learn about relationships between physiology and +Gz tolerance.
2. Participants will learn about associations between physiology and human centrifuge training.

[127] ARTERIAL STIFFNESS APPEARS IRRELEVANT TO +GZ TOLERANCE

Mikaela Gabler, Andrew Van Der Merwe, Sarah Pfahler, Derek Haas, Molly Wade, John Harrell
Air Force Research Laboratory - 711 HPW, Wright-Patterson AFB, OH, United States

(Original Research)

INTRODUCTION: Positive acceleration in the head-to-foot axis (+Gz) causes movement of blood to the lower body and limits venous return. A more rigid arterial tree may limit the downward fluid redistribution with increased +Gz. As arterial stiffness (AS) represents the rigidity within arteries to resist wall deformation, this study aimed to determine whether relaxed +Gz tolerance is associated with AS. **METHODS:** 58 healthy individuals (27 ± 5 yr, 8 women) were recruited from the high-acceleration human subject panel maintained at Wright-Patterson Air Force Base. Relaxed and strained +Gz tolerance was measured during gradual onset rate centrifuge exposures (GOR, 0.1 +Gz/s) without mechanical countermeasures in a 30° reclined seat. Either prior to centrifuge exposure or on a separate day, carotid pulse wave velocity (PWV) was measured in the supine position following 10-min of rest as an indicator of AS. Subsequently, PWV was dichotomized into equal groups for the highest and lowest values (i.e., Low- and High- PWV). Paired T-tests assessed differences between groups. Pearson's correlation analyses evaluated relationships between +Gz tolerance and physiological variables. **RESULTS:** Subjects in the Low-PWV group (p = .001) were younger (p = 0.001) and had lower diastolic blood pressure (p = 0.018); however, their relaxed and strained +Gz tolerance were similar to High- PWV (p > 0.05). Across all subject groups, men exhibited a negative correlation with relaxed +Gz tolerance (r = -0.29, p = 0.03) and taller subjects approached a negative correlation with relaxed +Gz tolerance (r = -0.24, p = 0.06). **DISCUSSION:** As expected, older subjects and those with higher diastolic blood pressure exhibited greater PWV. Despite greater AS, this did not appear to affect +Gz tolerance. Interestingly, women demonstrated a correlation with relaxed +Gz tolerance, as did shorter height. Whether these factors affect +Gz tolerance in conjunction, or independently, remains to be elucidated. In conclusion, while we show evidence of other physiological factors being related to +Gz tolerance, AS by itself does not appear to be, which may be due to the homogenous nature of our subjects.

Learning Objectives

1. Relaxed and strained +Gz tolerance are not related to arterial stiffness in our sample population.
2. Relaxed +Gz tolerance is correlated with the female sex and shorter height.

[128] VENOUS COMPLIANCE AND +GZ TOLERANCE

Andrew van der Merwe[1], Sarah Pfahler[2], Derek Haas[3], Justin Reed[4], Hannah Graves[4], Molly Wade[5], John Harrell[5]
[1]*711th Human Performance Wing, U.S. Air Force Research Laboratory, Wright-Patterson AFB, Dayton, OH, United States;*
[2]*UES, Wright-Patterson AFB, Dayton, OH, United States;* [3]*JYG Innovations, Wright-Patterson AFB, Dayton, OH, Dayton, OH, United States;* [4]*KBR, Wright-Patterson AFB, Dayton, OH, Dayton, OH, United States;*
[5]*711th Human Performance Wing, Air and Space Biosciences Division, Wright-Patterson AFB, Dayton, OH, United States*

(Original Research)

INTRODUCTION: Positive acceleration in the head-to-foot axis (+Gz) causes movement of blood to the lower body, reducing retinal and cerebral oxygenation. Venous compliance (VC) is the change in venous volume per change in pressure; therefore, less compliant leg veins may limit the downward fluid redistribution that occurs during increased +Gz. This study aimed to determine whether VC is associated with relaxed +Gz tolerance. We hypothesized that VC would be negatively associated with +Gz tolerance. **METHODS:** Thirty-two subjects (28 ± 5yr) participated in the study. Male (n = 24) and female (n = 8) subjects were all active duty members of the United States Air Force. VC was measured using mercury-in-silastic strain gauge plethysmography. A venous occlusion cuff was placed 5cm above the knee and inflated to 60mmHg for 6 minutes. Cuff pressure was then reduced by 1mmHg/s, while calf circumference was recorded. Relaxed and strained +Gz tolerance was measured during gradual onset rate centrifuge exposures (GOR, 0.1 +Gz/s), without mechanical countermeasures, in a 30° reclined seat. Subjects reported loss of 100% of peripheral vision without lower body strain (Relaxed +Gz tolerance) and with lower body strain (Strained +Gz tolerance). Delta +Gz tolerance was calculated as the difference between strained and relaxed +Gz tolerance. **RESULTS:** Subjects averaged 4.6 ± 2.6 GOR exposures. Correlation analysis indicated that neither absolute VC (r^2 = 0.0623) nor VC slope (r^2 = 0.0146) was associated with +Gz tolerance. Subject blood volume (r = -0.359, p = 0.044) was negatively correlated with +Gz tolerance, with height (r = -0.335, p = 0.061) and weight (r = -0.317, p = 0.077) approaching significance. Splitting subjects into Low and High VC groups showed no significant difference in relaxed (4.35 ± 0.52 vs. 4.27 ± 0.43 +Gz, p = 0.321), strained (6.11 ± 0.84 vs. 6.27 ± 0.87 +Gz, p = 0.308) or delta +Gz tolerance (1.73 ± 0.50 vs. 1.98 ± 0.59 +Gz, p = 0.117). **DISCUSSION:** These data indicate a clear relationship between vascular distensibility and +Gz tolerance is absent, and venous compliance alone cannot predict +Gz tolerance. Further research may reveal physiological and physical characteristics that may predict acceleration performance.

Learning Objectives

1. Understand how lower limb venous compliance is measured and analyzed in human subjects.
2. Better understand the relationship between venous compliance, physiological and physical characteristics, and +Gz tolerance in a young military population.

[129] CARDIOVASCULAR AND BLOOD VOLUME RESPONSES TO THREE LEVELS OF G-PROTECTION

Joseph Britton[1], Nicholas Green[1], Stephen Harridge[2], Ross Pollock[2]
[1]*Royal Air Force Centre of Aviation Medicine, Henlow, United Kingdom;*
[2]*King's College London, London, United Kingdom*

(Original Research)

BACKGROUND: Anti-G Suits provide protection against +Gz acceleration through several physiological mechanisms. The contribution of each of these mechanisms to improving G-tolerance, and how each relate to the degree of protection provided, is not fully understood. This study investigates the cardiovascular response to three levels of G-protection: No (*NP*), Moderate (*MP*; 5-Bladder Anti-G Trousers) and Improved (*IP*; Full Coverage Anti-G Trousers) protection. **METHODS:** 11 subjects undertook a series of rapid onset (3 G/sec; 15 sec plateau) runs in a human centrifuge with target +Gz increased until Peripheral Light Loss (PLL) was reached. Impedance plethysmography (IPG) assessed blood volume changes in the whole lower body (Total), Abdomen, Thigh and Calf. Non-invasive pressure waveform monitoring was used to calculate Blood Pressure (BP), Cardiac Output (CO), Stroke Volume (SV) and Total Peripheral Resistance (TPR). Heart Rate (HR) was calculated from 3-lead ECG. For each variable, changes between preceding baseline and the +Gz plateau at PLL were analysed using repeated measures analysis and post-hoc pairwise comparisons. A comparison between MP and IP at +3.2 Gz was also performed. **RESULTS:** +Gz at PLL increased with increasing protection (mean ± SD: NP; +3.4 ± 0.5 Gz, MP; +4.5 ± 0.6, IP; +5.0 ± 1.0 Gz). At PLL, there was no difference in the change in eye-level BP, SV or CO between conditions. However, the increase in TPR was greater for IP than MP. At +3.2 Gz, eye-level ΔBP was the same for MP and IP, but ΔHR was higher in MP, whilst ΔTPR was higher in IP. At PLL, Total ΔIPG decreased (i.e blood volume increased) for NP, but changes in individual segments were not significant. Total and Abdominal ΔIPG increased equally with both MP and IP. Thigh ΔIPG increased significantly with IP but was unchanged in the other conditions. Calf ΔIPG was unchanged from baseline in all conditions. At +3.2 Gz, Abdominal ΔIPG was increased more by IP than MP. **DISCUSSION:** At PLL, regardless of the level of protection, key measures of cardiovascular physiology were similar. Greater protection allowed these physiological changes to occur at higher +Gz. Both Anti-G suits reduced blood volume re-distribution to the lower body. The main difference with improved protection was a greater blood volume shift from the thigh. Thigh and abdominal compression appear key to the level of G-protection, whilst calf compression appears less critical.

Learning Objectives

1. The audience will learn about the differences in cardiovascular response between exposures to +Gz with and without G-protection.
2. The audience will learn about how differences in cardiovascular response reflect changes in G-tolerance.

[130] CARBON DIOXIDE INCREASES CEREBRAL BLOOD FLOW DURING LOWER BODY NEGATIVE PRESSURE

Andrew Muriithi[1], Rachel Beri[1], Lail Edelsztein[1], Ross Pollock[1], John Harrell[2]
[1]*King's College London, London, United Kingdom;*
[2]*711th Human Performance Wing, Air Force Research Laboratory, Wright-Patterson AFB, OH, United States*

(Original Research)

BACKGROUND: Pilots in high-performance aircraft are exposed to acceleration in the +Gz (Head-to-foot) axis which can result in G-induced Loss of consciousness (G-LOC). Breathing elevated levels of CO_2 have been reported to increase Systolic Blood Pressure (SBP) and Middle Cerebral Artery Velocity (MCAv) and therefore may potentially be used to improve G tolerance. Lower body negative pressure (LBNP) has been used as a tool to investigate responses to central hypovolemia and as a surrogate of hypergravity. The present study aimed to determine whether breathing 5% CO_2 increased cerebral blood flow and blood pressure during LBNP. **METHODS:** 15 subjects (9 M/6 F, 31±8 yr) undertook the experiment which involved breathing either room air or a mix of 5% CO_2, 21% oxygen, balance nitrogen for 3 mins followed by a 2 min period of -60mmHg LBNP. There was a 2-minute washout period between trials. We measured middle cerebral artery velocity (MCAv) with transcranial Doppler ultrasound. Continuous, non-invasive blood pressure was measured using finger plethysmograph with mean arterial pressure (MAP), stroke volume (SV), cardiac output (CO) and total peripheral resistance (TPR) determined. We corrected MCAv for blood pressure (MAP) and present it as cerebrovascular conductance index (CVCi). **RESULTS:** LBNP caused an increase in heart rate and TPR while SV and CO significantly

decreased ($p < 0.05$, main effect of LBNP) with each of these changes being similar between breathing gas conditions. MCAv, MAP, and CVCi were all greater during the 5% inspired CO_2 trials ($p < 0.05$, main effect of gas), irrespective of exposure to LBNP. **DISCUSSION:** Breathing a mixture of 5% CO_2 increased cerebral blood flow and blood pressure with these increases remaining during an analogue of hypergravity. While technical challenges exist in integrating CO_2 breathing inflight, increasing inspired CO_2 could contribute to better G-tolerance.

Learning Objectives

1. The audience will note that breathing a mixture of 5% CO_2 increased cerebral blood flow and blood pressure, and these increases were demonstrated in an analogue of hypergravity.
2. The audience will learn that increasing inspired CO_2 could contribute to better G tolerance.

Tuesday, 05/07/2024 ***10:30 AM***
Grand Ballroom B

[S-26]: PANEL: GENDER DYSPHORIA - THE USAF WAIVER PROCESS

Chair: Ryan Peirson

PANEL OVERVIEW: *Body: This panel discusses the USAF Aeromedical Consultation Service's (ACS) experience of evaluating transgender aircrew. It starts with a definition of Gender Dysphoria and its implications in the aerospace environment as well as a brief discussion about the enduring controversy associated with the nomenclature. The process and challenges of the USAF's Waiver system for Gender Dysphoria are then described. The history and changes in terms related to Gender Dysphoria are also covered. The panel examines the psychological profiles of evaluees and presents ACS procedures and experiences. The goal of the panel is to provide a clear understanding of the intersection between Gender Dysphoria, the USAF's aeromedical standards, and the evaluation process.*

[131] GENDER DYSPHORIA: USAF WAIVER GUIDE AND PROCESS

Kevin Heacock
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Tutorial/Review)

INTRODUCTION: Gender Dysphoria is a medical condition characterized by a marked incongruence between an individual's experienced gender and their assigned sex at birth. Those with Gender Dysphoria may experience distress related to this incongruence, which can manifest in various ways. Gender Dysphoria, like other medical conditions, can be managed with appropriate care and is eligible for flying waiver following clinical stability. **TOPIC:** Receiving a waiver to fly in the United States Air Force (USAF) after being diagnosed with Gender Dysphoria involves a comprehensive process. First and foremost, individuals diagnosed with Gender Dysphoria must prioritize their health and follow the prescribed medical treatment plan, which may include hormone therapy or gender-affirming surgery. Once they are found to be clinically stable, they can proceed with the waiver application. The waiver process starts with thorough documentation of their medical history, including records of their Gender Dysphoria diagnosis and treatment. This documentation should demonstrate their commitment to health and stability. It's crucial to provide detailed information about the management of Gender Dysphoria and any accompanying mental health care. **APPLICATION:** Aerospace medicine plays a pivotal role in evaluating individuals seeking a waiver for aviation duty in the USAF. The USAF's Medical Standards Directory identifies all diagnoses with an F-Prefix in the current version of the Diagnostic Statistical Manual of Mental Disorders (DSM-5-TR) as disqualifying for flying duties. Gender Dysphoria is one of these F-Prefix diagnoses and so requires a waiver to return to flying status. The waiver process looks for the successful management of Gender Dysphoria as well as the ability to manage the demands of the aerospace environment. This includes demonstrating the ability to maintain mental and emotional stability under high-pressure aviation conditions. The waiver process recognizes that individuals with Gender Dysphoria can contribute effectively to the mission while ensuring their well-being and readiness for flying duties. **RESOURCES:** 1. American Psychiatric Association (Ed.). (2022). *Diagnostic and statistical manual of mental disorders: DSM-5-TR* (Fifth edition, text revision). American Psychiatric Association Publishing. 2. CLEARED on 25 Oct 2023 - PAIRS CASE 2023-0957/AFRL-2023-4926.

Learning Objectives

1. Comprehend the Waiver Process for Gender Dysphoria in the USAF: Gain an understanding of the comprehensive process involved in obtaining a waiver to fly in the United States Air Force (USAF) after being diagnosed with Gender Dysphoria, including the importance of clinical stability and the required medical documentation.
2. Evaluate the Role of Aerospace Medicine in Aviation Waivers: Explore the pivotal role of aerospace medicine in evaluating individuals seeking a waiver for aviation duty in the USAF. Understand the specific medical standards and disqualifying criteria as outlined in the DSM-5-TR, and their implications for returning to flying status.

[132] GENDER DYSPHORIA: DEFINITIONS AND IMPLICATIONS IN THE AEROSPACE ENVIRONMENT

Terry Correll
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Tutorial/Review)

INTRODUCTION: In adolescents and adults dealing with gender dysphoria, there is often a mismatch between their experienced gender and their physical sex characteristics. This disconnect may or may not be accompanied by a strong desire to eliminate certain primary and/or secondary sex characteristics or an eagerness to acquire corresponding features of a different gender. Older adolescents and adults with gender dysphoria may, to varying degrees, adopt the behaviors, clothing, and mannerisms associated with their experienced gender, and they often experience discomfort when perceived or treated as members of their assigned gender in society. Self-identification as transgender is reported in the range of 0.5% to 0.6%, while experiencing an incongruent gender identity is seen in 0.6% to 1.1% of individuals. Feeling like a person of a different sex is reported by 2.1% to 2.6% of the population, and the desire to undergo medical treatment falls within the range of 0.2% to 0.6%. In adults, studies generally indicate that more individuals assigned male at birth seek gender-affirming treatment, with ratios ranging from 1:1 to 6.1:1 in most research conducted in the United States and Europe. **TOPIC:** The potential aeromedical implications are concerning. Gender nonconformity may affect peer relationships and may lead to isolation from peer groups and to distress. Gender dysphoria is associated with high levels of stigmatization, discrimination, and victimization, leading to negative self-concept, increased rates of depression, suicidality, and other mental disorder co-occurrence, school dropout, and economic marginalization, including unemployment, with attendant social and mental health risks, especially in individuals who lack family or social support. Individuals who have experienced harassment and violence may also develop posttraumatic stress disorder. Rates of suicidality and suicide attempts for transgender individuals are reported to range from 30% to 80%. **APPLICATION:** We will discuss important aspects of the aeromedical evaluation to assure that the transgender flyer is ready for waiver submission, safe flying, and is capable to fully function and complete their assigned mission. **RESOURCES:** 1. American Psychiatric Association (Ed.). (2022). *Diagnostic and statistical manual of mental disorders: DSM-5-TR* (Fifth edition, text revision). American Psychiatric Association Publishing.

Learning Objectives

1. We will discuss the potential aeromedical implications in individuals with gender dysphoria.

2. The potential asociated psychopathology with gender dysphoria will be reviewed.
3. We will examine important aspects of the aeromedical evaluation to assure that the transgender flyer is ready for waiver submission, safe flying, and is capable to fully function and complete their assigned mission.

[133] PSYCHOLOGICAL AND NEUROPSYCHOLOGICAL ASSESSMENT IN GENDER DYSPHORIA

Monica Malcein
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Tutorial/Review)

INTRODUCTION: Estimates of gender nonconformity range from 0.5% to over 1% in US samples. Gender dysphoria refers to psychological distress from an incongruence between one's sex assigned at birth and one's gender identity. Research suggests increased risk for co-morbid psychiatric diagnoses in those with gender dysphoria. Some transgender persons undergo gender transition treatment, which may include hormone therapy and/or undergoing medical procedures. For many, gender-affirming treatment results in reduced psychological distress. Treatment with hormones can also result in other emotional and mental/cognitive changes that are not well characterized. Psychological and neuropsychological assessment of individuals with Gender Dysphoria is part of an evaluation for waiver recommendation, although there are particular challenges for assessment in this group. The availability of appropriate normative data is extremely limited and use of assessment measures with gender norms can be problematic. **TOPIC:** Given the potential comorbid psychosocial issues and psychiatric diagnoses in those with a history of Gender Dysphoria, post-transition transgender pilots and aircrew are evaluated at the ACS. This evaluation includes clinical interviews with psychiatry and psychology, psychological/personality assessment, and intellectual/neurocognitive testing. A total of 14 flyers have been evaluated at the ACS for Gender Dysphoria. Most are male to female transition (71%). All were administered MAB-II, MicroCog, MMPI-2-RF, and NEO-PI-3. We present qualitative findings of these measures to explore the usefulness of psychological testing data in this population. Additionally, we address potential aeromedical implications and provide some recommendations for navigating the challenges in assessment of this unique population. **APPLICATION:** Gender Dysphoria is disqualifying for flying duties in the USAF, but a waiver may be considered for flying if stability can be documented. Comprehensive assessment, with the inclusion of objective measures of neurocognitive and psychological functioning can be useful, although there are several factors to consider when using assessment instruments that have not been normed or validated on the transgender population. Findings from the series of evaluations of those with Gender Dysphoria at the ACS are provided to highlight the usefulness of these measures and inform future assessments in this population.

Learning Objectives

1. The audience will have a greater understanding of Gender Dysphoria among aviation population.
2. The learner will be briefed on the challenges on psychological and neuropsychological assessment in gender nonconforming individuals.
3. Assess the usefulness of psychological and neuropsychological testing data in the evaluation of aircrew wtih Gender Dysphoria.

[134] GENDER DYSPHORIA – THE USAF WAIVER PROCESS

Henrik Close
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Tutorial/Review)

INTRODUCTION: The diagnosis of gender dysphoria has specific requirements per the psychiatric diagnostic manual. This presentation will elaborate upon these criteria and use an anonymized example patient case as a demonstration. **TOPIC:** One case representing an example of a gender dysphoria presentation will be discussed. Particular attention will be given to the application of diagnostic criteria for the condition, as well as the childhood and young adult experiences reported by our patient that contributed to the recognition of this condition. This discussion will build on the earlier panel presentations and highlight the ACS' experience as well as observations about trends within the cohort. **APPLICATION:** The discussion will be applicable primarily to U.S. Air Force flight surgeons and mental health providers. The concepts and process may be interesting to those administering waivers and or treating flyers in other military services and in civil aviation. **RESOURCES: 1.** American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders: Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Text Revision. **2.** U.S. Air Force Aeromedical Waiver Guide

Learning Objectives

1. The participant will be able to analyze and interpret a case study representing an individual with gender dysphoria, applying the diagnostic criteria to understand their condition.
2. The participant will be able to discuss the childhood and young adult experiences that may contribute to the recognition of gender dysphoria in individuals, using the anonymized case study as an example.

Tuesday, 05/07/2024 ***10:30 AM***
Grand Hall J

[S-27]: SLIDES: OCCUPATIONAL STRESSORS ON BEHAVIORAL/MENTAL HEALTH

Chair: Steve Vanderark
Co-Chair: Karen Keats

[135] IMPACT OF OCCUPATIONAL STRESSORS ON THE MENTAL HEALTH OF RPAS OPERATORS

Tooba Tahir
RAF, Lincolnshire, United Kingdom

(Education - Program/Process Review)

BACKGROUND: Military Remotely Piloted Aircraft Systems (RPAS) are used for surveillance, reconnaissance and weapon-strike operations. They are controlled by operators, often thousands of miles away from the combat zone. This results in unique occupational stressors. The visual and auditory data from real-time missions can lead to exposure of traumatic stimuli. Personnel exposed to combat zones are at an increased risk of developing PTSD and burnout. For RPAS operators, this can lead to incidents within flight. This review was carried out to determine which occupational stressors exist and the impact on mental health in RPAS operators. **OVERVIEW:** A systematic literature review was conducted across three databases: Pubmed, Scopus and API PyschInfo using variants of the search terms "RPAS" and "mental health" and "aircrew". 18 papers were included, all of which were original studies. Two main stressors were identified: 1) operational stressors 2) combat stressors. **DISCUSSION:** RPAS operators were not at an increased risk of mental health problems compared with other military personnel exposed to combat scenarios. Prevalence of disorders, including PTSD were low. However, symptoms were still present despite not meeting threshold criteria for diagnosis. 70% of RPAS operators reported functional impairment due to this and 14-26% described high levels of exhaustion and burn out. Variables increasing risk of PTSD included working greater than 51 hours a week and working for over 2 years at a station. Trouble sleeping and difficulty concentrating were amongst the most common symptoms expressed. Fatigue can impact cognition, increases risk of errors and degrades performance. This can compromise operational effectiveness and safety at a national and global level. The risk of PTSD was increased by combat

stressors including witnessing the impact of enemy forces on civilian bystanders. Within the UK and US, the biggest contributor for occupational stress were self-reported operational factors including long working hours and shift patterns. Due to the studies using self-reporting methods by the operators, it is possible that under-reporting of mental health issues may affect the accuracy of the picture. Recommendations to reduce occupational stressors include supportive outreach by psychiatric teams and leadership involvement to implement meaningful change.

Learning Objectives

1. Learn about which factors lead to an increase in occupational stress for RPAS operators.
2. Understand the impact of occupational stressors upon the mental health of RPAS operators and recommendations to reduce this.

[136] COGNITIVE WORKLOAD MANIPULATION WITH THE COGNITIVE ASSESSMENT OF AVIATION PERFORMANCE AND EVALUATION OF STATE

Andrew Dorsey[1], Jeffrey Phillips[1], Emily Bowers[1], Arnold Henry[1], Ryan Mayes[2]

[1]*Florida Institute for Human and Machine Cognition, Pensacola, FL, United States;* [2]*USAFSAM, Dayton, OH, United States*

(Original Research)

INTRODUCTION: High cognitive workload can be a significant hazard for operators in extreme environments. Environmental stress and task saturation often compound to negatively affect cognitive performance leading to a loss of situational awareness and mistakes, yet these effects can be transient and more difficult to measure. The U.S. Air Force School of Aerospace Medicine (USAFSAM) Cognitive Assessment of Aviation Performance and Evaluation of State (CAAPES) is a neuropsychological tool developed to rapidly detect operationally representative cognitive performance effects resulting from common aeromedical stressors. CAAPES also facilitates the ability to manipulate workload by adding or subtracting subtasks to create low and high workload conditions in concert with environmental stressors. This presentation explores CAAPES as a tool to manipulate workload effects across two independent studies and will discuss its application across multiple methodologies to explore the interaction between environmental stress and cognitive workload state. **METHODS:** Both studies were conducted at the Florida Institute for Human and Machine Cognition (IHMC) and approved by the IHMC and Naval Medical Research Unit-Dayton Institutional Review Board. In Study I participants (n = 10) from the general population performed each separate component of CAAPES alone and in all possible combinations. Participants rated their subjective cognitive workload with the NASA-TLX after each unique iteration. Study II (n = 16) recruited Student Naval Aviators from Naval Air Station Pensacola to perform CAAPES in both high and low workload conditions every 30 minutes across a six-hour period while either under a placebo or diuretic induced state of dehydration. **RESULTS:** Study I indicated a 16.4 increase in subjective mental workload between low and high workload and the ICCs performed on CAAPES Composite formulas all revealed values (>.80). Study II revealed a statistically significant performance effect for tracking across workload conditions (F (1, 13) = 58.05, $p < 0.05$, $np^2 = 0.817$). **DISCUSSION:** These findings demonstrate that CAAPES can reliably manipulate workload to facilitate investigations into workload by stressor interaction effects. Further research is warranted to understand the role of cognitive workload in performance effects associated with a variety of physiological stressors; CAAPES appears to be a valuable tool in understanding this complex interaction.

Learning Objectives

1. Learn how CAAPES facilitates the manipulation of cognitive workload by adding or subtracting subtasks to create low and high workload conditions.
2. Understand workload effects may impair performance in unexpected circumstances rather than routine scenarios when combined with physiological stressors, such as hypoxia, hypercapnia, or dehydration.
3. Appreciation for the need for further research in scenarios where cognitive workload may impede performance under a variety of physiological stressors.

[137] REALITY CHECK: OVERVIEW OF PILOT STRESSORS, BACKED UP BY RECENT HEADLINE-MAKING INCIDENTS

Marion Venus

Venus-Aviation Research, Training & Pilot Support, Zurich, Switzerland

(Original Research)

INTRODUCTION: This study examined multiple stressors pilots face on duty in the high-risk high-reliability system aviation. While aviation is promoted as extremely safe, many for pilots successfully managed stressful, potentially dangerous incidents, which recently made headlines. **METHODS:** More than 400 international pilots completed a cross-sectional online survey, which assessed psychosocial stress (PHQ-Stress) and work-related stressors like little experience, job-insecurity, short rest-periods, long working-hours, etc. Pilots' mean age was 40.93±10.62 years (M±SD), 70% of the pilots reported flying short haul, 30% long haul, 8% pilots were female. The pilots' comments regarding stressors were analyzed with a Qualitative Content Analysis (QCA). The results were listed and correlated with real recent aviation incidents, which made headlines. **RESULTS:** Professional pilots reported on average 116.9±41.2 duty hours in the last month. Pilots reported multiples stressors like irregular shift work, physiologist stressors like roster-related sleep-deprivation, psychological and psychosocial stressors, as well as work-related and existential pilot-specific stressors or threats. **CONCLUSIONS:** The extent of stress for pilots has been largely ignored and underestimated in recent years. When air operators strive for and achieve maximum productivity, this has negative effects on the stress and health of pilots. Even if aviation is still described as the safest transport medium, stress and, as a result, fatigue not only endanger flight safety, but also the psychological and physical health of pilots. Many headlines about stressful or even life-threatening events in flight make it clear that pilots are justifiably worried about their own safety and flight safety, which also puts a lot of strain on their mental health.

Learning Objectives

1. Participants will learn about different types of stressors for pilots, as pilots perceive them.
2. Participants will learn about recent stressful or life-threatening incidents, which represent job-related stressors for all pilots.

[138] INFLUENCE OF OLFACTORY VIRTUAL REALITY ON BEHAVIORAL HEALTH

Renee Abbott, Ana Diaz-Artiles

Texas A&M University, College Station, TX, United States

(Original Research)

INTRODUCTION: Isolation and confinement place astronauts at higher risk for developing adverse behavioral health conditions and many current psychological countermeasures are ill-suited for future exploration missions. Virtual reality (VR) technologies could promote relaxation by providing astronauts with a means to experience nature, which has been shown to have numerous psychological and physiological benefits. Creating a fuller, multisensory VR experience could further enhance these benefits. **METHODS:** We conducted an experiment to investigate the use of olfactory stimuli in nature-inspired VR environments. This was a within-subjects (7M/3F), counterbalanced design comparing the effects of a control condition (VR only) to the intervention condition (VR + scents). First, participants completed a public speaking task to elicit a stress response. Then, subjects had 15 minutes to freely explore the VR environment. This was repeated for the other VR condition. The Positive and Negative Affect Schedule (PANAS) and the 6-item State-Trait Anxiety Inventory (STAI-6) were used to evaluate mood and anxiety levels. These

surveys were administered before the stressor (baseline, T1), after the stressor (T2), and after the VR intervention (T3). **RESULTS:** In the VR + scents condition, negative affect ($p<0.01$) and anxiety ($p<0.001$) scores significantly decreased from T2 to T3. Anxiety scores were also significantly lower after the VR intervention (T3) than at baseline (T1) in the VR + scents condition only ($p<0.05$). Positive affect did not change over the duration of the experiment for either condition. **DISCUSSION:** We hypothesize that recruiting more sensory modalities increased immersion and presence in the VR environment, resulting in a decrease in subjective negative affect and anxiety after exposure. Qualitative feedback also indicated that some participants liked/disliked different scents and aspects of the VR environment, highlighting the importance of personalization in psychological countermeasures. Our ongoing work will examine the effect of our VR intervention over a longer period (several weeks) and will allow the user to choose between several different VR environments. We are also adding other somatosensory components simulating temperature changes and wind to further increase immersion, and we are expanding to include physiological measures and cognitive performance.

Learning Objectives

1. The audience will understand that creating multisensory experiences can enhance the psychological benefits of relaxing VR environments.
2. The audience will understand that psychological countermeasures should employ aspects of personalization to maximize effectiveness.

[139] ATTENTIONAL TUNNELING IN PILOTS DUE TO A VISUAL TRACKING TASK WITH A HEAD MOUNTED DISPLAY

Wietse Ledegang[1], Erik Van der Burg[2], Frank Kooi[1], Mark Houben[1], Eric Groen[1]
[1]*TNO, Soesterberg, Netherlands;* [2]*University of Amsterdam, Soesterberg, Netherlands*

(Original Research)

INTRODUCTION: It is known that presentation of symbology as a visual overlay may draw attentional resources away from other tasks, which is called 'attentional tunneling'. Moreover, actively aiming one's head, to keep Helmet Mounted Display (HMD) symbology aligned with an external target object, may also draw the pilot's attention away from the primary flying task. In a simulator study, we investigated the impact of active head aiming on an attitude control task while flying in clouds. Furthermore, we examined the effects of additional visual clutter on both head aiming and attitude control. **METHODS:** Eighteen pilots, with military flying experience, conducted the experiment in a generic fixed-base fighter simulator with a dome projection and head-slaved projection of HMD-symbology in the out-the-window visuals. The pilots' task was to continuously compensate a roll disturbance while actively aiming a head-referenced circle to a moving visual target. The diameter of this circle and amount of visual clutter were varied. Each run consisted of a small magnitude roll disturbance phase, sustained roll 'run-away' and high magnitude roll disturbance phase. Control inputs, roll angle, head direction and subjective measures were collected. The experiment was conducted with approval of the institutional ethics committee in accordance with the (revised) Helsinki Declaration. **RESULTS:** The results show that, when flying in clouds, the attitude control task deteriorated with increasing difficulty of the head aiming task. Vice versa, head aiming accuracy was worse in the high disturbance phase. Subjective ratings indicated that both tasks influenced each other equally. Besides control accuracy, active head aiming also increased the chance of roll-reversal errors. Although the subjects subjectively indicated that clutter was disturbing in the head aiming conditions, it had no significant effect on the objective performance measures. During the roll 'run-away', the subjects showed delayed response and more roll-reversal errors in the difficult head aiming condition. **DISCUSSION:** The results show that, while flying in clouds, active head aiming of HMD symbology causes attentional tunneling, leading to less accuracy on a simultaneously performed attitude control task representative of aircraft control. Also, head aiming may increase the risk for unrecognized spatial disorientation.

Learning Objectives

1. The audience will learn about the increased risk of attentional tunneling in pilots due to a visual tracking task with a head mounted display.
2. The audience will learn that head aiming may increase risk for unrecognized spatial disorientation.

[140] THE EFFECTS OF CO_2 ON EXECUTIVE AND NON-EXECUTIVE FUNCTION, BOHR EFFECT, AND YERKES-DODSON LAW

Jeffrey B. Phillips, Bowers Emily, Andrew Dorsey, Henry Arnold
Florida Institute for Human and Machine Cognition, Pensacola, FL, United States

(Original Research)

INTRODUCTION: Military divers and tactical aviators face numerous environmental hazards making each operation a calculated risk. Hypercapnia, elevated CO_2 in the arterial blood (PaCO2), is one of the stressors that can result in impairments in operator neurological status, increase the probability of an accident and present a significant risk to the operator. The following two studies explore the direction and magnitude of the effect of low-level exposures to CO_2 on tracking performance (TP), reaction time (RT) and executive function (EF). **METHODS:** Study 1: Thirty-five active-duty Student Naval Aviators (SNAs) ($M = 24.11$ years, $SD = 2.14$) performed two iterations of the Cognitive Assessment of Aviation Performance and Evaluation of State (CAAPES), while breathing four normobaric CO_2 concentrations, 1.0%, 2.5%, 4.0%, 5.5%, delivered via an MBU-20/P flight mask, for 15-minutes in each condition. Study 2: Twenty-five active-duty (SNAs) ($M = 23.36$ years, $SD = \pm 1.68$) performed either two or three iterations of a Stroop Task and a Go/No-Go Task while breathing normobaric CO_2 concentrations, 0.04%, 1%, 2.5%, and 4%, delivered via Interspiro MKII Divator Mask for 15 minutes in each condition. **RESULTS:** Transcutaneous ($PaCO_2$) increased in participants across all four of their respected CO_2 exposures. The ANOVA conducted on the tracking component of CAAPES without the subtasks showed, $f(1.69, 28.78) = 4.39$, $p = 0.027$, *partial eta square* = 0.21. TP peaked at 4.0% CO_2. Repeated Measures ANOVA of the Stroop Effect RT scores showed a significant effect, ($F(3, 72) = 3.494$, $p = .020$). Participants Stroop accuracy percentage showed no effect, ($F(72,3) = .319$, $p = .812$). A Repeated Measures ANOVA of average number of failed "No-Go" responses showed no effect, ($F(69, 3) = 1.106$, $p = .353$, $\eta p^2 = .046$). RT Performance Peeked at 2.5% and 4.0% CO_2. **CONCLUSION:** The stimulating and arousal effects of CO_2 significantly improved TP on CAAPES and RT on Stroop and Go/No-Go. CO_2 exposure did not negatively affect EF as measured by Stroop and Go/No-Go. Across all metrics high PaO_2 conditions were associated with better performance as predicted by the Yerkes-Dodson Law and the Bohr Effect.

Learning Objectives

1. Why is CO_2 a common stressor divers and aviators face operationally?
2. How executive and non-executive function cognitive processing is affected by CO_2.
3. How CO_2 affects performance through the Yerkes Dodson Law and the Bohr Effect.

Tuesday, 05/07/2024 ***10:30 AM***
Grand Hall K

[S-28]: PANEL: RESIDENT IN AEROSPACE MEDICINE (RAM) GRAND ROUNDS I

Chair: Robert Haddon
Co-Chairs: Sonya Heidt, Jonathan Elliot

PANEL OVERVIEW: *Clinical case presentations by residents and fellows*

[141] This abstract was moved to S-52.

[294] THE INFLUENCE OF NAVAL FLIGHT STATUS REGARDING THE TREATMENT OF A CERVICAL CHAIN SCHWANNOMA

Matthew Lindsey
Naval Aerospace Medical Institute, Pensacola, FL, United States

(Education - Case Study)

Naval Aviators often make health-related decisions that better enable them to fly. A recent study indicated that aviators were more likely to report medical conditions that have a lower propensity for grounding such as dermatological conditions. Naval aviators may also undergo medical procedures that enable them to fly through their medical qualification process. This has been seen often in receiving laser surgery to meet vision qualifications. However, there are other cases in which treatment decisions are influenced by the perceived necessity to fly in the operational setting. This can be seen in the case of a Cervical Sympathetic Chain Schwannoma. This report noted that an asymptomatic patient presented for a flight physical with a persistent lump on the left side of his neck. After a workup, the mass resulted in a cervical chain schwannoma measuring 2.4 x 1.7 x 3.3 cm posterior to the left carotid and jugular vein deep to the sternocleidomastoid. Cervical chain schwannomas are uncommon benign nerve sheath tumors that often present as an asymptomatic solitary neck mass. Surgical excision can be a treatment of choice for these tumors. However, the Naval Aerospace Medicine Institute (NAMI) otorhinolaryngology department chair recommended a conservative approach of observation since these tumors tend to be slow-growing. Given both options, the aviator chose to have surgery despite the risk of Horner's syndrome following surgery which, if prolonged, may be disqualifying in aviation. The aviator's reasoning was to save himself time, opportunity cost, and career investment in the Naval aviation community should observation result in needed surgery later which could be disqualifying. The more immediate surgery he elected to undergo did result in the expected surgical complications of Horner syndrome symptoms of ptosis and miosis without anhidrosis. Fortunately, Horner's syndrome resolved and had no impact on his vision. Ultimately, he was able to resume flight training with minimal grounding time. This case illustrates that Naval Aviators may be more willing to undergo procedural risk for the ability to fly.

Learning Objectives

1. Describe how pathology of the cervical chain schwannoma affects the aviation environment.
2. Describe how flight status may determine the Naval Aviators' medical decision-making.
3. Describe the pathophysiology, epidemiology, symptoms, diagnosis, and methods of treatment for a cervical chain schwannoma.

[142] CROHN'S DISEASE IN A HIGH-PERFORMANCE AIRCRAFT PILOT: A CASE FOR THE AEROMEDICAL CONSULTATION SERVICE MEDICAL RISK ASSESSMENT AND AIRWORTHINESS MATRIX

Preston Moore, Noel Colls, Victor Parker
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Case Study)

INTRODUCTION: This case report describes a high-performance aircraft pilot who presented with chronic fatigue, was found to be anemic, diagnosed with Crohn's disease, and eventually returned to flying status. **BACKGROUND:** Crohn's disease is a bowel disorder characterized by transmural inflammation that may affect any portion of the gastrointestinal tract from oral cavity to perianal area. Crohn's disease affects 422 people out of 100,000 in North America, and, with an age of onset between 15 and 30 years, is likely to affect pilots after becoming trained assets. For this reason, evidence-informed aeromedical decision making is critical for maintaining safety of flight and ensuring mission completion. **CASE PRESENTATION:** The subject of this case report was an experienced high-performance aircraft pilot who initially presented with a complaint of chronic fatigue. Evaluation of this complaint found anemia. Upon further workup, the subject was diagnosed with Crohn's disease. After surgical resection of his terminal and distal ileum and stabilization on adalimumab, the subject was initially returned to flying status with a waiver for ejection seat aircraft with two pilots. Subsequent demonstrated stability and flight safety allowed for upgrade to an unrestricted waiver. **DISCUSSION:** This case highlights the importance of evidence-informed aeromedical decision making with Crohn's disease. Crohn's disease is a non-curable illness with a relapsing-remitting course and the potential for both intestinal and extra-intestinal complications and is thus considered disqualifying for all flying classes. Up to 20% of patients with Crohn's disease experience prolonged remission after initial control and 50% have intestinal complications at 20 years, though this is more likely with certain risk factors such as perianal or rectal involvement. However, those adequately treated and in remission are less likely to develop complications. There is little published aeromedical literature, yet one case series has shown long-term flight and operational safety in pilots with Crohn's disease. In this light, the USAFSAM Aeromedical Consultation Service Medical Risk Assessment and Airworthiness Matrix provides a mechanism to apply the evidence in each clinical situation to inform aeromedical risk assessments and decisions to return trained assets to flying status.

Learning Objectives

1. The participant will be able to understand the aeromedical implications of Crohn's disease.
2. The participant will be able to understand how to apply the USAFSAM Aeromedical Consultation Service Medical Risk Assessment and Airworthiness Matrix in aeromedical decision making.

[143] DIAGNOSTIC ASSESSMENT OF HIGH ALTITUDE-INDUCED HYPOXEMIA

Wiaam Elkhatib[1], Jan Stepanek[2], Bruce Johnson[1], Michael Wolf[1]
[1]*Mayo Clinic Rochester, Rochester, MN, United States;* [2]*Mayo Clinic Arizona, Scottsdale, AZ, United States*

(Education - Case Study)

INTRODUCTION: This report discusses the diagnostic approach for a case of recurrent, subacute symptomatic hypoxemia at high altitude. **BACKGROUND:** Millions of people visit extreme altitudes via air travel and mountaineering. High altitude can elicit symptomatic hypoxemia via compensatory adaptations and in those with underlying cardiopulmonary or hematologic conditions. **CASE PRESENTATION:** A 71-year-old healthy retired male pilot presented for subacute dyspnea with oxygen saturations below 80% at altitude, headaches, and anxiety. Symptoms were discordant with altitude and evolved from previous nominal tolerance. Cardiology, pulmonology, hematology, and sleep medicine consults are obtained. Cardiopulmonary exercise stress testing, 12-lead resting electrocardiography, pulmonary function tests, positional pulse oximetry, right heart catheterization, chest x-ray, computed tomography with angiography assessing hepatopulmonary vasculature, and hemoglobinopathy work up with comprehensive metabolic laboratory studies were obtained, though in this case largely unrevealing. Additional high-altitude simulation testing, resting arterial blood gas, and overnight oximetry near sea level confirmed moderate hypoxemia. Non-obstructive coronary disease via imaging and trivial patent foramen ovale via transthoracic echocardiogram with shunt study were incidentally noted. Focused testing should be repeated at or above symptomatic altitude including pulse-oximetry, arterial blood gas, overnight sleep oximetry and transthoracic echocardiography with shunt study. Central versus peripheral hypoventilation were suspected, with differential etiologies considered including age-related changes, hyper-acute emergent conditions, altitude illness, metabolic, structural and functional cardiopulmonary, physiologic and anatomic vascular shunting, ventilation/perfusion mismatch, and normal physiologic adaptation. Diagnostic findings guide management. **DISCUSSION:** The risks, diagnoses, and outcome management of discordant symptomatic hypoxemia following high-altitude exposure are highlighted and reviewed through this case report. Developing a broad differential with

comprehensive algorithmic approach facilitates diagnosis and guides treatment or countermeasures for medical providers. This report illustrates imperative considerations for preserving health and mission-capability when presented with complex patients, pilots, and military personnel affected by extreme altitude environments.

Learning Objectives

1. Understand the clinical algorithmic approach to altitude-induced hypoxemia and the relative strengths and utility of varying diagnostic tests available.
2. Evaluate the broadened differential diagnostic considerations for clinically confirmed significant hypoxemia presenting with discordant symptomology.
3. Recognize the arterial blood gas as an under-utilized clinical test for guiding diagnosis and potential etiology of symptomatically discordant non-invasive oxygen desaturations.

[144] SIMPLE SHOULDER SYMPTOM SIGNALS SOMETHING SINISTER IN SHUTTLE SPACEWALKER

Rebecca Mendelsohn, Jeffrey McBride
UTMB, Galveston, TX, United States

(Education - Case Study)

INTRODUCTION: This case report describes a Shuttle-era astronaut, who completed a ground-breaking spacewalk while suffering from symptomatic Parkinson's Disease. **BACKGROUND:** Parkinson's Disease is a progressive disorder of the central nervous system (CNS), which has profound impacts to both cognitive functioning and motor skills in its later stages. Rarely diagnosed in the early stages, patients with Parkinson's Disease are often profoundly symptomatic, with tremors, unstable gaits, slowed movements, stiff body posture, and even difficulty swallowing. **CASE PRESENTATION:** A male astronaut in his mid-40s presented to Johnson Space Center's Flight Medicine Clinic for a routine physical. After an otherwise normal exam, the astronaut described experiencing decreased arm movements while walking, which he attributed to a shoulder injury from racquetball. Upon completion of a thorough neurological evaluation, the astronaut was diagnosed with Parkinson's Disease. This particular astronaut had already successfully completed multiple Shuttle missions, and was subsequently scheduled to perform a complex extra-vehicular activity (EVA) during an upcoming flight. In working with his neurologist and the flight surgeons at JSC, he successfully completed his mission and the EVA with no untoward effects from his Parkinson's diagnosis. **DISCUSSION:** After a critical diagnosis, this astronaut was able to complete an arduous, mission-critical, and historic EVA despite experiencing the psychomotor impacts of a degenerative neurological disease. By collaborating closely with the astronaut, his neurologist, the trainers at the Weightless Environment Training Facility (WETF), and NASA leadership, flight surgeons were able to monitor his progress and ensure that the astronaut would have a safe and successful mission without prematurely terminating a vibrant career.

Learning Objectives

1. After this presentation, learners will be able to recognize the early symptoms of Parkinson's Disease in an astronaut and will understand early treatment and mitigation approaches.
2. After this presentation, learners will have a better understanding of the complexities of aeromedically certifying individuals with progressive neurological disorders to perform mission-critical tasks during spaceflight.

[145] RABIN CONE CONTRAST TESTING: A DEMONSTRATION OF TRUE COLORS

Erica Murray, LTC Sonya Heidt
U.S. Army Medical Center of Excellence (MEDCoE), Fort Novosel, AL, United States

WITHDRAWN

[146] TYPE II DECOMPRESSION SICKNESS IN A PARACHUTIST DISPATCHER

Ian McIver
Naval Aerospace Medical Institute, Pensacola, FL, United States

(Education - Case Study)

INTRODUCTION: This case report describes a parachutist dispatcher who experienced type ii decompression sickness following repeated high-altitude exposure. **BACKGROUND:** During military parachute operations the aircraft must depressurize prior to disembarking jumpers and equipment. This exposes not only the jumpers but also parachutist dispatchers, the aircrew responsible for conducting jump operations, to decreased atmospheric pressure. At altitudes greater than 18,000 ft there is a risk of developing decompression sickness. The physically demanding process of dispatching jumpers and their equipment places parachutist dispatchers at increased risk. **CASE PRESENTATION:** The subject was a 36-yr old male Royal Air Force parachutist dispatcher aboard a C-130. He was considered competent and qualified for the jump operations that were being conducted and had successfully carried out similar operations previously. RAF guidance for high altitude exposure limitations and mitigation were followed. The incident occurred during a series of high altitude jump training operations. The crew completed the required denitrogenation period prior to depressurizing the aircraft. The aircraft was depressurized for 40 min at 25,000 ft. The crew remained on oxygen during the offload process. Shortly after landing he reported pain in multiple joints, paresthesia, a headache, blurred vision and mental fog. Other members of the aircrew reported his speech became difficult to understand and he vomited. Based on symptoms and altitude exposure he was diagnosed with decompression sickness. Due to his neurological symptoms this was classified as type ii. He was treated in a hyperbaric chamber per US Navy treatment table 6 resulting in resolution of his symptoms. On reevaluation the next day he reported difficulty recalling these events. **DISCUSSION:** Decompression sickness remains a significant hazard in the aviation environment. A thorough history, including detailed information on recent fight profiles is vital in the diagnosis of decompression sickness. Consideration of aggravating factors such as physical exertion are also important when evaluating potential cases. This case highlights the necessity for continued research into mitigation strategies for decompression sickness in the aviation environment.

Learning Objectives

1. The audience will learn about considerations when evaluating a potential case of decompression sickness in the context of aviation.
2. The audience will learn about factors that can increase the risk for developing decompression sickness in the aviation environment.

Tuesday, 05/07/2024 ***10:30 AM***
Grand Hall GH

[S-29]: PANEL: AEROSPACE TOXICOLOGY

Chair: Richard Pleus
Co-Chair: David Mattie

PANEL OVERVIEW: *Aerospace Toxicology is the multi-disciplinary approach to understanding and managing the effects and impacts of chemical and biological agent exposures while in flight or on the ground, preparing and servicing vehicles for flight to keep humans healthy and safe. Exposures to chemicals associated with all aspects of flight must be understood and managed to ensure everyone associated with aerospace operations is protected. The Aerospace Toxicology Association is a new organization that became an AsMA affiliate in 2023. While having diverse topics, the abstracts in the session all address issues related to toxicology associated with flight or maintenance operations.*

[147] MEDICAL CONSEQUENCES AFTER A FUME EVENT: A RETROSPECTIVE MATCHED-PAIR COHORT STUDY IN A MAJOR AIRLINE INVOLVING 15,000 CREWMEMBERS

Michel Klerlein
Air France, Roissy CDG, France

(Original Research)

INTRODUCTION: The so-called "aerotoxic syndrome" following a fume event is still controversial among aviation medicine practitioner, The occupational health department of the main French airline collects data from all the crewmembers exposed to a fume event since the beginning of 2017. **METHODS:** We present a retrospective cohort study involving 14953 crewmembers including 2577 exposed and 12376 matched controls. Our medical recording database uses the ICD-10 classification of diseases. The statistical methods were pairwise comparison of means, matched risk-ratio and Cox proportional hazard models for estimation of risk-ratios, incidence of diseases and prevalence. **RESULTS:** From 2017 to 2022, 357 fume events have been notified to the occupational health department, who recorded 2735 crewmember exposed. 2577 have been included as exposed and 12376 as matched controls. Prevalence of diseases that could be related to the fume event based on "possible" or "probable" level and date of occurrence posterior to the fume event was for exposed (controls): NEUROLOGIC 2.57% (2.47%), PSYCHIATRIC 2.80% (3.22%), NEUROVEGETATIVE 1.86% (1.57%), IRRITATIVE 5.08% (4.56%), FUNCTIONAL 2.95% (2.93%). Differences were not significant. Incidences of having any related disease are estimated at 1552 per 100000 person-years for exposed and 1497 per 100000 person-years for controls, with a non-significant hazard ratio of 1.04 [0.86-1.25] in the cox model. A subset of 2577 matched pairs exposed/control allowing specific statistical tests confirmed the lack of difference between exposed and controls: matched-pair risk ratio for any fume event related disease was 1.07 [0.85-1.34] p=0.54, and we found exactly the same result with a conditional fixed-effects Poisson regression. **DISCUSSION:** Our results clearly show that fume events are globally out of significant clinical consequences for cabin and cockpit crew. This is totally in line with the conclusions of the 2023 Cabin Air Quality Report from the French Agency for Food, Environmental and Occupational Health & Safety (ANSES).

Learning Objectives

1. The audience will learn about the current debate about the reality of the aerotoxic syndrome.
2. The audience will learn about the diseases occurring after exposure to a fume event.
3. The audience will learn about the design of a retrospective cohort study and the interest of epidemiology in the aeromedicine field.

[148] UPDATE: INTERNATIONAL AEROMEDICAL PANDEMIC LESSONS LEARNED

Kris Belland[1], Charles DeJohn[2], Diego Garcia[3], Gary Allen[4], Stephen Glaudel[4], Bill Mills[2]
[1]*AsMA, Keller, TX, United States;* [2]*AsMA, Oklahoma, OK, United States;* [3]*AsMA, Ormond Beach, FL, United States;* [4]*AeroClenz, Bonita Springs, FL, United States*

(Education - Tutorial/Review)

BACKGROUND: Worldwide aviation has been greatly and negatively impacted by the COVID-19 pandemic. Right from the outset, organizations, businesses, and individuals within the aviation industries have faced unique and complex challenges. Contingency planning has had to adapt. In this presentation, the author will provide an updated Systematic overview and update to the Aviation Multi-Layered Disease Defense Strategy (AMLDDS) and discuss Emerging risk-mitigations (application of Reason Swiss Cheese Theory to inflight disease transmission/translocation). Strategies will include current and emerging technologies to include the use of airborne Ultraviolet (UV-C) irradiation. Updates on three AsMA AMHP Blue Journal UV-C paper submissions undergoing peer review and AsMA UV-C Resolution 2023-01, as well as feedback from WHO, ICAO, CAPSCA, AHC, ICASM international conference presentations will be discussed. **OVERVIEW:** The author served as the AsMA representative to the International Civil Aviation Organization (ICAO) and Collaborative Arrangement for the Prevention and Management of Public Health Events in Civil Aviation (CAPSCA) during the last three years of the COVID-19 pandemic and has formed a unique perspective and best business practices. As the pandemic evolved, so did knowledge, attitudes, and expectations. The pandemic has created unique opportunities for learning and scientific technologic advances. Emerging layers of disease risk mitigation protection including the use of UV-C at safe levels and how they can reduce translocation and transmission of disease in flight will be discussed. **DISCUSSION:** After a thorough systematic review of subject publications resulting in three AMHP AsMA Blue Journal submissions, the author will discuss existing and emerging infectious diseases risk mitigation strategies critical to aviation - COVID-19 and beyond, and will provide an overview and update to the AMLDDS and discuss Emerging risk-mitigation (evolutionary application of James Reason, Swiss Cheese Model/Theory which was successfully adapted to international COVID-19 pandemic response by ICAO and CAPSCA. Lessons learned and emerging technologies will continue to reduce inflight disease transmission/translocation of disease and enhance future pandemic responses.

Learning Objectives

1. Attendees will become familiar with updated current programs and future initiatives in supporting aeromedical response to emerging pandemic transmission/translocation and manmade biologic events.
2. Attendees will learn about updated areas of advancement in global preparation for the next pandemic.
3. Attendees will understand updated advantages and potential methods of a multi-layered response to emerging disease transmission and translocation.

[149] INVESTIGATING THE POTENTIAL HEALTH DERMAL AND RESPIRATORY HEALTH EFFECTS ON CREW UNIFORMS

Richard Pleus[1], Gavin Bell[2], Gretchen Bruce[2]
[1]*Intertox/Aerospace Toxicology Association, Seattle, WA, United States;* [2]*Intertox, Seattle, WA, United States*

(Original Research)

INTRODUCTION: Aircrew members have raised concerns about skin and respiratory reactions after donning new uniforms, leading to speculation that the uniforms may release chemicals inherent to textile components. This study investigated the potential for these chemicals to cause dermal and respiratory health effects. **METHODS:** We conducted a comprehensive literature review to identify chemicals in aircrew textiles that are potential dermal allergens or respiratory irritants or sensitizers. Additionally, we explored textile certification standards and regulations addressing chemical usage in textiles. Partnering with specialized laboratories, we designed a testing program to collect data aligned with toxicological requirements. Potential health risks were assessed using established risk assessment methodologies. **RESULTS:** Our evaluations revealed the presence of various chemical agents in the textiles. Organic compounds included perfluorooctanoic acid (PFOA) and inorganics included zinc, used in antimicrobial treatments; copper, prevalent in dyes and antifungal agents; and titanium, found in dyes and polymers. We also detected aldehyde emissions including formaldehyde, acetaldehyde, and others. **DISCUSSION:** In a conservative estimate, 1 in 20 individuals already sensitized to zinc might react upon exposure to the maximum detected level of zinc, but risk drops significantly for those not sensitized. Models of aldehyde exposure using emission data from fabrics indicate a probability of respiratory reactions in sensitized and non-sensitized individuals of 1 in 1,000 and 1 in 250,000 respectively, under conservative

exposure scenarios outside of commercial aircraft, and under 1 in 1,000,000 for both groups in commercial aircraft. While data suggest the potential for exposure exceeding toxicity guidelines for some chemicals under conservative scenarios, the overall likelihood of predicted adverse effects is much lower than reported frequency of adverse effects in uniform-wearing groups. Evaluating uniforms for potential chemical exposures before distribution is recommended.

Learning Objectives

1. The audience will understand the types of chemicals found in air crew uniforms.
2. The audience will understand the how to consider and scientifically and medically approach to addressing dermatological and respiratory concerns from uniforms.

[150] OBTAINING KEY MEDICAL INFORMATION REGARDING THE HEALTH IMPACTS OF CHEMICALS IN THE CABIN AIR OF COMMERCIAL AIRCRAFT

Richard Pleus[1], Kelli Hackney[2], Gretchen Bruce[2], Cameron Bellamoroso[2]
[1]*Intertox, American Toxicology Association, Seattle, WA, United States;* [2]*Intertox, Seattle, WA, United States*

(Original Research)

INTRODUCTION: Studies show that small quantities of jet engine oil or hydraulic fluid can seep into commercial aircraft's environmental systems and cabin air. Characteristic odors or fumes may be detected in cabin air by passengers or crew, and some concerns have arisen about the potential health effects of exposure during these fume events. We identified data gaps in the industry approach to collecting air quality and health data post-fume events and propose a comprehensive, multi-tiered health and safety protocol for these events. **METHODS:** We extensively reviewed and analyzed literature and guidance from authoritative entities as well as reports and medical data from several incidents to identify where data gaps exist in current industry procedures. We used James Reason's "Swiss cheese model" as a framework to bridge data gaps. **RESULTS:** Data gaps existed in education and training, procedures, communication and reporting, data collection and analysis, and medical information. We focused primarily on identifying actions to bridge data gaps in data and medical information collection, including: 1. Enhancing the aircrew questionnaire to standardize and obtain air quality and health data post-fume event, focusing on toxicologically pertinent details such as odor characteristics, event duration, and symptoms. 2. Providing relevant exposure information to medical providers responding to fume events and proposing a program to guide them in adopting medically grounded diagnostic methods, aiming to increase chances of apt medical care. **DISCUSSION:** Building upon existing carrier measures, we developed a comprehensive multi-tiered health and safety protocol to respond to cabin air fume events, to support enhanced, dependable data collection, and to aid the medical community in addressing aircrew exposures.

Learning Objectives

1. The audience will understand the medical concerns of the need for better quality medical data regarding fume events.
2. The audience will understand the types of medical information that is currently obtained and what information would be scientifically and medically useful.

Tuesday, 05/07/2024 ***10:30 AM***
Grand Hall I

[S-30]: SLIDES: SPACE- THE BIG PICTURE

Chair: Moriah Thompson
Co-Chair: Jennifer Fogarty

[151] A SYSTEMATIC REVIEW OF LITERATURE FOR DESIGN OF LUNAR HEALTH MAINTENANCE FACILITIES (HMF) IN LUNAR MISSIONS

Souktik Bhattacherjee, Amit Srivastava
The University of Adelaide, Adelaide, Australia

WITHDRAWN

[152] DETERMINING PHARMACUETICAL STABILITY AFTER LONG-DURATION EXPOSURE TO SPACEFLIGHT ABOARD THE INTERNATIONAL SPACE STATION: PHASE 1 OF THE DRIBBLE STUDY

Corinne Rezentes[1], Dennis Lovett[2], John Reichard[3], Craig Nowadly[2]
[1]*Brooke Army Medical Center, San Antonio, TX, United States;* [2]*59th Medical Wing, San Antonio, TX, United States;* [3]*NASA JSC, Houston, TX, United States*

(Original Research)

INTRODUCTION: Pharmaceuticals on the International Space Station (ISS) are exposed to high ambient carbon dioxide levels, solar and galactic cosmic radiation, and microgravity. Previous research raised concerns that the unique environment of spaceflight may lead to degradation of active pharmaceutical ingredients. The mechanisms by which spaceflight facilitates loss of API potency remain poorly characterized. The "Dribble" study was performed to fill that knowledge gap. **METHODS:** FDA-approved pharmaceuticals were packaged by the Johnson Space Center (JSC) pharmacy into spaceflight (experimental) and lot-matched ground controls. Experimental pharmaceuticals were launched to the ISS aboard SpaceX CRS-15, CRS-16, CRS-17, CRS-18, CRS-20, and Cygnus NG-11. Ground controls remained in stability chambers at JSC. Space-exposed pharmaceuticals returned to Earth and were placed into stability chambers. After an unexpected delay caused by the COVID-19 pandemic, the pharmaceuticals were transferred to the US Air Force for analysis. Solid and liquid pharmaceuticals were appropriately prepared and sampled ten times. Each sample was subsequently tested utilizing ultra-high-performance liquid chromatography and tandem mass spectrometry. Experimental and controlled medications were compared against commercial standards for each medication. Phase 1 analysis of Dribble includes: caffeine (tablet), diazepam (vial), diphenhydramine (vial and capsule), epinephrine (vial), ketamine (vial), lidocaine (vial), naloxone (vial), and promethazine (tablet and vial). **RESULTS:** Experimental medications were stored on the ISS 132 – 573 days, varying by medication and mission. All pharmaceuticals were expired at the time of analysis. During a preliminary analysis, Naloxone 1 mg/mL vials showed no significant degradation in flown or control samples across three missions (potency ranging 97.6 ± 2.3% to 102.1 ± 2.9% of commercial standard). By contrast, there were epinephrine samples flown on SpaceX CRS-15 and SpaceX CRS-17, showed an 8.3-10.3% lower potency relative to ground controls. **DISCUSSION:** The "Dribble" pharmaceuticals showed varying stability and degradation patterns. Although all medications were expired at the time of analysis, the time period of analysis is relevant to exploration missions. This study will allow for informed development of exploration pharmaceutical programs. Immediate follow-up of Phase 2 medications is planned.

Learning Objectives

1. Understand the stability and degradation patterns of select medications across varying exposures to microgravity.
2. Understand the factors that influence stability and degradation of select medications across varying exposures to microgravity.
3. Understand the relevance of pharmaceutical stability to exploration spaceflight.

[153] ENABLING DEEP SPACE MISSIONS WITH AN EXPLORATION MEDICAL SYSTEM

Sara Khan, Sylwia Kaduk
KBR - European Space Agency, Cologne, Germany

WITHDRAWN

[154] SPACE MEDICINE AND HUMAN FACTORS RESEARCH GAPS IN SUPPORT OF HUMAN COMMERCIAL SPACE FLIGHTS

Melchor Antunano
FAA CAMI, Oklahoma City, OK, United States

(Education - Program/Process Review)

Space flight exposes individuals to an operational environment that is far more hazardous than what is experienced by passengers who fly onboard current airline transports. With suborbital and orbital flights, pre-existing medical conditions can be aggravated or exacerbated by exposure to environmental and operational stressors such as acceleration, microgravity, and solar/cosmic radiation, among others. Most of the space medicine knowledge and experience to date has been obtained from career astronauts between the ages of 35 and 50 years old. Most of the biomedical data (medical, physiological, psychological) collected to date are based on the effects of space flight (short and long) on generally healthy career space crews. Because of medical privacy laws and individual space career considerations, individual biomedical data from career space crews is not readily available for scientific study. There is a limited amount of medical information on pathologies occurred among career astronauts during short-duration and long-duration space flights. Limited biomedical information has also been collected and analyzed from commercial spaceflight participants in suborbital and short-duration (up to 2 weeks) orbital flight. Furthermore, available biomedical information from spaceflight participants who have moderate-to-severe pathology is also very limited (quantitatively and qualitatively). Such an insufficient level of overall medical knowledge and experience represents a challenge to those space medicine practitioners who are responsible for the medical assessment of prospective commercial spaceflight participants who have a wide range of health and fitness levels. Therefore, more space medicine research is needed to address the medical safety of spaceflight participants. This presentation will discuss: 1) Examples of relevant space medicine and human factors research conducted through the FAA CST COE, 2) The space medicine research gaps identified in the final report of the CSF/MITRE Workshop to Create a Human Research Program for Spaceflight Participants in the Commercialization of Space, and 3) Ongoing FAA internal discussions about research priorities in aerospace medicine and human factors in support of human commercial spaceflight operations.

Learning Objectives

1. The audience will learn about high priority research needs in space medicine and human factors in support of human commercial space flights.
2. The audience will learn about completed research areas in space medicine and human factors conducted through the FAA Commercial Space Transportation Center of Excellence.

[155] WILLIS ISLAND RESEARCH STATION- A RETROSPECTIVE SPACEFLIGHT TELEHEALTH ANALOGUE

Meg O'Connell
Royal Flying Doctors Service- Queensland, Cairns, Australia

(Original Research)

INTRODUCTION: Willis Island is a remote isolated weather station located approximately 450km East of the coast of North Queensland, Australia. Established in 1921, Four live-in staff deploy for six-month rotations in isolated, resource limited, extremely remote circumstances. Like the International Space Station, research staff perform scientific experiments, weather forecasting and maintenance activities. Exploration medical support is provided by Royal Flying Doctors Service Queensland Service (RFDS) Telehealth Medical Officer and supported by an on island RFDS Medical Chest. Like ISS astronauts, researchers undergo first aid training, emergency management planning and communications training prior to deployment. Like spaceflight, the island presents many medical risks, including radiation injuries from the sun, skin and musculoskeletal injuries, decompression illness, and the psychological difficulties of working in small, isolated teams for long periods of time. This research uses retrospective analysis to determine if the medical issues faced by small group extreme deployments is comparable to those experienced during spaceflight. **METHODS:** This site was analysed at length to determine if it was a naturally occurring retrospective spaceflight analogue. Hazards, risks, medical evacuation, pre-deployment training, and onsite medical facilities were compared and contrasted between the ISS, Space Shuttle Missions and Willis Island operations. A literature review of the medical incidents experienced by ISS Astronauts over the same time period was completed. **RESULTS:** A total of 81 telehealth phone calls were made from Willis Island during the study period. This is a mean phone calls of 5.4 per year, but likely reflects the young and health population self-selecting to deploy. The most common injuries were musculoskeletal and skin injuries, followed by ear infections. Over the last 16-year period, only one phone call was related to a mental health issue. **DISCUSSION:** Remote Island scientific bases represent a goldmine of useful data that can inform expedition and wilderness medicine, along with aerospace medicine. This research paper has demonstrated that retrospective analysis of remote places can be used to better understand human spaceflight healthcare and its limitations for small and isolated deployments.

Learning Objectives

1. Participants will learn the methodology of how to evaluate remote places to understand if they are an analogue for spaceflight telehealth.
2. Participants will get a better understanding of the RFDS remote telehealth service, accompanied by the RFDS medical chest, a locked box of 50 medications including emergency drugs. There are 2500 of these throughout australia.

[156] DEVELOPMENT OF TAILORED TRAUMA GUIDELINES FOR SPACE EXPLORATION UTILIZING KNOWLEDGE FROM MAJOR TERTIARY TRAUMA CENTERS

Lisa Brown[1], Jeremy Hsu[2], David Read[1], Kate Martin[1], Rose Shakerian[1], Anthony Phillips[3], Benjamin Thomson[1]
[1]*The Royal Melbourne Hospital, Melbourne, Australia;* [2]*Westmead Hospital, Sydney, Australia;* [3]*The University of Auckland, Auckland, New Zealand*

(Original Research)

INTRODUCTION: Guidelines for the management of major trauma are used terrestrially to guide and subsequently evaluate complex trauma situations. Prior research exists on the altered human physiology encountered in microgravity and how this would influence a trauma patient in the environment of the Moon, Mars or within a space vehicle. NASA's Integrated Medical Model confirms that trauma situations are a significant component of the medical risks in space exploration. **METHODS:** The aim of this study was to develop trauma guidelines for space exploration - integrating current knowledge of human physiology, specifically related to trauma in microgravity, with current trauma guidelines from major Australian surgical trauma services. A review of the major medical databases (Pubmed, Medline, Ovid, Google Scholar) was undertaken using keywords of ("TRAUMA" OR "ACCIDENT") and ("MICROGRAVITY" OR "SPACE" OR "MOON" OR "MARS"). Expert Trauma Surgeon review was then performed of the results with application of the currently used Hospital (The Royal Melbourne Hospital, Melbourne

and Westmead Hospital, Sydney) trauma guidelines to space exploration. **RESULTS:** Understanding of human physiology in microgravity is critical in the management of trauma with long duration missions to the Moon and Mars. A trauma guideline specifically for microgravity was developed based on current major trauma centres guidelines. Specific considerations within the guideline included: the use of diagnostic peritoneal lavage in the absence of cross-sectional imaging; Focused Assessment with Sonography for Trauma (FAST) scan training for Astronauts; considerations for chest drain use in the altered pressure environment and specifically re-entry; and development of stabilisation of fractures through minimal weight or 3D printed devices. **DISCUSSION:** Current trauma guidelines can be modified to develop tailored guidelines for space exploration. Trauma guidelines from major trauma centres were reviewed and compared to known physiological responses in microgravity and an applicable guideline developed.

Learning Objectives

1. The audience will learn about physiology in microgravity as it relates specifically to trauma.
2. The audience will learn of a trauma guideline for space exploration developed in conjunction with currently used major center trauma guidelines.

Tuesday, 05/07/2024 ***10:30 AM***
Grand Suites 2 & 3

[S-31]: POSTERS: TRAVEL TRANSPORT AND SAFETY

Chair: Erin Smith
Co-Chair: Andrew Lam

[157] COMPARISON OF EMERGENCY AIR MEDICAL TRANSPORT UTILIZATION IN THE TAIWAN OFFSHORE ISLANDS

Hsin-Pei Liu[1], Hsin Chu[2], Hsin-Hui Chen[3], Chung-Yu Lai[4], Hao Su[5], Ko-Chiang Hsu[3]
[1]*Taoyuan Armed Forces General Hospital, Taoyuan City, Taiwan (Greater China);* [2]*Civil Aviation Medical Center, Taipei City, Taiwan (Greater China);* [3]*Tri-Service General Hospital, National Defense Medical Center, Taipei City, Taiwan (Greater China);* [4]*National Defense Medical Center, Taipei City, Taiwan (Greater China);* [5]*The 4th Tactical Fighter Wing of ROCAF, Chiayi City, Taiwan (Greater China)*

(Original Research)

INTRODUCTION: With over a hundred offshore islands separated by sea from the Taiwan mainland, the necessity for advanced medical care often leads patients to rely on Emergency Air Medical Transport (EAMT) to reach healthcare facilities on the mainland. The Ministry of Health and Welfare (MOHW) is committed to improving the healthcare infrastructure in these remote island areas. Therefore, the primary objective of this study is to analyze and present the evolving patterns of EAMT utilization across the various islands in the region. **METHODS:** This was a cross-sectional study to analyze the National Health Insurance Research Database (NHIRD) and the EAMT Data (EAMTD) provided by the MOHW. Information regarding emergency visits was extracted from the NHIRD files specifically labeled "Ambulatory care expenditures by visits". The number of patients moved by air was collected from the EAMTD accessible through the MOHW's official website. The rates and trends of the EAMT during the period spanning from 2016 to 2018 will be presented according to the distinct geographical regions, namely Penghu, Kinmen, and Matsu. **RESULTS:** A total of 521 patients were transported by the aircraft with varying numbers distributed across distinct regions: Penghu accounted for 213 patients, Kinmen for 199 patients, and Matsu for 109 patients. The rates of the EAMT for emergency visits showed a consistent upward trend across all three regions. Penghu had the lowest rate, at 19.1 visits per 10,000, while Kinmen recorded rates of 25.5 visits per 10,000, respectively. Notably, Matsu had the higher rate, with 51.3 movements per 10,000 visits. **DISCUSSION:** In recent years, this work was the first study to illustrate the EAMT rate by the integration of the released information in Taiwan. Our findings shed light on the actual EAMT rates in various regions. These discrepancies in rates may be attributed to variations in resources and capabilities within the local medical facilities. Authorities can use these observed rates as benchmarks so as to evaluate the effectiveness of their policy implementations.

Learning Objectives

1. To obtain the proportion of EAMT utilization across the various islands.
2. To use the observed rates as benchmarks to evaluate the effectiveness of policy implementations.

[158] PREVALENCE OF DEGENERATIVE FINDINGS IN LUMBAR SPINE AMONG MILITARY ROTATING WING PILOTS OF AN AIR BASE LOCATED IN THE STATE OF MEXICO.

Vicente Lozada-Balderrama[1], Liliana Reyes-Castañeda[2], Jesús José Arreola-Bastidas[3], Nadia María Espinosa-Largo[4], Alejandro Vieyra-González[1]
[1]*Instituto Politécnico Nacional, Mexico City, Mexico;* [2]*Hospital Militar Regional Santa Lucía, Santa Lucía, Mexico;* [3]*Hospital Militar de Zona de Apatzingán, Apatzingán, Mexico;* [4]*Hospital Central Militar, Mexico City, Mexico*

(Original Research)

INTRODUCTION: Mechanic vibrations produced during the flight on rotary wing aircraft have been widely associated with the presence of neck and back pain, and in some studies, with cases of degenerative disk disease. This study aims to calculate the prevalence of degenerative disk disease in military rotary wing pilots of an air base located in the State of Mexico. **METHODS:** Descriptive, analytical, cross-sectional study with convenience sampling of 35 pilots between 20 and 40 years old, apparently healthy, BMI lower than 28 points, total flight hours (FH) resulted between 480 and 3370. Between January and April 2017, after signing an informed consent form every pilot went under a nuclear magnetic resonance interpreted later by an experienced radiologist based on Pfirrmann classification. For statistical analysis the sample was divided in three groups, Group 1: 480-1000 flight hours; Group 2: 1000-2500 flight hours; Group 3: >2,500 flight hours. Descriptive and inferential statistic tests were performed. Method was previously approved by National Bioethics Commission. **RESULTS:** Age mean was 32.86 ±4.78 years old, weight mean 79.37 ±7.19 Kg, BMI mean 26.01 ±1.51 points, helicopter flight hours mean 1 065 ±893.39. Prevalence of degenerative disk damage was 91.42% (n=32). Pfirrmann grade 1 changes were found in 2.86% (n=1, with 1,043 FH), grade II was found in 45.71%(n=16, X=1,680.38 FH), grade III in 25.71% (n=9, X=603.78 FH) and grade IV in 20% (n=7, X=1,943.86 FH). Most frequent affected region was L1-S1 in 48.57% (n=17). Statically significant difference was found in Pfirrman stage between group II and IV. No statically significant association between groups and Pfirrmann staging was found. **DISCUSSION:** Prevalence of discal degenerative findings in military pilots was higher than the prevalence in general population. Pfirrmann grade II was the most frequently found in rotary wing pilots.

Learning Objectives

1. The audience will be able to perceive the difference between the prevalence of findings of disc degeneration in general population and in military rotary wing pilots.
2. The participants will know about the efects of flying rotary wing aircraft, a reliable method to assess disk damage and it´s asociations with job characteristics.

[159] OPIOID OVERDOSE INCIDENCE ON US COMMERCIAL FLIGHTS

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(Original Research)

INTRODUCTION: Opioid overdose is a major cause of death and hospitalizations in the US. The overall incidence of non-fatal opioid overdose emergency department visits in the US is 133.9 per 100,000 people. It is reasonable to expect opioid overdose to affect passengers in-flight. The objective of this study is to estimate the incidence of opioid overdoses on commercial airline flights. **METHODS:** Data from 2022 were extracted from an internal database of in-flight medical events collected by a major ground-based medical support provider among major US airlines. Potential opioid overdoses were flagged using multiple criteria with different degrees of certainty into three scenarios: Conservative, Medium, and Liberal. The conservative scenario only included cases of clinical suspicion and naloxone administration. Medium included the "conservative" cases plus cases identified by a ChatGPT-4 analysis of events categorized by the doctors as "Altered Mental Status". The artificial intelligence platform was trained to identify cases of potential overdose using standard diagnostic criteria. The liberal scenario included the "medium" cases plus cases of non-shockable cardiac arrests in adults aged 20-55. Published passenger traffic for 2022 was obtained for the airlines involved in the same period of the study. Incidence was calculated as events per passenger. **RESULTS:** 14,788 in-flight medical events affecting US airlines in 2022 were available for analysis. Seven airlines were represented, for a total of 400,263,000 passengers. Applying the predefined criteria, incidence was calculated as:

- Conservative Scenario: 12 cases. Incidence: 1 per 33.4 million passengers
- Medium Scenario: 44 cases. Incidence: 1 per 9.1 million passengers
- Liberal Scenario: 54 cases. Incidence: 1 per 7.1 million passengers

DISCUSSION: The findings suggest that the incidence of opioid overdoses on commercial airline flights is relatively low, below the incidence of other serious medical events even when using the most liberal inclusion criteria. The discrepancy between this and national incidence of opioid overdose may be due to the limited duration of flights or specific demographics of individuals that fly. There are important limitations in this study given the retrospective nature of data analysis and the absence of confirmatory evidence of opioid utilization in the cases identified.

Learning Objectives

1. The audience will learn that the incidence of opioid overdose for in-flight medical events is relatively low, even if we use the most inclusive criteria for the estimation.
2. The audience will learn how we approached a way to estimate the incidence of opioid overdose for in-flight passengers by using a risk-stratified approach.

[160] WHERE AND HOW WELL DO CABIN CREW SLEEP DURING LONG-HAUL FLIGHTS?

Lucia Arsintescu[1], Cassie J Hilditch[1], Sean Pradhan[2], Kevin B Gregory[3], Erin E Flynn-Evans[3]
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(Original Research)

INTRODUCTION: Sleep loss and circadian disruption pose a significant risk in aviation. Many studies have shown that inflight rest locations influence alertness and performance among pilots, but few studies have evaluated cabin crew. The aim of this research was to assess sleep outcomes among cabin crewmembers sleeping in a bunk during both outbound and inbound compared to alternating sleep in a bunk or a jump seat during one long-haul route. **METHODS:** Twenty-nine (5 male) cabin crewmembers (M_{age} = 30.61, SD = 2.91) flew the same long-haul route (outbound and inbound) with a flight duration of 10:41 (± 0:14) hours. Participants were randomly assigned to fly on an aircraft with a bunk in both directions or to fly an aircraft with a bunk in one direction and with a high comfort jump seat (HCJS) in the other direction for their sleep opportunity. They wore an Actiwatch throughout the entire study and completed a sleep diary at bedtime and upon waking for each sleep opportunity. Seventy-seven percent of the flights had a bunk and 23% had a HCJS. A series of mixed-effects models were performed to assess the differences in several sleep parameters when crewmembers slept in the bunk during both directions of the flight (bunk-only) compared to sleep obtained in the HCJS during one direction and bunk in the other (bunk+HCJS). **RESULTS:** Fifty-seven flights were included in the analyses. There were significant differences between sleep time (b = 22.56, SE = 9.07, p = .02, Hedges' g = -0.65) and sleep efficiency (b = 16.75, SE = 4.49, p = .001, Hedges' g = -1.07) obtained in bunk-only vs. bunk+HCJS. Crewmembers obtained more sleep and had better sleep efficiency when they slept only in the bunk compared to bunk+HCJS. **DISCUSSION:** Our results showed that cabin crewmembers slept longer and had better sleep efficiency when they used the bunk. Further research is needed to understand how subjective sleepiness and subsequent performance are influenced by sleep opportunity in a bunk-only compared to bunk+HCJS.

Learning Objectives

1. Understand where and how well cabin crew sleep during long-haul flights.
2. Provide awareness of the need to study cabin crew fatigue and performance during long-haul flights.

[161] HYPOXIA INCREASES NF-κB ACTIVATION AND CYTOKINE EXPRESSION BUT DECREASES EXPRESSION OF IRF5/7, JUN AND INTERFERONS IN SMALL AIRWAY EPITHELIAL CELLS

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WITHDRAWN

[162] HYPOXIA-REOXYGENATION INDUCED DYSREGULATED MIRNA EXPRESSION ASSOCIATED WITH LUNG INJURY AND IMMUNE DYSFUNCTION IN HUMAN SMALL AIRWAY EPITHELIAL CELLS

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[1]*National Defense Medical Center, Taipei, Taiwan (Greater China);* [2]*Taipei Tzu Chi Hospital, New Taipei City, Taiwan (Greater China)*

(Original Research)

INTRODUCTION: Hypoxia-reoxygenation (H/R) has been shown to occur during transition from the hypobaric hypoxic cabin environment in air traveling to normobaric normoxia during landing, and it mimic the ischemia-reperfusion situation encountered in vivo during organ transplantation. Hence we are interested in studying whether exposure to H/R may influence the expression of microRNAs that regulate airway inflammation, immunity and injury in human small airway epithelial cells (SAECs). **METHODS:** The normal and COPD-diseased SAECs (respectively N-SAECs and D-SAECs) were purchased from Lonza Biotechnology Company and respectively cultured under normoxia (21% O_2) or under 24/24-hour cycles of H/R (i.e., 1% O_2 and 21% O_2 alternately) for 6 days in total, followed by extraction of total RNAs for small RNA sequencing. **RESULTS:** We found that most of the microRNAs (miRNAs) showing dysregulated expression levels in the SAECs exposed to H/R are either tumor suppressors or oncogenes and reveal opposite fold changes in N-SAECs and D-SAECs. Among the miRNAs showing expression changes in the same direction in both types of SAECs under H/R, upregulated tumor

suppressor miR-147b-3p and downregulated oncogene miR-483-3p both contribute to elevated airway inflammation by increasing IL-6 and TNF-α expression and promoting IGF1-induced NK cell activity. In addition, downregulated oncogene miR-483-3p, together with the upregulated oncogene miR-1290 and downregulated tumor suppressor let-7c-3p in both N-SAECs and D-SAECs cultured under H/R, are associated with increased pulmonary fibrosis. On the other hand, downregulated oncogene miR- 27a-3p in D-SAECs and upregulated miR-193b-5p in both N-SAECs and D-SAECs under H/R are associated with GSK3β- and TNF-inhibited expression of the tight junction proteins Claudin-5 and Occludin, and may contribute to the LPS- and TNF-induced acute respiratory distress syndrome (ARDS) and lung injury. Interestingly, both of the NRF2-regulated miRNAs, miR-365a-5p and miR-365b-5p, were upregulated in N-SAECs whereas downregulated in D-SAECs, while miR-365b-5p has been reported to target the 3′ UTR of the SARS-CoV-2 RNA. **DISCUSSION:** Our study reports for the first time that hypoxia-reoxygenation induces dysregulated miRNA expression associated with increased airway inflammation, pulmonary fibrosis and ARDS lung injury in both the healthy and COPD-diseased SAECs.

Learning Objectives

1. The audience will gain knowledge about how hypoxia-reoxygenation will change the expression level and different functions of various small RNAs in human small airway epithelium.
2. The audience will understand what are the common and differential changes of small RNA functions in the healthy versus COPD-diseased airways exposed to hypoxia-reoxygenation, and how the dysregulation of these microRNA levels may affect the etiology of the airway epithelium.

[163] SECONDARY AERO-RESCUE, "THE NEW CONCEPT OF MEDICAL CARE IN THE TRANSFER OF CRITICAL PATIENTS BY AIR"

Wagner Samaniego[1], Vicente Ciancio[2], Marcos Saldivia[3]
[1]*Hospital Regional De Coyhaique, Coyhaique, Chile;* [2]*Universidad De La Plata, La Plata, Argentina;* [3]*Samu, Coyhaique, Chile*

WITHDRAWN

[164] TITLE: SUITABILITY OF ARMY AMBULANCE MEDICAL EQUIPMENT SETS AND CONSUMABLE SUPPLIES FOR ARCTIC OPERATIONS

Sarah Snyder, Laura Kroening
U.S. Army Aeromedical Research Laboratory, Fort Novosel, AL, United States

(Original Research)

INTRODUCTION: US. Army operational forces are not currently "Arctic-capable." The performance of essential military MES items used in en route care (ERC) patient transport has not been studied or tested in the arctic environment. **METHODS:** Retrospective data was consolidated from patient movement items (PMI) and reviewed from the U.S. Aeromedical Research Laboratory's Enroute Care Group Testing & Evaluation team to determine the temperature operating range and average battery life of the U.S. Army's most current air ambulance electronic medical equipment set (MES). The project lead performed a site visit July 2023 to Fort Wainwright, AK and Fort Greely, AK to look at medical evacuation (MEDEVAC) capability gaps identified from operational active-duty Critical Care Flight Paramedics (CCFPs) serving in Charlie, 1-52 General Support Aviation Battalion, 16th Combat Aviation Brigade, at an active-duty cold weather location outside the continental U.S. **RESULTS:** A site visit to Fort Wainwright, AK revealed reports from CCFPs serving in Alaska are performing MEDEVAC operations in temperatures as low as -37 to 40 degrees Celsius (-34.6 to -40 degrees Fahrenheit). Generally, the electronic MES can operate under the current Joint En route Care Equipment Test Standard, Revision 1 (JECETS, Rev. 1) standards, but the affiliated battery systems will most likely deplete in Arctic operations before the electronic MES item(s) malfunction(s) or become inoperable. **DISCUSSION:** The current JECETS, Rev. 1, which is used for airworthiness release certification and aeromedical certification to add PMI to the standing Aeromedical Certification Memorandum, does not meet the cold weather operational requirements for tactical ERC under arctic weather conditions.

Learning Objectives

1. To determine if the performance of essential electronic military MES items used in ERC patient transport are suitable for Army rotary-wing MEDEVAC in artic environments.
2. This abstract seeks to identify if the current JECETS, Rev. 1 for Climatic – Low Temperature testing of electronic MES item(s) used in ERC are suitable for MEDEVAC operations in subzero, arctic operating environments.

[165] MEDICAL SELF-DISCLOSURE RATES AMONG NAVAL AVIATORS

Michael Weipert, Jacob Westerberg, Jonathan Elliot
U.S. Navy, Pensacola, FL, United States

(Original Research)

INTRODUCTION: Aviators can be hesitant to disclose medical information to their flight surgeons for fear of negative repercussions. However, failing to disclose this information can have negative health and financial consequences, both short- and long-term. Without full medical information, an aviator's medical record cannot be updated, making it difficult to identify and treat illness or disease in the acute phase. Furthermore, VA disability claims may not be granted in the future without proper documentation in a service member's Service Treatment Record (STR). Well before that point, untreated medical conditions may also represent an operational flight safety concern. **METHODS:** To determine what percentage of Naval Aviators are not disclosing health concerns, and to further identify what types of medical issues aviators are reticent to disclose, a cross-sectional epidemiological study using an original survey was conducted among designated aviators at Naval Aviation Safety Command. **RESULTS:** The study found that 57% of Naval Aviators have failed or are failing to disclose medical concerns to their flight surgeons. The study also revealed that only small percentages of aviators were willing to discuss concerns in particular medical categories: Psychiatry (17%), Neurology (23%), Medication/Supplements (27%), Internal Medicine (34%), and Pulmonary (36%). The Naval Aviators were also asked to comment on how many of their fellow pilots regularly did not disclose medical concerns; over half of those surveyed believe that a majority of their peers are flying despite experiencing undisclosed medical concerns. **DISCUSSION:** The survey revealed that a large percentage of Naval Aviators are unwilling to take advantage of the medical system that the Navy currently provides. The problem of aviators not confiding in their flight surgeons is not new, but this study showed how widespread the problem remains. Aviators who are unwilling to seek medical care for themselves present a potential safety risk, in addition to possibly denying themselves future VA health benefits. The information collected here can help influence Navy policy to improve aviators' experience of aerospace medicine and serve as a call for further research into how to effect meaningful changes.

Learning Objectives

1. Identify the prevalence of Naval aviators not disclosing medical concerns to their flight surgeons and determining how widespread this problem is in the Naval aviation community.
2. Identifying which medical conditions Naval aviators are more likely to discuss with their flight surgeons and what conditions Naval aviators are most likely to not disclose.

[166] DEVELOPMENT OF POINT-OF-CARE TESTING TECHNOLOGY FOR 20 TYPES OF CHEMICALS THAT COULD CAUSE INFLIGHT INCAPACITATION

Yuan Luo, Zhusong Mei, Longmei Fang, Qiao Ye, Bingqian Guo, Dongyun Feng, Lu Wang, Guangyun Wang
Air Force Medical Center, Air Force Medical University, PLA, P.R. China, Beijing, China (Mainland)

WITHDRAWN

[167] PILOT PREFERENCES FOR SLEEP DATA COLLECTION AND DATA SHARING USING CONSUMER SLEEP TECHNOLOGIES (CSTS)

Jaime Devine, Jake Choynowski, Steven Hursh
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(Original Research)

INTRODUCTION: Regulatory bodies that govern aviation, such as the Federal Aviation Administration (FAA), require organizations to collect objective sleep data to ensure that crew members are obtaining sufficient sleep. Consumer sleep technologies (CSTs) are increasingly popular and may become a viable tool for collecting sleep data in aviation. However, pilot preferences and willingness to share data from CSTs has not been investigated beyond anecdotal reports. The current study assesses pilot opinions about the use of CSTs for work purposes and their preferences on data sharing with the goal of improving participant compliance to data collection. **METHODS:** Pilots were asked to provide information about their duty length, CST use, and to give their opinions about the use of CSTs during operations and their willingness to share data under a variety of circumstances. CST users reported brand preferences; non-users reported reasons for non-use. All respondents indicated what type of device they thought would be best for aviation and rated their likelihood to share data with their organization under a series of hypothetical situations. **RESULTS:** One hundred and eight pilots from short haul (n=56), medium haul (n=33), long haul/ultra long range (n=16), or on-call (n=2) responded between Jan-July 2023. Smart watch CSTs were preferred by 37% of pilots. Apple was the preferred brand by 26% of CST-users. Twenty percent of non-users cited "no need" as their reason; only 9% of non-users mentioned privacy concerns. Pilots were most likely to share data with their organization if they were given a sleep tracker by their organization. **CONCLUSIONS**: Pilots seem most willing to provide sleep data from a CST if the organization provides the device. There was not overwhelming brand loyalty among current CST users; reasons for not using a CST were ambivalent rather than distrustful. Taken together, these findings suggest that organizations could increase compliance to data collection by supplying pilots with company-purchased CSTs for data collection or continuing to use research actigraphs.

Learning Objectives

1. This survey establishes pilots' willingness to share data using consumer sleep trackers.
2. This survey explores pilots' reasons for using or not using a consumer sleep tracker.

[168] METHODOLOGY FOR MATCHING LEGACY ACCELERATIVE EXPOSURES ACROSS MULTIPLE SUBJECT TYPES

Shannon McGovern, Ardyn Olszko, Alicia Abraczinskas, Christine Beltran, Kimberly Vasquez, Valeta Chancey
U.S. Army Aeromedical Research Lab, Fort Novosel, AL, United States

(Original Research)

INTRODUCTION: The Biodynamics Data Resource (BDR) at the U.S. Army Aeromedical Research Laboratory houses data for ~7,000 non-contact inertial loading exposures (non-injurious and injurious) from vertical and horizontal sled runs previously conducted at the Naval Biodynamics Laboratory (1971-1996). Kinematic and physiologic responses were measured from human research volunteers (HRVs) (only non-injurious), anthropomorphic test devices (ATDs), and non-human primates (NHPs). Therefore, data can be used to develop human injury criteria; however, a methodology is first needed to match non-injurious parameters across subject types to extrapolate the non-injurious human responses to injurious ranges. **METHODS:** Twenty-six parameters (peak sled acceleration, impact direction, etc.) were scored as high, medium, low, or negligible and classified as numeric or categorical. Classifications were made using multiple statistical assessments. Two processes were used to determine tolerances on numeric parameters: classifying parameters into statistical distributions and equal-frequency varying-bins histograms. Tolerances were selected from equal-frequency varying-bins histograms based on the largest bin size. Data were matched based on exact categorical and numeric parameters within a tolerance range. **RESULTS:** Fifteen parameters had high-priority classification: categorical (6) and numeric (9). The data spread for most numeric parameters were right-skewed, and none fit a known statistical distribution. All HRV exposures fell within the range of the ATD and NHP exposures for all parameters. Equal-frequency varying-bins histograms determined a static frequency per parameter, allowing for bin sizes and number of bins (16 to 80) to vary. The largest and smallest tolerances of all parameters encompassed 94.79% and 15.94% of the range, respectively. All parameters were matched between subject types but not across all three subject types. **DISCUSSION:** The right-skewness of the numeric parameters was due to higher ATD and NHP (injurious) exposures, causing selected tolerances to encompass a large percent of each parameter range. While this generated matches, no matched group contained all three subject types despite large tolerances. While future work could apply these methods solely over the HRV range and decrease bin sizes to optimize groups with matched parameters, real-world data and subject variability may not be suitable for such statistical binning to determine matched pairs.

Learning Objectives

1. Learn a methodology for matching datasets across multiple subject types for a variety of matching parameters, where parameters included are both numeric and categorical.
2. Learn that when assessing exposures across multiple subject types and intensities, parameters chosen to match must be limited by relevance to the research question to make comparisons.

[169] A BIOFIDELIC TESTING METHODOLOGY FOR AIRCREW HELMETS

Alasdair Mackay[1], Matthew Lewis[1], Mazdak Ghajari[2]
[1]*Royal Air Force Centre of Aerospace Medicine, Henlow, United Kingdom;* [2]*Imperial College, London, United Kingdom*

WITHDRAWN

Tuesday, 05/07/2024 ***2:00 PM***
Grand Ballroom CD South, EF

[S-32]: PANEL: HIGHLIGHTS AND LESSONS LEARNED FROM THE FIRST MISSIONS AT A COMMERCIAL SPACE COMPANY

Chair: Michael Harrison

PANEL OVERVIEW: *The first spaceflight missions at any organization provide a number of opportunities to learn lessons and refine processes. This panel summarizes the first three missions flown by a commercial space company while highlighting the differences associated with meeting the needs and satisfying the priorities of the different types of commercial spaceflight*

customer who may fly. This evolution occurred in less than 24 months and is likely to continue as planning and training occurs for the fourth and subsequent future missions. To date, the missions have included a individuals of different ages, backgrounds, cultures, and experience in extreme environments. These lessons are crucial in establishing processes and practices by which to make commercial spaceflight safely accessible to all.

[170] PRIVATE ASTRONAUT MISSIONS TO THE ISS: LESSONS LEARNED IN OPERATIONAL AEROSPACE MEDICINE

Ted Duchesne[1], Michelle Hong[2], Melinda Hailey[1], William Powers[2], John Marshall[2], Alexander Rubin[1], Lindsey Hieb[1], Mayur Bhakta[1], Michael Harrison[2]
[1]*Axiom Space Inc, Houston, TX, United States;* [2]*Axiom Space Inc & Hercules Medical Group, Houston, TX, United States*

(Education - Program/Process Review)

BACKGROUND: As part of its strategy to support the growth of a Low Earth Orbit (LEO) economy, National Aeronautics and Space Administration (NASA) introduced the opportunity for commercial providers to utilize the International Space Station (ISS) as a destination for Private Astronaut Missions (PAM). Since that announcement in 2019, Axiom Space has medically certified, trained, and successfully completed two PAM missions to the ISS comprised of Axiom employee astronauts, private individuals, and non-US government astronauts. **OVERVIEW:** A successful private astronaut mission required the medical team to work within the resources and legal framework of a private company while interfacing with a wide variety of people including medical and non-medical personnel in various government agencies and within other private companies, external project managers, and personal executive assistants to name a few. Moreover, each mission was comprised of a unique complement of astronauts with varying backgrounds. In 2022, Ax-1 became the first all-private astronaut mission to the International Space Station. This was followed by Ax-2 in 2023 which included privately flown non-US government astronauts. Axiom Space is currently preparing for Ax-3 which includes astronauts representing five countries from three different government agencies. **DISCUSSION:** The Axiom private astronaut missions represent a number of operational firsts including: 1. large scale medical selection efforts with a foreign government and 2. collaboration with multiple government agencies to provide appropriate risk assessment and medical certification for both private and foreign government-sponsored astronauts. In addition to assisting with selection, medical certification, and maintaining crew health and wellness, Axiom's medical team helped developed a flight controller certification plan for their console positions, managed mission related food, developed medical quarantine standards, provided launch and landing support, assisted with crew family support, and were integrally involved in contingency situation planning.

Learning Objectives

1. The audience will learn about the wide range of individuals who are potential commercial space crewmembers and the unique considerations associated with providing medical support for their spaceflight.
2. The audience will be able to identify common processes associated with providing medical support for a commercial space mission at one company.
3. The audience will understand the challenges associated with supporting a commercial space mission in the current legislative context.

[171] OPERATIONAL CHALLENGES OF FACILITATING MEDICAL CARE FOR THE FIRST ALL PRIVATE CREW TO THE ISS

Alexander Rubin[1], Michelle Hong[2]
[1]*Axiom Space, Houston, TX, United States;* [2]*Axiom Space/Hercules Medical Group, Houston, TX, United States*

(Education - Program/Process Review)

BACKGROUND: Ax-1 was an unprecedented mission that saw a fully private crew fly to the ISS. The crew was comprised of three Ultra High Net Worth Individuals (UHNWI) and a former NASA astronaut employed by Axiom Space. Each Ax-1 crewmember received over 700 hours of spaceflight training in addition to payload training. The crew completed twenty-five research investigations as well as media, outreach, and commercial events. **OVERVIEW:** The Axiom Medical Team (AMT) was charged with certifying these self-selected crewmembers for flight. Subsequently, the AMT presented to NASA and the International Partners (IPs) for risk acceptance. Significant integration was required to combine the medical operations of a commercial space entity with the existing processes used by NASA Medical Operations to fly government astronauts. The need to establish new medical processes drove the majority of the implementations by the AMT for Ax-1. **DISCUSSION:** In flying a fully private crew for a 17-day mission, Axiom had to develop a unique operational paradigm to support our suite of activities. It was quickly discovered that there is no "one size fits all" for Private Astronaut Missions (PAMs). Risk acceptance was predicated upon meeting NASA requirements and implementing new processes for a variety of medical needs. For example, Axiom worked with NASA to find a secure path for all PHI generated during the mission. This included agreements concerning medical imagery transfer, secure email processes, and payload science data management. Other operational challenges included:

- Coordination of exercise as a countermeasure to the effects of microgravity.
- Negotiating the timing and resource allocation required to facilitate on-orbit medical conferences.
- Establishing the division of medical authority among the medical teams at Axiom, NASA, and the US Commercial Vehicle provider during all phases of flight.
- Integration and assistance to facilitate commercial science endeavors.

Learning Objectives

1. The participant will be able to recognize some of the unique medical operational challenges faced by a commercial space company.
2. The participant will learn about strategies used to address the medical operational challenges faced during Axiom's Ax-1 mission.

[172] MEDICAL CERTIFICATION OF A MIXED COMMERCIAL CREW FOR SPACEFLIGHT, FROM SELECTION TO FLIGHT

John Marshall, Michelle Hong, Williiam Powers
Axiom Space, Inc, Houston, TX, United States

(Education - Program/Process Review)

BACKGROUND: The Axiom-1 (Ax-1) crew was comprised of three "Ultra High Net Worth Individuals" (UHNWI) and one veteran, Axiom employed astronaut. This mission demonstrated the successful medical certification of self-selected individuals that ultimately executed a successful mission of outreach and science. The Axiom-2 (Ax-2) mission again demonstrated a successful science and outreach mission but with a dramatically different crew contingent and medical selection process. **OVERVIEW:** In mid-2023, Axiom Space, Inc. launched Ax-2, its second mission to the International Space Station (ISS). The selected crew was especially diverse, comprised of one UHNWI, two government employed astronauts from the Kingdom of Saudi Arabia (KSA)-one of civilian and the other of military background-and one veteran, Axiom employed astronaut. The crew selection methods were also diverse. In contrast to Ax-1, the Ax-2 crew selection mixed UHNWI self-selection with an Axiom led selection campaign executed in cooperation with the KSA's then Saudi Space Commission (SSC). Axiom then undertook the final medical certification process of all Ax-2 crewmembers for risk acceptance by the National Aeronautics and Space Administration (NASA) and Multilateral Space Medicine Board (MSMB). In doing so, Axiom combined and applied known medical standards, aerospace medicine physician training and experience, and targeted medical consultant knowledge to assess astronaut medical

and mission risk and safely certify a multitude of medical comorbidities. **DISCUSSION:** The Ax-2 mission represents a number of operational firsts, the most significant of which involves the first time a commercial space entity has led large scale medical selection efforts with a foreign government to select foreign government astronauts. In doing so, Axiom successfully collaborated with multiple government agencies to risk assess both career and non-career and government and private astronauts under one mission umbrella. These efforts required Axiom to establish a selection process that accommodated widely different customer backgrounds and mission goals in the face of diverse astronaut demographics.

Learning Objectives

1. The audience will understand the complexities of medically certifying commercial, private astronaut crewmembers for missions to the International Space Station.
2. The audience will understand the role that Axiom Space plays in advising burgeoning space agencies on the medical selection process.

[173] AX-3 MISSION SPECIFIC DETAILS

William (Ed) Powers[1], Mayur Bhakta[2], Alex Rubin[2], Michael Harrison[1]
[1]*Hercules Medical Group/Axiom Space, Houston, TX, United States;* [2]*Axiom Space, Houston, TX, United States*

(Education - Program/Process Review)

BACKGROUND: While the crew composition of missions Ax-1 and Ax-2 had Ultra High Net Worth Individuals (UHNWI's), by contrast Ax-3 have none. All crewmembers have extensive military aviation experience (three fighter pilots and a flight engineer). Four European countries are represented (Commander has dual citizenship) and Ax-3 is considered to be the first all-European space mission. **OVERVIEW:** In early 2024, Axiom Space will launch the Ax-3 mission. This is the third mission to dock with the International Space Station and NASA's third Private Astronaut Mission (PAM). The crew consists of the Commander who is an Axiom employee with dual citizenship (Spain and USA), a former Naval Aviator and an experienced NASA astronaut; the Pilot who is an Italian Air Force officer and fully trained as a Soyuz flight engineer; Mission Specialist 1 who is the first astronaut from Turkiye and a former fighter pilot and commercial airline pilot; and Mission Specialist 2 who is a Swedish fighter pilot and test pilot and was recently selected by the European Space Agency (ESA) as an astronaut. The Turkish astronaut underwent a selection process with collaboration between Axiom Space and the Turkish Space Agency, Tubitak Uzay. During the mission, experiments will be performed that are sponsored by the Italian Air Force, Tubitak Uzay, ESA and various other contributors. Much of the medical qualification tests were completed outside the US for two astronauts. All astronauts were approved for risk acceptance for flight to the International Space Station by the National Aeronautics and Space Administration (NASA) and the Mulilateral Space Medicine Board (MSMB). **DISCUSSION:** The Ax-3 mission has significant first-time milestones including: the first astronaut from Turkiye, the first all-European astronaut crew, the first use of NASA Launch Complex 40 for human spaceflight, and the first international partner flight surgeon to support a mission at Axiom (ESA flight surgeon). Additionally, to reduce reliance on limited NASA resources, Axiom has successfully established processes for providing and packing ascent/descent food and acquired in-house ownership of assets for secure communications between the ground medical team and the on-orbit crew.

Learning Objectives

1. The audience will learn about the distinctive crew of Ax-3, the third private astronaut mission to the International Space Station.
2. The audience will learn about the significant first-time milestones accomplished by the Ax-3 mission.

[174] FUTURE SIGHTS ON LONG DURATION MISSIONS: INTEGRATING MEDICAL SUPPORT WITH AX-4 AND BEYOND

John Marshall, Michelle Hong, Mayur Bhakta, Michael Harrison
Axiom Space, Inc., Houston, TX, United States

(Education - Program/Process Review)

BACKGROUND: The first three private astronaut missions (PAM) planned and executed by Axiom Space were of a diverse crew composition within and between missions. The first mission flew ultra-high net worth individuals while subsequent missions were composed increasingly of government agency astronauts. Just as the crewmember composition developed mission by mission, medical hardware and supply support similarly underwent an iterative process to accommodate the changing diversity of crew composition and mission parameters. **OVERVIEW:** The current United States Carrier Vehicle (USCV) transporting astronauts to the International Space Station (ISS) includes a medical support kit to provide medical care during freeflight. Due to the extended nature of Axiom Space's current Private Astronaut Missions (PAM) involving docked missions to the ISS, additional medical supplies were included as part of a supplementary medical kit during the first Axiom PAM mission, Ax-1. Subsequent missions expanded on the Axiom Space provided medical supplies and crew training material and care delivery paradigms were developed to accommodate both medically experienced and inexperienced crewmembers from different cultural and agency backgrounds. For the Ax-4 mission to be flown, it is planned that the medical kit complement involves a further leap on the iterative design for parent containers, contents, and crew training. **DISCUSSION:** Along with plans for more new partnerships and crew compositions, the Ax-4 mission's medical support hardware and designs will pave the way for ground and flight testing for a minimum viable product for long duration, i.e. "Segment", operations integrated with the training and care delivery paradigms of an increasingly independent commercial space company. As the Ax-4 crew is to be determined at the time of this writing, all design and training instances will need to accommodate further diverse crew possibilities to include newly partnered agencies, e.g. the United Kingdom Space Agency. The tasks of creating de novo training materials, flight hardware testing and certification, and integration of processes with multiple agencies and crewmember backgrounds presents a particularly complex set of challenges that upon completion will push forward Axiom Space's long duration endeavors.

Learning Objectives

1. The audience will understand the iterative process of creating a crew medical support system that encompasses hardware, medications, training materials, and interagency dialogue.
2. The audience will understand the need for different training and care delivery paradigms that fit the mission type, crew composition, and interagency support.

Tuesday, 05/07/2024 ***2:00 PM***
Grand Ballroom A

[S-33]: PANEL: MODELING G-INDUCED LOSS OF CONSCIOUSNESS (GLOC): A COLLABORATIVE CENTRIFUGE STUDY

Chair: Chris Dooley

PANEL OVERVIEW: *High Performance Aircraft (HPA) in the Air Force and Navy place unique physical demands on their aircrew. Consequently, aircrew are at an ever-present risk of G-induced loss of consciousness (GLOC) when performing flight maneuvers. Pilots undergo substantial training to improve and maintain G-tolerance via centrifuge and live flight. Currently, there is limited ability for quantitative evaluation of HPA aircrew's physiologic resistance to, and real time risk of, GLOC and subsequently recovery. Recent improvements in physiologic sensing in flight open new avenues to explore real-time feedback of physiologic risk, including GLOC, for pilot safety and training effectiveness. Recruited from the WPAFB high-G human subject panel, participants experienced a simulated flight profile designed to safely and reliably induce GLOC. Participants were subjected to 3 spins with no aircrew flight equipment (AFE) and 3 spins with AFE. Data captured*

during these events included heart rate, pupillometry, EEG, and pulse oximetry. Cognitive performance was assessed continuously via simultaneous visuomotor and math task to assess cognitive changes from pre-G exposure through G-loading and including post-G recovery. This study will result in improved models for real-time physiologic risk assessment for pilots, possibly preventing future mishaps and improving pilot training and performance. This collaborative study pulled expertise from Air Force and Navy subject matter experts, as well as leaning on support from academic partners. Multiple follow-on efforts are ongoing using the dataset generated. This panel will present an overview of the study design and execution as well as a subset of the primary analyses that are being completed with the data. Air Force representatives will present on the study design, physiologic presentation of GLOC, and model development for predicting cognitive deficit due to sustained Gz. Navy collaborators will present on the novel implementation of EEG under sustained Gz and model development for physiologic prediction of GLOC events. This study was reviewed and approved by the AFRL IRB.

[175] MODELING G-INDUCED LOSS OF CONSCIOUSNESS (GLOC): STUDY DESIGN AND EXECUTION

Chris Dooley[1], Megan Gallo[1], Kara Blacker[2], Kim Cates[3], Lucas Potter[1], Hannah Kohne[1]
[1]*711th Human Performance Wing, Wright-Patterson AFB, OH, United States;* [2]*Navy Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States;* [3]*KBR, Baltimore, MD, United States*

(Original Research)

INTRODUCTION: USAF and USN High Performance Aircraft (HPA) place unique physical demands on aircrew. Consequently, aircrew are at an ever-present risk of G-induced loss of consciousness (GLOC) when performing flight maneuvers. Aircrew undergo training to improve and maintain G-tolerance via centrifuge and live flight. Currently, there is limited ability for quantitative evaluation of aircrew's physiologic resistance to, and real time risk of, GLOC and subsequent recovery. Improvements in physiologic sensing in flight open new avenues to explore real-time feedback of physiologic risk, including GLOC, for pilot safety and training effectiveness. WPAFB high-G human subject panel volunteers experienced centrifuge profiles designed to safely and reliably induce GLOC. Participants completed three spins with no aircrew flight equipment (AFE) and three spins with inflated AFE. **METHODS:** The study design was based off Tripp et al 2006 study exploring the same phenomena. The primary augmentations were inclusion of sensors with improved temporal resolution, EEG, and eye tracking. 13 volunteers from the WPAFB High-G Human Subject Panel combined to make 116 lab visits for task familiarization and data collection events. Volunteers were non-aircrew who've been 9G qualified in the WPAFB centrifuge. Subjects were outfitted with 16- or 32-lead BrainVision EEG, Tobii eye tracking glasses, NIRSense Aerie patch, and an Equivital Lifemonitor. Data collection profile consisted of a gradual onset rate exposure to capture daily baseline G-tolerance followed by a rapid onset rate (ROR) exposure to a threshold set above their daily G-tolerance. Participants simultaneously performed continuous visuomotor tracking and discrete arithmetic tasks before, during, and after the ROR. **RESULTS:** 75 data collection spins were successfully completed, 37 with no aircrew flight equipment (AFE) and 38 with inflated COMBAT EDGE system (anti-G suit, 55/P Helmet, MBU 20/P mask, and pressure breathing for G (PBG)). Of those spins, all 37 of the no AFE spins resulted in GLOC while only 8 of the AFE spins resulted in GLOC. **DISCUSSION:** The following presentations in this panel will highlight the insights that this dataset has enabled. Physiologic data collection in aerospace environments remains a challenge. However, the ability to collect high resolution, high quality physiologic data can unlock key insights into improving aircrew safety and performance.

Learning Objectives

1. Understand physiologic indicators of GLOC and their time course relative to the onset of sustained Gz forces.
2. Understand challenges and limitations to implementing physiologic sensors in the sustained Gz environment.

[176] MODELING G-INDUCED LOSS OF CONSCIOUSNESS (G-LOC): DETERMINATION BY AUDIOVISUAL CLUES - AGREE TO DISAGREE

Megan Gallo, Hannah Kohne, Lucas Potter, Christopher Dooley
Air Force Research Laboratory, Dayton, OH, United States

(Original Research)

INTRODUCTION: Historically, G-LOC events in human centrifuge exposures have been determined by observation from subject matter experts (SMEs). From 75 spins completed during this study, 45 G-LOC events were identified. The occurrence of G-LOC was determined via observation of live audio and camera feed from inside the centrifuge. This brief shall provide video examples of how the research team identified LOC through observation. Additionally, this brief will touch on the contentious debate of "almost" LOC. **METHODS:** For each G-LOC, three event times were recorded: time of suspected LOC, time of return to wakefulness, and time the participant resumed the visuomotor task. To identify LOC, researchers looked for indicators including dual eye closure, slumping of the head and upper body, and jaw muscle relaxation. Often, a combination of indicators occurred simultaneously with participants releasing a handbrake, and/or the head falling to the side or forward. The presence of aircrew flight equipment (AFE) did in some cases obscure determination of when or whether G-LOC had occurred. Return of wakefulness was identified by eyes reopening, sitting upright, and/or verbal feedback from the participant. Lastly, time to resumption of the task was identified by the participant replacing their hand on the joystick, and input on the task. The duration of time it took subjects to resume the visuomotor task also assisted in confirmation of whether G-LOC did in fact occur. After completion of the data collection session, the research team compared times, reviewed the video, and made a final determination of event times. Those event times were then merged into the physiologic and performance data files. **DISCUSSION:** Determination of LOC events in this study were consistent with previous work from Tripp et al. (2006) using similar indicators. Both efforts noted nuances in the phases of incapacitation, both absolute and relative. Comprehensive understanding of the phases of G-LOC are important in proper event determination, and ultimately aid in working towards protective measures for aircrew.

Learning Objectives

1. Audience will learn visual indicators of loss of consciousness (LOC).
2. Audience will learn about the phases of G-induced loss of consciousness (G-LOC).

[177] NEURAL MARKERS OF G-INDUCED LOSS OF CONSCIOUSNESS (GLOC) AND RECOVERY

Kara Blacker[1], Christopher Dooley[2]
[1]*Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States;* [2]*Air Force Research Laboratory 711th Human Performance Wing, Wright-Patterson AFB, OH, United States*

(Original Research)

INTRODUCTION: Military aircrew in high-performance aircraft are often exposed to +Gz forces, resulting in a reduction of cerebral perfusion. Reduced blood supply to the brain can eventually lead to gravity-induced loss of consciousness (GLOC). GLOC incapacitates aircrew and even once consciousness is regained can severely impact safety and performance. While the physiological mechanisms that underlie GLOC itself are well characterized, prediction of impending GLOC and neurocognitive recovery following GLOC remain less understood. **METHODS:** Thirteen participants from the WPAFB high-G human subject panel participated in a total of 6 spins each. Along with other physiological measures, electroencephalography (EEG) was recorded. Participants completed a 5 min cognitive task before and after a rapid onset rate (ROR) profile intended to induce GLOC. Here, we report the EEG results during the time on task, during the GLOC, and return to consciousness phase. Power spectra were calculated

using a time-frequency transformation based on multiplication in the frequency domain from 1-30 Hz using a Hanning taper applied in short sliding time windows. **RESULTS:** From the onset of the ROR until GLOC, we observed a significant increase first in alpha power (8-13Hz), followed by a significant increase in theta power (4-7Hz). During GLOC, participants exhibited high delta power (1-3Hz), which is expected, as delta is most often associated with deep sleep. Interestingly, as participants regained consciousness, we saw the opposite effect, whereby first they transitioned from delta to theta, then theta to alpha. This cascade aligns with EEG characterization known from sleep research. Moreover, we compared frequency spectra for the cognitive task prior to the ROR and after the GLOC event. We found significant increases in delta and alpha following GLOC compared to before the ROR. This suggests that participants are not "back to baseline" for the 5 min following a GLOC event. **DISCUSSION:** Here, we were able to track individual's conscious awareness as before, during, and after GLOC. Evidence suggests there are neural indicators of impending GLOC that may be capitalized on for algorithm development and advancement of an early warning system. Moreover, delayed recovery of neurocognitive function following GLOC has implications for aircrew safety protocols.

Learning Objectives

1. Understand how EEG measures and tracks conscious awareness (or lack thereof).
2. Understand the neural markers that indicate impending GLOC, GLOC, and return to baseline.

[178] G-INDUCED LOSS OF CONSCIOUSNESS (GLOC) PREDICTIVE MODEL DEVELOPMENT

Bridget Rinkel[1], Chris Dooley[2], Kara Blacker[3], Megan Gallo[2], Kim Cates[4], Lucas Potter[4], Hannah Kohne[4], Adam Lammert[5]

[1]Naval Air Warfare Center - Aircraft Division, Patuxent River, MD, United States; [2]711th Human Performance Wing, Wright-Patterson AFB, OH, United States; [3]Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States; [4]KBR, Dayton, OH, United States; [5]Worcester Polytechnic Institute, Worcester, MA, United States

(Original Research)

INTRODUCTION: Military aircrew are often exposed to sustained +Gz in the high-performance cockpit, which can reduce cerebral blood volume and tissue oxygenation, putting aircrew at risk for G-Induced Loss of Consciousness (GLOC). GLOC can temporarily render aircrew unable to control their aircraft and is a major threat to aircrew safety and mission execution. Aircrew would benefit from having an early warning system that alerts them to impending GLOC based on data collected in operationally relevant environments. **METHODS:** Data collected from the 711th Human Performance Wing's GLOC study, including EEG, eye tracking, heart rate, and breathing rate, were used to develop machine learning-based models that provide accurate early indication of the onset of GLOC. Models tested included Random Forest, Support Vector Machine, and Ensemble Learning with Gradient Boosting. Three model systems were designed and evaluated against each other to predict impending GLOC: 1) in *unenrolled* participants, whose data the model had not been trained on, 2) in *enrolled* participants, whose data the model had been trained on, and 3) in enrolled participants, whose data were used to train personalized models, to predict impending GLOC based on individual physiology. Accuracy, efficiency, and operational relevance were evaluated and optimized across models. **RESULTS:** Models were able to predict impending GLOC up to fifteen seconds before it occurred. We found that the highest accuracies were obtained by training individual models for each participant based on individual physiology. The lowest accuracy measures were found in model system 1, which makes predictions on a participant's data it hasn't seen before based on other participant's physiology as GLOC approaches. **DISCUSSION:** We trained statistical models to predict impending GLOC based on physiological data collected in an operationally relevant environment and demonstrated the tradeoff in model performance based on data collection and system objectives. The models help define the time course of development of GLOC from a physiologic, neurologic, and performance perspective, and allow identification of features with the strongest predictive power for real-time risk assessment.

Learning Objectives

1. The participant will understand which data contribute the strongest predictive power to detecting impaired aircrew physiological and cognitive functioning.
2. The participant will understand how variations in cross validation affect model performance.

[179] MODELING COGNITIVE PERFORMANCE DURING HIGH +GZ EXPOSURE

Kimberly Cates[1], Charles Fechtig[2], Chris Dooley[3], Lucas Potter[4], Kara Blacker[5]

[1]KBR, Seton Hall University, Baltimore, MD, United States; [2]University of Maryland, College Park, MD, United States; [3]AFRL, Johns Hopkins University, Dayton, OH, United States; [4]KBR, Old Dominion University, Dayton, OH, United States; [5]Naval Medical Research Unit, Temple University, Dayton, OH, United States

(Original Research)

INTRODUCTION: G-force induced loss of consciousness (G-LOC) continues to be a risk in high-performance aviation with potential for aircraft destruction and more importantly, loss of life. Many studies have evaluated the physiological and anthropometric markers of G-tolerance to understand predictors of G-LOC; However, there's been limited success in predicting cognitive impairment in such simulated flight conditions. This paper provides an approach to modeling cognitive performance through identification of changes in physiological signals as subjects approach their G-tolerance threshold. **METHODS:** The study consisted of 13 participants who were 9-Gz qualified members of the High-G Acceleration (HGA) Human Subject Panel (HSP). Each participant had 6 runs in the centrifuge where half were with aircrew flight equipment (AFE), and half were without AFE. Participants first experienced a gradual onset run, 0.1 Gz/s, (GOR) to establish daily +Gz tolerance. The participants underwent a rapid onset run, 3.0 Gz/s, (ROR) where +2 Gz were added to the established +Gz tolerance threshold in the AFE condition and +1 Gz to the Non-AFE condition to induce G-LOC. During the ROR, participants were continuously performing a 2-part cognitive task, solving basic arithmetic operations while simultaneously tracking a reticle to a fixed target. The cognitive performance metric was calculated from these tasks to estimate the participant's executive functioning. Physiological signals (EEG, HR, PPG, and pupilometry) were evaluated for predictability of cognitive performance. Preprocessed EEG signals were transformed into Alpha, Beta, Theta, and Delta components and fed into the model as derived inputs. Other physiological signals such as pupil diameter, pupil velocity, and heart rate were also added. **RESULTS:** A long-short term memory (LSTM) neural network model learned how changes in physiological signals related to cognitive performance. A model (M1) was trained on all the runs and the following models focused on only runs with AFE, or Combat Edge, (AFE) (M2) and runs without AFE (M3). All models revealed high predictability of cognitive performance with RMSE scores between 0.014 - 0.020. **DISCUSSION:** Key characteristics of in-flight cognitive decline can be inferred by training the LSTM model on physiological changes. The cognitive performance model will allow for improved human machine teaming between pilot and aircraft to enhance safety and performance.

Learning Objectives

1. We will introduce previous attempts at modeling cognitive performance, how we preprocessed and aligned the sensors, and the associated limitations with preparing the data.
2. Identify physiological markers of cognitive performance, understand how to measure cognitive performance, and review LSTM model training and validation.

3. Understand challenges and limitations to modeling cognitive performance given manual data collection, sensor technicalities, and individual differences.

Tuesday, 05/07/2024 ***2:00 PM***
Grand Ballroom B

[S-34]: PANEL: INTERNATIONAL PANEL ON SCREENING FOR HEART DISEASE IN AIRCREW

Chair: Eddie Davenport

PANEL OVERVIEW: INTRODUCTION*: Heart disease is one of the leading causes of medical disqualification in aircrew. Screening for heart disease to prevent sudden incapacitation is controversial and published guidelines do not take into consideration high risk occupations such as aviation. Furthermore, specific features of military aviation (such as +Gz, positive pressure breathing, air combat sorties) place high levels of stress on the cardiovascular system. Determining the acceptability of cardiovascular disease in military aviation is challenging given the paucity of evidence and limited number of military aviation cardiologists. TOPIC: This panel will consist of 5 countries presenting current standards for cardiac screening in aircrew. Topics will include Arrhythmias to include ventricular pre-excitation, channelopathies, valvulopathies, cardiomyopathies to include athletic heart, and coronary artery disease to include anomalous coronary arteries. We will conclude with a moderated discussion with the 5-country panel to foster ongoing collaboration to establish an evidence-based consensus working group to develop international screening guidelines for heart disease in pilots and other high-risk occupations. APPLICATION: Screening for heart disease in aircrew and other high-risk occupations is often overlooked and ill-defined. International consensus in aerospace medicine prevention is necessary in the modern era of air and space travel. This also provides a unique opportunity for the flight surgeon or aeromedical examiner to not only ensure safety of flight but possibly safe a life through prevention.*

[180] SCREENING FOR ARRHYTHMIAS TO INCLUDE VENTRICULAR PRE-EXCITATION IN UNITED STATES AIRCREW

Eddie Davenport
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Tutorial/Review)

INTRODUCTION: Heart disease is one of the leading causes of medical disqualification in aircrew. Screening modalities include echocardiogram to look for structural heart disease, ECG to look for electrical abnormalities/arrhythmia, and exercise stress testing to look for coronary artery disease. Unlike traditional risk factors for coronary artery disease, arrhythmias to include ventricular pre-excitation may be more prevalent in active and athletic individuals and thus screening is essential yet difficult. Furthermore, much debate exists in screening ECGs, ambulatory cardiac monitors, and stress testing. There are no established guidelines for arrhythmia screening in aircrew, however the US military has undergone many revisions of screening policy in the past 50 years. **TOPIC:** Screening for arrhythmias will be discussed in detail to include the current guidelines from the US Preventive task force as well as the American College of Cardiology and American Heart Association. Special attention will be made to athletic guidelines and the relevance to military aircrew. Current United States Air Force arrhythmia screening policy will be discussed. FAA and NASA policy will also be mentioned and evidence-based recommendations for ongoing research and collaboration to establish a more universal, formal, and evidence-based screening protocol will be discussed. **APPLICATION:** Arrhythmias are very common and can lead to sudden incapacitation and thus aircrew should be screened; however, modality and frequency are very controversial and no consensus has been established even within countries. This presentation will discuss USAF recommendations and need for ongoing evidence based international collaboration.

Learning Objectives

1. Understand the importance of screening for arrhythmia in aircrew to prevent sudden incapacitation.
2. Screening for arrhythmia if often overlooked and ill-defined without international guidelines. Heart disease guidelines for military and commercial pilots should be developed through an international working group of aerospace physicians and cardiovascular subspecialists.
3. Aeromedical Examiners and flight surgeons have a unique opportunity to screen for and even prevent heart disease thus ensuring safety of flight and saving lives.

[181] AEROMEDICAL ASSESSMENT OF MILITARY PILOT APPLICANTS – DETECTION AND MANAGEMENT OF CHANNELOPATHIES

Norbert Guettler
German Air Force Centre of Aerospace Medicine, Cologne, Germany

(Education - Tutorial/Review)

INTRODUCTION: Due to the challenging working environment of military pilots, applicants undergo a profound cardiovascular screening with a slightly different profile in different nations. Channelopathies are examples for inherited cardiac diseases, which might be detected during screening and potentially affect young people. These diseases are usually caused by transmembrane ion channel or protein mutations involved in intracellular calcium handling and can possibly lead to ventricular tachyarrhythmia and sudden cardiac death. The German screening policy for military pilot applicants will be explained using the example of channelopathies. **TOPIC:** Cardiovascular screening of military pilot applicants in Germany includes medical history, physical examination, laboratory testing, ECG, exercise ECG, transthoracic echocardiography, and Duplex sonography of the carotid arteries. Additional examinations may be performed on indication. Channelopathies including Brugada syndrome, congenital Long QT syndrome, Short QT syndrome, Catecholaminergic Polymorphic Tachycardia syndrome, and malignant Early Repolarization syndrome are rare, but are not compatible with flying in many cases even if asymptomatic. Early diagnosis and risk assessment is therefore of utmost importance and will be explained along with treatment options for risk mitigation. Risk stratification and treatment should be performed in specialist centers using international guidelines and can be very challenging. **APPLICATION:** Cardiovascular screening of military pilot applicants is important despite their mostly young age. Screening policies are slightly different among nations, differences will be discussed in the panel with the aim to achieve a multinational consensus. Screening profiles for military pilot applicants can be used as an example for screening in other high-risk occupations including divers, emergency workers, mountaineers, and commercial drivers with variations depending on the respective profession.

Learning Objectives

1. Learn the importance of cardiovascular screening in military pilot applicants and other high-hazard occupations.
2. Learn that cardiac channelopathies are a group of inherited ion channel diseases possibly leading to ventricular tachyarrhythmia and sudden cardiac death in young people.
3. Learn ECG criteria of Brugada syndrome, congenital Long QT syndrome, Short QT syndrome, and Early Repolarization syndrome, as well as differences between benign and malignant Early Repolarization syndrome.

[182] VALVULOPATHIES IN AIRCREW

Thomas Syburra[1], Norbert Guettler[2], David Holdsworth[3], Denis Bron[4], Lysette Broekhuisen[5], Olivier Manen[6], Eddie Davenport[7]
[1]*Hôpital de La Tour, Meyrin/Geneva, Switzerland;* [2]*German Air Force, Cologne, Germany;* [3]*British Army, London, United Kingdom;* [4]*Swiss Air Force, Dubendorf, Switzerland;* [5]*Dutch Air Force, Amsterdam, Netherlands;* [6]*French Air Force, Paris, France;* [7]*U.S. Air Force, Centerville, OH, United States*

(Education - Tutorial/Review)

INTRODUCTION: Aeromedical risk is determined by aeromedical standards, which aim to eliminate individuals with identifiable medical risk from air operations. The assessment has the potential to lead to medical disqualification. Cardiovascular disease is responsible for half of all aircrew licenses declined in the Western world and is the leading cause of sudden incapacitation. As the retirement age from active flying continues to increase, more aircrew are at risk of developing relevant cardiovascular diseases. **TOPIC:** Valvular heart disease (VHD) is relevant to aircrew because it may limit the appropriate augmentation of cardiac output, especially in high-performance flying, and it predisposes to arrhythmias. Aircrew with VHD need close follow-up to ensure their fitness to fly. Concomitant aortopathy may be found, especially in the presence of bicuspid aortic valves (BAV). The gold standard of care for VHD particularly when associated with aortic disease as seen in conjunction with BAV, remains currently open-heart surgery within the age range of active flying duties. Yet, the right choice of surgical procedure (e.g. mechanical versus tissue valve prosthesis in aortic VHD, repair rather than replacement in mitral VHD, left atrial appendage exclusion, among others) is key for medical license renewal. Restrictions on aircrew duties, especially on high-performance airframes or solo flying, are usually required. **APPLICATION:** To mitigate avoidable license withdrawal or limitations, optimal communication and coordination between the flight surgeon and the heart surgeon is paramount.

Learning Objectives

1. To understand the primary importance of valvular heart disease in aircrew.
2. To appreciate the current surgical therapeutic options in accordance to the aeromedical regulations and the surgical guidelines.
3. To understand the licensing limitations after open heart surgery and their mitigation through the right assessment modalities, the use of current surgical techniques and the communication between all the involved partners

[183] ATHLETIC HEART AND CARDIOMYOPATHIES

Lysette Broekhuizen[1], Norbert Guettler[2], Denis Bron[3], David Holdsworth[4], Olivier Manen[5], Thomas Syburra[3], Joanna d'Arcy[6]

[1]*Central Military Hospital/University Medical Center Utrecht, Zeist, Netherlands;* [2]*German Air Force Center for Aerospace Medicine, Cologne, Germany;* [3]*Aeromedical Centre, Swiss Air Force, Dübendorf, Switzerland;* [4]*Royal Army, RAF Aviation Clinical Medicine Service, RAF Centre of Aviation Medicine, RAF Henlow, United Kingdom;* [5]*Aviation Medicine Department, Aeromedical Centre, Percy Military Hospital, Clamart, France;* [6]*RAF Aviation Clinical Medicine Service, RAF Centre of Aviation Medicine, RAF Henlow, United Kingdom*

(Education - Tutorial/Review)

INTRODUCTION: Differentiating cardiomyopathies (hypertrophic or dilated) from exercise related remodeling can be a challenge for the aeromedical examiner and cardiologist. Cardiac remodeling induced by exercise is an adaptive increase in cardiac chamber size and wall thickness that is promoted by the physiological demands of exercise, often referred to as the 'Athletes heart'. **TOPIC:** Regular high intensity exercise promotes structural, functional, and electrical changes of the heart, this rarely leads to adverse clinical effects, such as the onset of arrhythmias or sinus node dysfunction. In patients with a genetic predisposition for certain cardiomyopathies (CMP), mainly arrhythmogenic cardiomyopathies or ACM: Arrhythmogenic right ventricular cardiomyopathy (ARVC), arrhythmogenic dilated cardiomyopathy (DCM) and biventricular arrhythmogenic cardiomyopathy, it has been suggested that exercise can promote early development of arrhythmia and pathological alterations, mainly of the RV, and therefore high performance activities usually need to be discouraged. As both entities can look very similar, differentiating the trained athletes heart with 'physiological' remodeling from pathological structural changes associated with inherited and acquired cardiac disorders calls for experience together with good diagnostic techniques. CMR is the gold standard for evaluating left and right ventricular function, giving detailed information on presence of regional wall motion abnormalities, myocardial thinning, and ventricular aneurysms. Additional late gadolinium enhancement (LGE) images detect edema and fibrosis which can be used for prognostic purpose. Holtermonitoring and exercise testing in order to screen for arrhythmias or conduction disorders are pivotal additional diagnostic methods. Prior to medical investigation it is needed to perform a thorough interview asking about symptoms and family history of cardiovascular disease and sudden cardiac death (SCD). If the family history is positive genetic counseling may help to further determine the diagnosis. **APPLICATION:** However rare, recognizing real CMP from the athletes heart in aircrew is essential as heart muscle disease can lead to acute incapacitation or even SCD, but also to determine treatment goals. On the other hand, misdiagnosing an athletes heart calling it cardiomyopathy can have a serious impact on someone' s career and lead to unnecessary restrictions.

Learning Objectives

1. To understand why it is usefull to screen aircrew for myocardial disease and know the different types of cardiomyopathy and their complications.
2. To understand that exercise induced remodeling of the heart can mimic cardiomyopathies and learn how to differentiate between "normal' cardiac adaption to sports and pathology.
3. To learn about diagnostic strategies that can be used to determine cardiovascular risk.

[184] INTERNATIONAL PANEL ON INITIAL SCREENING FOR HEART DISEASE IN AIRCREW - CORONARY ARTERY DISEASE AND CORONARY ARTERY ANOMALIES

David Holdsworth[1], Lysette Broekhuizen[2], Denis Bron[3], Norbert Guettler[4], Olivier Manen[5], Thomas Syburra[3], Eddie Davenport[6]

[1]*University of Oxford, Oxford, United Kingdom;* [2]*Central MIlitary Hospital/University Medical Center Utrecht, Utrecht, Netherlands;* [3]*Aeromedical Centre, Swiss Air Force, Duebendorf, Switzerland;* [4]*German Air Force, Cologne, Germany;* [5]*Aeromedical Centre, Percy Military Hospital, Paris, France;* [6]*U.S. Air Force, Centreville, OH, United States*

(Education - Tutorial/Review)

INTRODUCTION: Appropriate screening of aircrew applicants for coronary artery disease is challenging. The majority of evidence for diagnosing coronary artery disease is drawn from symptomatic patients presenting with exertional chest pain. Where evidence does exist for asymptomatic groups, or guidance has been provided for primary prevention of coronary disease, this is often appropriate for middle-aged individuals who still may not reflect the typical professional aviation applicant. **TOPIC:** The clinical history and physical examination continue to provide the bedrock of appropriate screening for both premature coronary artery disease and anomalous coronary origins. A detailed history of episodes of collapse (especially mid-exertion); concerning family history of premature coronary disease; cardiac or unexplained death at a young age and smoking history are essential. The use of population-based 10-year cardiovascular risk estimates is appropriate for older applicants. These will often require blood tests to identify/exclude dyslipidemia. Young applicants are at such a low absolute risk of coronary events that exercise ECG is generally unhelpful due to the high false positive rate, while CACS misses non-calcified plaque which is important in the young/middle-aged. Applicants who are at high risk would be excluded from flying on the basis of this risk. This leaves the group with intermediate risk. The question remains for middle-aged applicants whose population-based risk score indicates

borderline/intermediate risk: can exercise ECG, functional imaging or some form of gated CT imaging enhance risk stratification to improve not only clinical management but also occupational recommendation? There is a trans-Atlantic difference in the uptake of gated cardiac CT between full CT angiography (CTCA) and coronary-artery calcium scoring (CACS). Given that calcification of coronary atheroma is known to occur at a later stage in the natural history of coronary atherosclerosis, it seems reasonable to propose that CTCA may outperform CACS (insensitive to non-calcified plaque) in early discovery of coronary disease in a younger group. **APPLICATION:** SCOT HEART II and ORFAN aim to reveal whether there is any incremental advantage of CTCA over CACS. The results may lead to significant changes in the CAD screening potential of both patients and aircrew applicants.

Learning Objectives

1. To understand the primary importance of pretest probability to appropriate investigation for coronary artery disease in asymptomatic aircrew applicants.
2. To appreciate the fallacy of focusing on determining the presence or absence of an anatomical coronary narrowing (stenosis) rather than establishing the likelihood of a coronary event. This is the false elevation of anatomy over clinical outcome.
3. To understand the relative advantages and disadvantages of full-gated CT coronary angiography over coronary artery calcium scoring in the identification of coronary atherosclerosis and the potential of future radiomic markers of coronary artery inflammation in prediction of coronary events.

Tuesday, 05/07/2024 ***2:00 PM***
Grand Hall J

[S-35]: SLIDES: UNDERSTANDING FACTORS IN MENTAL HEALTH

Chair: Mary Cimrmancic
Co-Chair: Adam Sirek

[185] UNDERSTANDING FACTORS THAT INFLUENCE MENTAL HEALTHCARE AVOIDANCE IN US PILOTS AND SOLUTIONS FOR THE FUTURE: CIVILIAN TRAINEE PILOT PERSPECTIVE

Elizabeth Bjerke, Joelle Ruthig
University of North Dakota, Grand Forks, ND, United States

(Original Research)

INTRODUCTION: Evolving data suggest that a population pilots participate in healthcare avoidance behavior due to fear or loss of flying status. The factors that influence healthcare seeking behavior in trainee pilots remain uncertain. The objective of this study was to conduct an assessment of trainee pilots' perceptions on seeking healthcare (physical and mental) in order to identify factors that (1) uniquely discourage/encourage disclosure, (2) understand factors that aid the aeromedical provider/aviator relationship, and (3) identify interventions that could be implemented to address discouraging factors. **METHODS:** A qualitative assessment was conducted to evaluate civilian trainee pilots' perceptions on health care seeking services. 20 semi-structured interviews with commercial aviation students at a large U.S. based collegiate aviation university were conducted, transcribed and synthesized as part of this research process. Interview transcriptions underwent thematic content analysis by two independent researchers, which involves deriving concepts from data and comparing them with other data to facilitate meaningful categorization. **RESULTS:** The analysis of the qualitative data revealed multiple themes that influence healthcare seeking in this population. Many of the themes that emerged were negative barriers perceived by pilots that could impact their progression and future careers in aviation. It was also found that misunderstanding and lack of information/communication play a pivotal role to pilot healthcare seeking behavior. **DISCUSSION:** Factors that influence trainee pilot healthcare seeking behavior are heterogeneous. Understanding these factors may permit the generation of interventions and strategies to address pilot healthcare avoidance. Increasing access and education in regards to aeromedical screening is important for civilian pilot trainee decision making to seek help, as well as a focused effort to streamline the process for increased efficiencies. These findings are uniquely pertinent in the setting of rising rates of reported mental health concerns in a younger generation of pilots.

Learning Objectives

1. The audience will understand the perceptions and influences of civilian pilot trainees in regards to healthcare seeking behavior of pilots.
2. The audience will learn of strategies and interventions aimed to improve the decision making of civilian pilot trainees in seeking appropriate healthcare solutions.

[186] WHAT FACTORS INFLUENCE HEALTHCARE SEEKING BEHAVIORS AMONG U.S. AIR FORCE PILOTS?

Rachael Martinez[1], Tanya Goodman[2], Christopher Thompson[3], William Hoffman[4]
[1]*USAFSAM, Wright-Patterson AFB, OH, United States;* [2]*Neurostat Analytical Solutions, LLC, Great Falls, VA, United States;* [3]*U.S. Air Force, Dayton, OH, United States;* [4]*59th Medical Wing, San Antonio, TX, United States*

(Original Research)

INTRODUCTION: Unlike airline transport pilots, military pilots on duty not including flying status are assigned other non-flying duties such as administrative work and their status does not impact their pay, but recent research has shown that military pilots also participate in healthcare avoidance behavior. **METHODS:** We conducted qualitative interviews with U.S. Air Force (USAF) pilots using a semi-structured interview guide to collect firsthand accounts and perspectives of (1) factors that support mental healthcare seeking and health information disclosure, (2) factors that discourage those behaviors, and (3) potential solutions to address pilot healthcare avoidance. Interview transcriptions underwent thematic content analysis by two independent researchers that involved deriving concepts from data and comparing them with other data to facilitate meaningful categorization. **RESULTS:** We conducted 21 interviews lasting an average of 30 min with USAF pilots. There were 138 pages of transcript, and code saturation occurred after 13 interviews. The most reported factors that discourage military pilot healthcare disclosure and healthcare utilization overall were medical revocation (90%, n = 19/21), stigma (90%, n=19/21), and lack of trust in providers (43%, n = 9/21). Unit embedded services (81%, n = 17/21), ease of access (48%, n = 10/21), and severity of condition (38%, n = 8/21) were the most reported factors encouraging disclosure and utilization. The top-reported recommendations from pilot interviewees were increased flight doctor accessibility (57%, n = 12/21) and education/support of policies (33%, n = 7/21). **DISCUSSION:** This is the first in-depth, systematic exploration of pilot perspectives on healthcare disclosure and utilization in the USAF. The results of this study will be used to shape USAF line and medical leadership strategies geared toward improving embedded mental healthcare capabilities for pilots in tip-of-the-spear communities.

Learning Objectives

1. The participant will be able to understand the factors that influence mental healthcare avoidance behaviors among military pilots.
2. The audience will learn about potential solutions for encouraging disclosure of health symptoms and utilization of healthcare services among military pilots.

[187] A QUALITATIVE ASSESSMENT OF FACTORS THAT INFLUENCE MENTAL HEALTHCARE SEEKING AND HEALTH INFORMATION DISCLOSURE IN US AIRLINE PILOTS

William Hoffman
Columbia University Medical Center, New York, NY, United States

(Original Research)

INTRODUCTION: US airline pilots are required to meet certain medical standards to maintain their flying status. Evolving data suggest that a portion of US airline pilots participate in healthcare avoidance behavior due to fear for loss of flying status, which has the potential to influence pilot health, the effectiveness of aeromedical screening and safety. The factors that influence US airline pilot mental healthcare seeking behavior and information disclosure remain unknown. **METHODS:** We conducted qualitative interviews with airline pilots using a semi-structured interview guide to collect firsthand accounts and perspectives of (1) factors that support mental healthcare seeking and health information disclosure, (2) factors that discourage those behaviors, and (3) potential solutions to address pilot healthcare avoidance. Interview transcriptions underwent thematic content analysis by two independent researchers, which involves deriving concepts from data and comparing them with other data to facilitate meaningful categorization. **RESULTS:** We conducted 36 interviews lasting an average of 30-35 minutes with US airline pilots. There were 268 pages of transcript and code saturation occurred after 25 interviews. The most reported discouraging factors for pilot healthcare disclosure and utilization were medical revocation (97%, n=35/36), policy misinformation and lack of education (44%, n=16/36), and stigma (39%, n=14/36). The most reported encouraging factors were peer support services (33%, n=12/36), company support (33%, n = 12/36), and union embedded medical resources (31%, n = 11/36). Proposed solutions included addressing culture surrounding mental health (72%, 26/36), education about medical certification policies (47%, 17/36), and medical certification processing times (25%, 9/36). **DISCUSSION:** The factors that influence mental healthcare seeking and health information disclosure in US airline pilots are highly heterogeneous. In our study, there were multiple modifiable factors identified by pilots that could support healthcare seeking and information disclosure. Further research should focus on conducting safety analyses of efforts aimed at addressing factors that negatively influence these behaviors.

Learning Objectives

1. Describe two factors that support mental healthcare seeking and health information disclosure in US airline pilots.
2. Describe two factors that discourage mental healthcare seeking and health information disclosure in US airline pilots.

[188] A QUALITATIVE LOOK AT THE PERSPECTIVES OF FEMALE U.S. COMMERCIAL PILOTS: CONTINUED BARRIERS IN SEEKING HEALTHCARE

Tanya Goodman[1], Nicole Devlin[1], Rachael Martinez[2], Christopher Thompson[2], Billy Hoffman[3]

[1]*Neurostat Analytical Solutions, LLC, Great Falls, VA, United States;* [2]*Wright-Patterson AFB, OH, United States;* [3]*59th Medical Wing, San Antonio, TX, United States*

(Original Research)

INTRODUCTION: Data indicate that pilots express high anxiety around seeking healthcare, seen across sex and age, resulting in pilots withholding information from their physicians and delaying seeking medical care. These barriers to seeking healthcare were seen across male and female aviators, but there is little research on the unique concerns female aviators have when it comes to seeking healthcare and maintaining their flight status. **METHODS:** We conducted qualitative interviews with airline pilots using a semi-structured interview guide to collect firsthand accounts and perspectives of (1) factors that support mental healthcare seeking and health information disclosure, (2) factors that discourage those behaviors, and (3) potential solutions to address pilot healthcare avoidance. Interview transcriptions underwent thematic content analysis by two independent researchers that involved deriving concepts from data and comparing them with other data to facilitate meaningful categorization. **RESULTS:** From the total sample of 36 interviews with U.S. airline pilots, there was a subset of 12 female airline pilots. Female pilots reported that medical revocation (92%, n = 11/12), stigma (58%, n = 7/12), and policy misinformation and lack of education (42%, n = 5/12) were the overall biggest factors that discouraged healthcare disclosure and utilization. The most reported encouraging factors were peer support services (50%, n = 6/12), third party resources (33%, n = 4/12), and union embedded medical resources (25%, n = 3/12). Recommendations from this sub-sample of airline pilots centered around changes with the female experience in mind or family-oriented concerns (e.g., adjust Federal Aviation Administration policies on women's health). **DISCUSSION:** Results suggest that female pilots want work environments that foster inclusivity and acknowledgment of their diverse needs. Their suggestions reflect a need for a cultural shift in their work environments, a need for acknowledgment and understanding of the differences in health needs of men and women, and a need for more attention given to clarifying, expanding, updating, and disseminating information about healthcare policies and processes.

Learning Objectives

1. The presenter will help the audience see the need for acknowledgment and understanding of the differences in health needs of men and women.
2. The presenter will help the audience understand the need for more attention given to clarifying, expanding, updating, and disseminating information about healthcare policies and processes.

Tuesday, 05/07/2024 ***2:00 PM***
Grand Hall K

[S-36]: PANEL: RESIDENT IN AEROSPACE MEDICINE (RAM) GRAND ROUNDS II

Chair: Serena Auñón-Chancellor
Co-Chairs: Thomas Jarnot, Sonya Heidt

PANEL OVERVIEW: *Resident in Aerospace Medicine (RAM) Grand Rounds consists of 6 clinical case presentations. Each case is presented by current RAMs who will review the clinical case, diagnosis, treatment pathway and current policies* from *different agencies. The aviator's aeromedical disposition and waiver or special issuance outcome (if applicable) will be discussed. These unique case presentations describe clinical aviation medicine as well as policy updates for common medical and/or mental health conditions encountered in the practice of Aerospace Medicine*

[189] GIANT CELL TUMOR IN A MILITARY AVIATOR: A CASE REPORT

David Smith, William Smith

USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Case Study)

INTRODUCTION: This case describes a military aviator diagnosed with giant cell tumor of bone (GCTB) of the right leg following evaluation for chronic right knee pain with running. **BACKGROUND:** GCTB is a rare, locally aggressive non-cancerous tumor of the bone that typically occurs between 20-40 yr of age, with a slight female predilection. Approximately 50% occur in the distal femur or proximal tibia, although also found in the ulna, proximal femur, humerus, and spine. Localized pain is the most common presenting symptom, usually associated with activity, relieved with rest, and progressively worsens over time. While typically benign, GCTB can grow quickly and affect nearby joints. Metastases to the lung may occur but is usually in the setting of locally recurrent disease; malignant transformation is less than 1%. Pathologic fracture occurs occasionally. Surgical excision is the preferred treatment for GCTB, although radiation, tumor embolization, or monoclonal antibody injection may be used in cases not amenable to surgery. **CASE PRESENTATION:** This pilot presented in his mid-30s with 2 yr of progressively worsening right knee pain that was limiting his ability to run. Failure of conservative management led the patient to seek care. Initial plain film imaging was

remarkable for a 6.7-cm cystic lesion. Suspicion of GCTB was confirmed with computed tomography-guided biopsy. The patient underwent excision of the entire tumor with curettage, bone grafting, and plating. He gradually returned to full symptom-free activity and was returned to flying status with waiver. **DISCUSSION:** GCTB is a rare but aeromedically significant disorder requiring careful consideration. Benign neoplasms are disqualifying within the U.S. Air Force when the condition prevents satisfactory performance of duty or is not remediable/refused, ongoing specialty follow-up is prohibitive, or the tumor is likely to enlarge or has malignant potential. All military branches note that symptomatic retained hardware may be disqualifying. Civilian standards do not specifically address benign tumors of the bone. Symptomatic GCTB can be disqualifying, and aeromedical decisions should be made after careful evaluation of the precipitating factors and success of treatment. In this case, the waiver authority considered the aviator's stability and demonstrated ability in making the decision.

Learning Objectives

1. Ensure aerospace medicine clinicians consider giant cell tumor and other pathologic disorders in their differential diagnosis when evaluating aviators with complaints of knee pain.
2. Review the common considerations for giant cell tumor as it pertains to the aeromedical environment.

[190] I CAN SEE CLEARLY NOW: FIGHTER PILOT WITH CENTRAL SEROUS RETINOPATHY

Monica Pierce Wysong, Lyndsey Vu
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Case Study)

INTRODUCTION: This case report describes a pilot diagnosed with central serous retinopathy (CSR) after complaining of visual distortion. **BACKGROUND:** CSR occurs when fluid builds up under the retina, causing a small detachment leading to vision changes. CSR is more likely in middle-aged men and more common in those with Type A personality, chronic corticosteroid use, obstructive sleep apnea, and autoimmune disorders. **CASE PRESENTATION:** A 31-yr-old otherwise healthy experienced male fighter pilot presented to flight medicine complaining of distortion of lines and blurring of a portion of the visual field in his right eye. He was referred to optometry; fluid was seen in the macular region on optical coherence tomography. He was diagnosed with CSR and advised to decrease stressors. Eplerenone was initiated 6 wk later due to persistent symptoms with resolution of both clinical symptoms and objective findings on optical coherence tomography. He was granted a waiver after full resolution of the condition, cessation of medication, and recommendation by the Aeromedical Consultation Service. **DISCUSSION:** The average age of pilots in the United States in 2020 was 43.9 yr. As CSR is seen mostly in males 30-50 yr old, aerospace medicine specialists should have a low threshold for suspicion of this condition. Recurrence can be as high as 50% in untreated individuals. Overactivation of mineralocorticoid receptors by corticosteroids leading to choroidal vasodilation is the proposed pathogenesis for the disease. Intranasal steroids are used frequently for allergic rhinitis and are generally considered to have few systemic symptoms. However, while corticosteroid use has an odds ratio of 4.29 for CSR, nasal/inhaled steroids have an odds ratio of 2.44 based on a meta-analysis of 17 studies. Eplerenone works as a mineralocorticoid receptor antagonist and has the benefit of decreasing fluid thickness. The Aeromedical Consultation Service recommends initiating eplerenone at initial diagnosis to decrease duration of symptoms and earlier waiver potential. Aviators with CSR should be screened for autoimmune disorders, *H. pylori* infection, hypertension, and obstructive sleep apnea. Stress management for all aviators should be discussed at annual visits, and counseling on the risk of nasal steroids should highlight systemic risks, including CSR for aviators.

Learning Objectives

1. The audience will understand the diagnosis of Central Serous Retinopathy (CSR), its pathophysiology, and comorbid conditions.
2. The audience will understand the treatment modalities of CSR with a focus on eplerenone, which may decrease time to waiver.

[191] AN ACOUSTIC NEUROMA RESULTING IN SUDDEN UNILATERAL HEARING LOSS IN AN AIR BATTLE MANAGER: A CASE REPORT

Clifford Nolt, Cameron Conard
Wright-Patterson AFB, OH, United States

(Education - Case Study)

INTRODUCTION: This case report describes a sudden episode of unilateral hearing loss in an Air Battle Manager leading to the diagnosis and treatment of an acoustic neuroma. **BACKGROUND:** Acoustic neuromas have an increasing incidence of 4.2 in every 100,000 person-years in the last decade. Early diagnoses tend to lead to a better prognosis, as treatment can be less invasive with a quicker recovery for small tumor size. **CASE PRESENTATION:** A 35-yr-old Air Battle Manager presented to a local urgent care with sudden unilateral hearing loss while on temporary duty in September 2021. He was prescribed steroids with no improvement the following day. His primary care manager ordered a magnetic resonance imaging of his brain and internal auditory canals to evaluate for structural etiologies of his hearing loss. The imaging revealed a mass on the right acoustic nerve with features consistent with vestibular schwannoma (acoustic neuroma). After evaluation by Otolaryngology and discussion of treatment options, he underwent 5 rounds of gamma knife treatment in December 2021. Follow-up imaging in December 2022 showed a reduction in tumor size, and the member's hearing had returned to H1 hearing. He was ultimately granted a waiver for 1 yr, with possibility of extending beyond 1 yr on next review with demonstrated stability. **DISCUSSION:** The case highlights the importance of having a high suspicion for an acoustic neuroma in the presence of sudden asymmetric hearing loss, as a delay in diagnosis could lead to an increase in tumor size and a need for more invasive treatment. If an early diagnosis can be made, less invasive treatments—such as linear accelerator or gamma knife radiosurgery—can be used, with a quicker recovery and shorter grounding time for the individual. Early treatment can also help prevent permanent neurologic sequelae that would interfere with the member's ability to perform required duties.

Learning Objectives

1. Recognizing the symptoms of an acoustic neuroma and other causes of sudden unilateral hearing loss to prevent delay in diagnosis.
2. Understand how this condition can be treated to minimize the impact on a members aviation status and career.

[192] MEDICAL RISK ASSESSMENT IN A HYPOTHETICAL LUNAR CREWMEMBER WITH SEVERAL CHRONIC MEDICAL CONDITIONS

Michael LaBarbera[1], Craig Kutz[1], Matthew Makowski[1], James Pattarini[2], Serena Auñón-Chancellor[1]
[1]*UTMB, Galveston, TX, United States;* [2]*NASA JSC, Houston, TX, United States*

(Education - Case Study)

INTRODUCTION: This hypothetical case report presents operational and medical considerations of certifying an experienced astronaut with several stable chronic medical conditions assigned to a long-duration spaceflight mission to the lunar surface. **BACKGROUND:** Pre-flight aeromedical risk assessment aims to optimize astronaut crew performance by minimizing the likelihood of in-flight medical emergencies. Future lunar missions will likely employ novel ambient pressures and oxygen partial pressures to enable frequent sorties to the lunar surface, which present unique physiologic stresses and operational considerations. Including more experienced astronaut crew on such missions would likely improve mission performance, though it is not yet known how the

unique environmental and operational exposures of a lunar surface mission might influence aeromedical risk in individuals with chronic, stable medical conditions. This case report presents aeromedical risk assessment for a hypothetical astronaut crew with mildly elevated cardiovascular risk and considerations in chronic hypobaric and hypoxic exposure. **CASE DESCRIPTION:** A hypothetical 55-year-old female mission specialist is chosen to participate as prime crew for a 3-week duration lunar surface mission. She is highly experienced with two prior long-duration spaceflights including several prior mission extra vehicular activities. On her preflight physical, she is noted to have mildly elevated cardiovascular risk based on coronary artery calcium (CAC) score and elevated serum lipids, though has no history of cardiac arrhythmia and no significant family history of cardiovascular disease. Further cardiovascular evaluation is negative, and her prior annual physical was notable for stage I hypertension that is well controlled with diet and exercise. **DISCUSSION:** Future spaceflight missions to the lunar surface will greatly benefit from the operational experience of experienced astronaut crewmembers, though it is not known how the unique ambient pressure and oxygen tension of that environment may impact crew health and performance in individuals with existing chronic medical conditions. We present considerations for aeromedical risk assessment of an individual with cardiovascular risk factors operating within a unique ambient environment on the lunar surface.

Learning Objectives

1. The audience will gain an appreciation for potential aeromedical considerations of cardiovascular risk factors in future lunar missions.
2. The audience will gain an appreciation for the impact of spaceflight, crew performance, and health risks of cardiovascular risk factors in future lunar missions.

[193] A HYPOTHETICAL CASE OF DECOMPRESSION SICKNESS DURING LUNAR SURFACE EXTRAVEHICULAR ACTIVITY AND RETURN TO DUTY CONSIDERATIONS

Craig J. Kutz[1], Matthew S. Makowski[1], Michael A. LaBarbera[1], James M. Pattarini[2], Serena M. Auñón-Chancellor[1]
[1]*UTMB, Galveston, TX, United States;* [2]*NASA JSC, Houston, TX, United States*

(Education - Case Study)

INTRODUCTION: This case report presents a hypothetical lunar decompression sickness (DCS) event with consideration of treatment approach and disposition. **BACKGROUND:** Lunar extravehicular activities (EVA) pose a risk of developing DCS from operational shifts in pressure between suits and lunar habitats. Although prebreathe protocols theoretically decrease the risk of DCS through denitrogenation, the consequences of an event are mission critical. Type I DCS represents the majority of hypobaric pathology and many medical organizations implement 'return-to-duty' guidelines following treatment. This case will overview a hypothetical occurrence of Type I DCS on a lunar surface EVA in an experienced astronaut and will highlight treatment, return to flying status, and mission impact. **CASE PRESENTATION:** A 55-year-old female crewmember with extensive EVA experience developed right knee pain during her first lunar surface sortie. The pain severity distracted her from mission objectives and the EVA was aborted by the supervising flight surgeon given suspicion for DCS. The crewmember was treated with an in-suit repressurization protocol and her symptoms resolved. She had no prior history of DCS and subsequent EVA for the following three days were cancelled by flight medicine due to the risk of recurrence and performance decrement. **DISCUSSION:** Exploration missions will require extensive EVA capabilities for sustained space operations, including the lunar surface and beyond. Although recurrence of treated DCS is plausible, a clear delineation of risk factors makes 'return-to-duty' difficult so mitigation continues to be the best treatment for DCS. Clinical guidelines to minimize post-treatment risk of DCS recurrence exist within the Department of Defense, commercial diving, and recreational diving sectors, however, there is a paucity of literature for cases such as this astronaut treated with hyperbaric pressures utilizing in-suit protocols. This case report will highlight the current mission implications of DCS including unavailability of standard 41.1 psia (2.8 ATA) hyperbaric oxygen, difficulty in medical evacuation from the lunar surface, and approach to returning a crewmember back to mission EVA status.

Learning Objectives

1. The audience will gain an appreciation of risk assessment for recurrent decompression sickness in a hypothetical astronaut crewmember on a long-duration lunar surface mission.
2. The audience will learn how existing medical guidelines may apply to return-to-duty assessment for individuals operating in a hypobaric lunar habitat environment and lunar surface EVA.

[194] MARIJUANA USE WAIVERS: HIGH TIME TO CHANGE?

Barrett Campbell
U.S. Army Medical Center of Excellence, Fort Novosel, AL, United States

(Education - Case Study)

INTRODUCTION: This case report discusses two Soldiers, a 27-year-old and a 33-year-old, presenting for their installation student flight physical, both with a remote history of marijuana use. **BACKGROUND:** As the legal landscape surrounding marijuana use shifts in the United States, many individuals find themselves navigating a complex web of state and federal regulations. For military personnel with use before joining the military, this complexity is compounded by the intersection of civilian laws with military and aviation regulations. **CASE PRESENTATION:** The first Soldier, a 27-year-old, used marijuana during high school and reported this use on his three prior approved flight physicals. The second Soldier, a 33-year-old, reports use at age 18 during his college years. He also reported this use on his two prior approved flight physicals. Though neither Soldier reports ongoing use nor a history of drug abuse treatment, the past experimental use poses a challenge for their aviation aspirations based on current policy. **DISCUSSION:** The evolving legal status of marijuana in various U.S. states brings forth challenges in military and aviation contexts. While certain states have decriminalized or legalized marijuana, the Department of Defense (DoD) and its branches maintain strict policies against use by its Servicemembers. The FAA holds a clear stance that marijuana, including medicinal use, is not allowed for pilots or air traffic controllers within the last two years or with a failed drug test or history of dependence, and all drug use without prior FAA evaluation must lead to deferral of the physical by an AME to the FAA for clearance and issuance of an eligibility letter. This case exemplifies the tension between state-level marijuana legalization and federal and military regulations for use before military service. For aspiring aviators, understanding these policies is crucial. Maintaining a transparent, evidence-based, and legally sound approach mitigates various risks for these organizations. This issue underscores the need for continuous review and possible alignment of policies as societal norms and legal frameworks evolve.

Learning Objectives

1. Understand the distinctions between state-level marijuana legalization and federal/military policies on prior marijuana use.
2. Evaluate the current DoD and FAA policies in light of evolving societal norms and discuss the drivers for policy revisions.

Tuesday, 05/07/2024 ***2:00 PM***
Grand Hall GH

[S-37]: PANEL: SAFETY CENTERS: YEAR-IN-REVIEW

Chair: Philippe Stewart

PANEL OVERVIEW: *This panel presents a review of recent aerospace safety data. Representatives from military and civil aerospace organizations*

will present summaries and analyses of recently collected safety data. Topics may include: cause factors including mechanical and human factors, identifiable safety trends, and updates on mitigation strategies for current risks. With certain types of accidents becoming rare events, the panel discussion is a unique opportunity to review the collective experiences of multiple safety programs and consider a variety of risk mitigation solutions.

[195] TRANSPORT CANADA: YEAR IN REVIEW

Tyler Brooks
Transport Canada, Ottawa, ON, Canada

(Education - Program/Process Review)

BACKGROUND: Transport Canada is the federal regulator responsible for policies and programs which promote safe, secure, efficient, and environmentally responsible transportation in Canada. This presentation will familiarize participants with the mission of the Civil Aviation Medicine (CAM) Branch of Transport Canada, and highlight topics of interest arising in over the past year. **OVERVIEW:** The mission of the CAM Branch of Transport Canada is to ensure aircrew and air traffic controllers are medically fit, to close gaps in scientific knowledge of Canadian aviation medicine, to promote health and safety in the field of aviation, and to prevent aircraft accidents due to medically related human factors. The CAM Branch will present an overview of notable civil aviation medicine issues encountered over the past year. **DISCUSSION:** Aviation medicine practices and policy respond not only to changes in medicine, but also to changes in society, politics, and global events. The CAM Branch of Transport Canada shares its experience responding to a variety of issues.

Learning Objectives

1. Understand the mission of Transport Canada Civil Aviation Medicine branch.
2. Understand key policy updates of Transport Canada Civil Aviation Medicine branch.

[196] U.S. ARMY AVIATION SAFETY: FY 2023 YEAR IN REVIEW

Luis Rivero, Sean O'Connell
U.S. Army Combat Readiness Center, Fort Novosel, AL, United States

(Education - Tutorial/Review)

INTRODUCTION: Discuss (FY) 2023 statistics and analysis for USA Class A aviation mishaps including Human Factors Analysis. **METHODS:** FY2023 data was obtained from the USA Combat Readiness Center database (ASMIS2.0) for Class A thru C manned aviation mishaps and reviewed for human factors as determined by the Safety Investigation Boards. **RESULTS:** In the manned aircraft category, Army aviation experienced 67 Class A - C manned aircraft Flight mishaps in FY23. This was an increase from the 50 Class A-C Flight mishaps reported in FY22. The US Army experienced eight Class A manned aviation Flight mishaps during FY23, 100% over the four Flight mishaps reported for FY22. The accident rate for Class A Flight mishaps (per 100,000 flying hours) was 0.96 in FY23, a 92% increase from the 0.50 Class A record rate recorded in FY22. There were 14 aviation mishap fatalities in FY23 compared to 2 in FY22. **DISCUSSION:** For the fourth year in a row, Army Aviation has remained below a rate of one mishap per 100,000 flying hours and the overall five-year rate of 0.89 is the result of four years of single digit Class A Mishaps (FY20 = 6, FY21 = 8, FY22 = 8, and FY23 = 9). As a result, the Army continued to maintain a Class A mishap rate below established norms during FY23. FY23 manned Class A flight mishap rate was 0.96 per 100,000 flight hours, the fifth time in the last eight years the rate has been below the mark of 1.0 mishap per 100,000 flight hours. However, this FY had the most aviation mishap fatalities, 14, in the last 10 years and is the highest since FY08 when Army Aviation sustained 16 mishap fatalities. There were nine Class A mishaps (8 Flight; 1 Aircraft Ground) reported in FY23 with approximately 835,063 hours flown. Human error continues to be the leading cause factor in Army Class A Flight mishaps.

Learning Objectives

1. The audience will review US Army Aviation mishaps in the manned and unmanned categories.
2. The audience will be able to understand trends in US Army Aviation related to mid-level experience gap in Army Aviators which is correlated to degraded human factors capabilities in power management, operating in degraded visual environments and terrain flight skills.
3. The audience will learn about the leading causes of US Army Aviation mishaps from FY16 to FY22, which include object strikes, CFIT and hard landings, and the reason behind them.

[197] ROYAL CANADIAN AIR FORCE FLIGHT SAFETY: YEAR IN REVIEW 2023

Philippe Stewart
Canadian Armed Forces, Ottawa, ON, Canada

(Education - Program/Process Review)

BACKGROUND: The Commander of the Royal Canadian Air Force (RCAF) is appointed as the Airworthiness Authority for all aviation in the Canadian Armed Forces (CAF). The Director of Flight Safety (DFS) is appointed as the Airworthiness Investigative Authority for all flight safety occurrences with the goal of preventing accidental loss of aircraft and personnel. Contributory or causal human factors are identified using the Canadian Forces Human Factors Analysis and Classification System (CF- HFACS). Statistics and analysis from 2023 are discussed. **OVERVIEW**: Accidents and incidents from 2023 were reviewed to identify human factors which may have caused or contributed to these occurrences. **DISCUSSION**: Fatigue, culture and substances hazardous to aviation continue to be relevant hazards in the RCAF. DFS has helped to propel several risk mitigation initiatives specifically aimed these factors, including the implementation of the RCAF Fatigue Risk Management System, while facilitating the international distribution and use of SAI for accident investigations.

Learning Objectives

1. The audience will learn about the overall trends in RCAF flight occurrences in 2023.
2. The audience will learn to identify various Human Factors Analysis and Classification System (HFACS) categories that contribute to aviation incidents.

[198] NAVAL AVIATION SAFETY: 2023 YEAR IN REVIEW

Jonathan Erpenbach, George Rice, Jefferson Grubb, Jarrett Moore, Nicola Robinson
U.S. Navy, Naval Safety Command, Norfolk, VA, United States

(Education - Program/Process Review)

BACKGROUND: The Naval Safety Command analyzes Navy and Marine Corps aviation safety investigation reports in order to identify mishap causal factors and recommend corrective actions. **OVERVIEW**: All Class A flight mishaps involving U.S. Navy and Marine Corps aircraft during fiscal year 2023 (FY 2023) were reviewed using the Human Factors Analysis and Classification System (HFACS). During FY 2023, there were multiple Class A flight mishaps in the U.S. Navy and U.S. Marine Corps. A review of Class A flight mishaps over the past ten years demonstrated that human factors were the predominant causal factor. The Naval Safety Command team will also present a review of current physiological episodes and events in Naval Aviation. **DISCUSSION:** HFACS can be a useful tool in safety investigation analysis and assist in identifying mitigation strategies to prevent future mishaps. Evolving capabilities and understanding regarding physiological episodes and events are enabling technological improvements, better training, and impactful research to further reduce occurrences, risks, and impacts to mission.

Learning Objectives
1. Review the overall trend in U.S. Navy and Marine Corps flight mishaps and the most common human factors identified as causal factors.
2. Review the trends in Naval Aviation mishap HFACS causal factors over the last decade.
3. Become familiar with emerging topics of discussion at the Naval Safety Command related to aviation, including physiologic events.

[199] AIR FORCE AVIATION AND SPACE SAFETY: 2023 YEAR IN REVIEW

Kevin Alford, Andrew Metelko, Mark Noakes
U.S. Air Force, Albuquerque, NM, United States

(Education - Program/Process Review)

BACKGROUND: The United States Air Force Safety Center's Human Performance and medical experts support commanders and safety professionals Air Force wide by applying human factors (HF) expertise to identify, anticipate, analyze, and mitigate human factors risk in Air Force operations while advancing safety culture. **OVERVIEW:** All Class A & B mishaps, manned/unmanned aviation mishaps were analyzed to assess trends in human factors across event types to include physiological events using the Air Force Safety Automated System database of mishap reports. Mishap rates were stable from preceding years with notable patterns of HF identified during subset analyses. Implementation of the Department of Defense Human Factors Analysis and Classification System (HFACS) verison 8.0 presents challenges in comparing HFACS over time. **DISCUSSION:** Human factors contribute significantly to aviation mishaps representing a pivotal area for improvement in the goal to reduce mishaps. Results of data analysis on mishap trends and characteristic among varying event types are presented and highlight opportunities for interventions to improve aviation safety.

Learning Objectives
1. Review the overall trends in US Air Force aviation and space mishaps.
2. Identify the most common Human Factors Analysis and Classification System (HFACS) categories for USAF US Air Force mishaps across event types.
3. Understand the limitations of human factors trend analysis and consider methods to improve human factors mishap recommendations to instill behavior changes that reduces mishap frequency and severity.

Tuesday, 05/07/2024 ***2:00 PM***
Grand Hall I

[S-38]: SLIDES: ASTRONAUT MEDICAL OPERATIONS

Chair: Benjamin Johansen
Co-Chair: Jennifer Fogarty

[200] HUMAN AND ENVIRONMENTAL RESEARCH MATRIX FOR EXPLORATION OF SPACE (HERMES) PROJECT

Jimmy Wu, James Hury, Jennifer Fogarty, Rihana Bokhari, Emmanuel Urquieta, Dorit Donoviel
Baylor College of Medicine, Houston, TX, United States

(Education - Program/Process Review)

BACKGROUND: The emerging commercial spaceflight industry has several companies all building an assortment of spaceflight vehicles, space stations, and habitats each with different levels of health care and capabilities to provide the spaceflight participants (SFP) a pleasurable spaceflight experience. The Human and Environmental Research Matrix for Exploration of Space (HERMES) project aims to standardize and manage the biomedical and environmental data needed to maintain the human health and performance of SFP as they venture through their spaceflight journey. **OVERVIEW:** HERMES is a semi-autonomous, vehicle agnostic, data management infrastructure with capability to 1) seamlessly aggregate spaceflight related biomedical, research, operational, and environmental data, 2) store said data in an efficient manner that allows for 3) access and distribution of the data to human users, to algorithmic (AI/ML) users, and to downstream spacecraft that also have HERMES infrastructure. This project addresses a commercial spaceflight landscape where space vehicles and destinations are built and operated by various commercial entities making it challenging to establish a standardized way for data to be aggregated, stored, and distributed. **DISCUSSION:** HERMES allows for a paradigm shift in how medical, research, and environmental data is managed across disparate space vehicles and destinations. SFP health status, research, and environmental exposure data collection, storage, and distribution are standardized making the infrastructure flexible enough to be ubiquitously deployed regardless of the spacecraft, biomedical data sources, and data analysis users. This enables a novel data management model where a SFP's data can follow the SFP as they continue their spaceflight journey allowing subsequent spaceflight operators insight into the SFP's health, performance, and exposure history. HERMES can support any organization that operates multiple non-standardized transportation vehicles and remote destinations such as NASA's Artemis Program and the military where collection, storage, and analysis of their personnel's data is critical to maintenance of health and performance. This research is supported by the Translational Research Institute for Space Health (TRISH), funded under NASA Cooperative Agreement NNX16AO69A.

Learning Objectives
1. The audience will learn about the challenges in collecting biomedical, operational, and environmental data on commercial spaceflight missions.
2. The audience will learn about common and novel data management approaches that can be applied to human health and performance on commercial spaceflight missions.

[201] HAZARDS VULNERABILITY ANALYSIS FOR COMMERCIAL SUBORBITAL FLIGHT

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(Education - Program/Process Review)

BACKGROUND: As commercial suborbital spaceflight increases in popularity and decreases in cost, the need for readiness to respond to medical emergencies and mass casualty events increases. Many of the launch facilities are in remote areas far from definitive care and having skilled responders on site can save money and time in costly evacuations as well as lives in extreme cases. Prior work described hypothetical guidelines in 2012 but the industry has matured substantially in the more than decade since and it is important to revisit the needs in light of the no longer hypothetical flights. This study reviews the hazards, training, and response needs for providers supporting suborbital space activities. **DESCRIPTION:** This study uses standard event medicine, disaster medicine, and emergency medicine techniques to guide the creation of an emergency operations plan that encompasses an all-hazards model. A hazards vulnerability analysis (HVA) was created for a commercial suborbital spaceflight mission encompassing prelaunch procedures, launch, landing, and post flight procedures. Specific hazards included in the analysis included on board and on ground temperature extremes; chemical exposure, communications failure, earthquake, explosion, fire, flood, inclement weather, mass casualty incident-Hazmat; mass casualty

incident—trauma, picketing, tornado, workplace violence, active shooter. In addition, common injury and illnesses during commercial, aerobatic, and space flights were reviewed and considered to scope emergency readiness and training needs. **DISCUSSION:** The use of emergency, event, and disaster medicine planning techniques is useful to developing response plans and scoping the training needs for those responding to suborbital spaceflight incidents.

Learning Objectives

1. The audience will learn about how to create an emergency operations plan based on a hazards vulnerability analysis relevant to commercial space flight operations
2. The audience will learn how a hazards vulnerability analysis can guide discussions about safety of commercial spaceflight launch and landing operations.

[202] NASA-KENNEDY SPACE CENTER (KSC) BIOMEDICAL SUPPORT OF ARTEMIS I

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(Education - Program/Process Review)

BACKGROUND: NASA is preparing to return humankind to the moon in a program called Artemis. The first step in this journey was the Artemis I uncrewed flight around the moon at the end of 2022. This presentation will cover the multiple aspects of preparing and supporting the first Artemis mission provided by NASA Kennedy Space Center biomedical personnel. **OVERVIEW:** KSC civil servant and contractor medical, environmental health, biomedical engineers, and others provided support to Artemis I. Support consisted of Emergency Medical Services/Triage, Mine Resistant Ambush Protected Vehicle (MRAP) outfitting and training, and Launch Control Center Firing Room Console Command and Control all in place to cover potential ground crew emergencies occurring within the Artemis I active Blast Danger Area near the launch pad. Biomedical personnel supported all Artemis I readiness reviews, wet dress rehearsals, launch attempts, and the successful launch of Artemis I on November 16, 2022. Medical screening for all Orion capsule Landing and Recovery personnel and landing simulation at-sea tests were provided. Direct medical support preparations on the Orion Rapid Response Team as team physician for worldwide medical care was also provided. Key planning support also included as NASA Health and Medical Technical Authority (HMTA) delegate overseeing all Artemis Requirements, Design, Construction, Testing and Operations Readiness Reviews for Orion Ground Processing, Vehicle Stacking and Integration, Rollout, Launch, Landing and Recovery, and Deservicing activities. NASA-KSC personnel worked alongside Johnson Space Center and NASA Headquarters Health and Medical personnel in various efforts to ensure all aspects and lessons of Artemis I benefit the safety and human-rating success for Artemis II and subsequent crewed missions. **DISCUSSION:** The multiple aspects of preparation and biomedical support at the NASA-KSC of the historic Artemis I mission directly enhanced and prepared NASA to support future crewed Artemis missions.

Learning Objectives

1. The audience will learn about NASA's new program to return to the moon.
2. The audience will understand the multiple biomedical aspects that were involved in support of Artemis I.
3. The audience will appreciate the importance of experience gained in Artemis I to be applied toward future crewed Artemis missions.

[203] PRESERVED RED BLOOD CELLS FOR TRANSFUSION THERAPY IN REDUCED GRAVITY

George Pantalos[1], Brett Janis[2], Jonathan Kopechek[1], Charles Elder[1], Sienna Shacklette[1], Thomas Roussel[1], Michael Menze[1]
[1]*University of Louisville, Louisville, KY, United States;* [2]*Desicorp, Louisville, KY, United States*

(Original Research)

INTRODUCTION: Spaceflight-induced anemia or traumatic blood loss can threaten astronaut health and will require blood transfusion for treatment on an exploration spaceflight. Until mitigation countermeasures are created, there is a critical need for a red blood cell transfusion method compatible with spaceflight. The limitations of current whole blood storage methods (regulated refrigeration for no more than 42 days) are unacceptable for spaceflight missions. A new technology that preserves red blood cells by optimized dehydration (dRBC) for up to four years at ambient cabin conditions provides an emerging option. **METHODS:** Using compounds upregulated in desiccation-tolerant organisms (anhydrobiotes) and automation of biomedical processes, dehydration techniques for RBCs combined with flow-through ultra-sound induced loading of lyoprotectants have resulted in the successful preservation of dRBCs for more than four years. Flight performance of dRBCs was evaluated during 0-g periods of parabolic flight to assess rehydration and cell recovery as well as blood gases. **RESULTS:** Successful rehydration and recovery of dRBCs (>70%) comparable to 1-g values was demonstrated in parabolic flight with in-flight $pO_2 \geq 150$ mm Hg. Effective simulation of dRBC infusion was also demonstrated in parabolic flight. **DISCUSSION:** The dRBC-based transfusible units are thermally stable, easily stored, have significantly extended shelf-life compared to current blood preservation protocols, rehydrate rapidly in reduced gravity, are lightweight, and use a conventional blood infusion set. We anticipate that crews will launch from Earth with dual-chamber bags containing compatible dRBCs and rehydration solution, and COTS transfusion sets packed in medical supply kits for immediate use. The Crew Medical Officer would manually rehydrate the dRBC and IV transfuse the crew member using a standard transfusion set with pressure bag augmentation. These favorable characteristics of dRBCs support critical care capabilities for exploration space missions. Further evaluation of dRBC rehydration in microgravity will occur during a suborbital flight in 2025. Four units will be automatically rehydrated using a mechanical compression system while optical sensors determine oxyhemoglobin and methemoglobin levels. Rehydrated RBC morphology (after in-flight fixation) will be assessed post-flight by SEM. [NASA-80NSSC18K1664, DOD W81XWH-20-1-0866, NSF PFI-1827521, NASA 80NSSC23K0855]

Learning Objectives

1. Understand the difference between the current practice to preserve red blood cells (packed cells) for transfusion therapy and the preservation of dehydrated red blood cells.
2. Understand the difference between the current useful period and methods for storage of red blood cells and the useful period and methods for storage for dehydrated red blood cells.
3. Understand the difference between the current preparation methods for the transfusion of currently used red blood cells and the preparation methods for the transfusion of dehydrated red blood cells.

[204] THE MORTALITY OF RUSSIAN SPACE EXPLORERS, 1960-2021

Kristina Betts[1], Igor Bukhtiyarov[1], Igor Ushakov[2], Yuri Voronkov[3], Maksim Kharlamov[4], Anatolyi Zhernavkov[4]
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WITHDRAWN

Tuesday, 05/07/2024 ***2:00 PM***
Grand Suites 2 & 3

[S-39]: POSTERS: SPACE FOR POSTERS

Chair: Thomas L. Powell
Co-Chair: Chuck Reese

[205] SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME: ASSOCIATIONS AND RELATIONSHIPS

Shilpi Ganguly[1], Catie Cole[2], Scott Wallace[3], Millennia Young[4], Sara Stroble Mason[5], Charles Gibson[6], Mary Van Baalen[4], William Tarver[4], Ann Tsung[6], Tyson Brunstetter[4]
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(Original Research)

INTRODUCTION: Spaceflight Associated Neuro-ocular Syndrome (SANS) is a condition that negatively impacts crew eyesight and ocular health and is defined by four primary ocular signs: optic disc edema, chorioretinal folds, hyperopic refractive error shift, and globe flattening. Exact pathogenesis and relationships between signs remain poorly understood. **METHODS:** Data were collected from U.S. astronauts utilizing diagnostic modalities at pre-, in-, and post-flight time points. This dataset was assessed for associations and relationships across a variety of variables including disc edema, chorioretinal folds, MRI/US globe flattening, refractive error, sex, laterality, and prevalence of SANS using Fisher's exact t-test. **RESULTS:** Global analysis determined that 58% of subjects (n=260) demonstrated signs of SANS. From the subset diagnosed with SANS, cycloplegic refractive error was significantly associated with optic disc edema and chorioretinal folds ($p = 0.001$ and $p = 0.0029$, respectively). Males were more affected than females ($p = 0.005$). The association of disc edema and chorioretinal folds was statistically significant ($p < 0.0001$). There was no difference in prevalence of SANS regarding eye laterality ($p = 1.00$), regardless of sex (M(n=409 eyes)/F(n=90 eyes) $p = 0.869$ vs 0.766 respectively). **DISCUSSION:** SANS signs showed a variable distribution. Some individuals had no signs, while others displayed multiple. Given limitations, it is difficult to ascertain whether this is due to differences in sex seen prior to missions or due to changes during missions, as females were noted to have statistically significantly less total number of flights and flight mission time than males.

Learning Objectives

1. The audience will be able to describe current Spaceflight Associated Neuro-ocular Syndrome (SANS) findings, significance, and countermeasures.
2. The audience will be able identify and appreciate relationships and associations between individual variables related to spaceflight associated neuro-ocular syndrome, with an understanding that there are significant difficulties and limitations when performing spaceflight related ocular measurements and analysis.

[206] BRAIN BIOMARKERS TO UNDERSTAND SPACEFLIGHT IMPACT

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(Education - Tutorial/Review)

INTRODUCTION: The brain undergoes multiple changes in spaceflight. Cephalad fluid shifts occur with venous congestion and cerebrospinal fluid (CSF) redistribution. The brain shifts upward and there is vertex crowding with narrowing of the central sulcus. Microgravity, in combination with continuous space radiation and increased carbon dioxide levels on the International Space Station (ISS), could also lead to disruption of the blood-brain barrier (BBB) and subsequent increased permeability and inflammation. Changes in gray and white matter volumes and periventricular white matter hyperintensities have been seen on imaging studies of previous crewmembers who completed long duration spaceflight missions. The long-term effects on the brain remain unknown, but could include a possible increased risk of cognitive decline or dementia. Out of 371 total NASA astronauts, seven individuals who experienced spaceflight were diagnosed with neurodegenerative dementia between 1994 and 2019, including five with Parkinson's disease, one with Alzheimer's disease, and one with frontotemporal dementia. **TOPIC:** A recent pilot study of five cosmonauts exposed to the long-duration spaceflight environment measured blood-based biomarkers commonly associated with brain pathology including neurofilament light chain (NfL), glial fibrillary acidic protein (GFAP), total tau protein, and two amyloid-beta proteins (Aβ40 and Aβ42), demonstrating possible deleterious effects of the space environment. **APPLICATION:** A research protocol for monitoring of blood biomarkers in astronauts has been developed to provide more comprehensive data of selected biomarkers before and after spaceflight missions. The voluntary protocol will be administered initially with the astronaut selection medical exam to establish a baseline. After identification for a specific spaceflight mission, further biomarker testing of the astronaut will be accomplished at intervals prior to launch and after landing until reaching a plateau. Assessment of blood biomarkers will resume when the astronaut is identified for another spaceflight mission. Upon retirement, blood biomarkers will be checked every five years as part of surveillance exams. If biomarkers are found to be elevated or have an increasing trend, a referral to a neurodegenerative disorder specialist will be placed for further workup.

Learning Objectives

1. Understand the mechanism of potential deleterious effects of spaceflight on the brain.
2. Determine if blood-based biomarkers can be used to monitor brain injury and/or the development of future neurodegenerative disease.

[207] FAST ULTRASOUND USE IN SPACE – A STUDY WITH MEDICALLY INEXPERIENCED INDIVIDUALS

Janina Post[1], Gabriel Johannes Huber[1], Lara Valentina Dietlein[1], Sylwia Izabela Kaduk[2], Clara Tamai[2], Raphael Kneffel[2], David Cyrol[2], Stefan Sammito[2]
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(Original Research)

INTRODUCTION: Focused assessment with sonography in trauma (FAST) is a quick procedure of high accuracy that can be used in emergency medicine diagnostics. For other medical measurements (blood pressure, ECG, oxygen saturation) it was shown that individuals with no experience can conduct these measurements by following in-built instructions and without any relevant difference to medical personnel in duration and quality. However, the quality of FAST outcomes is highly dependent on the proficiency of the operator. Most astronauts are neither medical doctors nor ultrasound professionals, receiving only a certain degree of medical training before missions. Because of that, it is important to investigate and develop strategies to support astronauts during medical procedures, especially in the perspective of deep space exploration. **METHODS:** Participants (35 men and 4 women, median age 31 years [min-max: 18-58 years]) with only basic first aid training and

without ultrasound experience were instructed to conduct a FAST (including right and left upper quadrants, and pelvic scans) on a simulated patient after an accidental abdominal blunt-force trauma. Participants were instructed to follow in-built instructions provided by the vital signs monitor TEMPUS Pro and to evaluate the workload with the NASA-TLX. The ultrasound video recordings were examined by physicians with ultrasound experience, evaluating if the participants were able to conduct an acceptable FAST. **RESULTS:** The NASA-TLX showed a low median total score (6.3 [3-15]) with no significant differences in the sub-scales: mental (9.0 [1-18]), physical (5.0 [1-13]) and temporal demand (8.0 [1-19]), performance (7.0 [1-17]), effort 7.0 [2-18]), and frustration (5.0 [1-17]). Although the reported workload was low, participants were not able to conduct an acceptable FAST ultrasound with a valid examination of all three compartments. **DISCUSSION:** In contrast to other medical procedures that can also be used by people with little medical experience with an in-built instruction, our study shows that this cannot be transferred to FAST. For future deep space exploration missions, it will be necessary to improve the in-built instructions and to train astronauts to be able to conduct an acceptable FAST.

Learning Objectives

1. The participants will learn how automatically in-built instructions in medical systems can support deep space exploration missions.
2. The participants can understand that further training is necessary for inexperienced individuals conducting FAST ultrasound diagnostics, before sufficient results are achievable.

[208] VITAMIN D LEVELS IN ISRAELI AIRCREW MEMBERS

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(Original Research)

INTRODUCTION: Vitamin D is crucial for calcium homeostasis, bone health, and various biological processes. There is no consensus regarding vitamin D sufficiency levels. Various scientific societies suggest different thresholds with accepted values of 25(OH)D being 30, 20 and 12 ng/mL. The aim of this study was to establish normal vitamin D values for the Israeli Air Force (IAF) air personnel. **METHODS:** Data from medical records of aircrew who underwent an annual routine health checkup between 2020 and 2022 were analyzed. The subjects were examined at the IAF Aeromedical Center. All subjects were healthy and had no clinical signs of vitamin D deficiency. This study was approved by the Institutional Review Board. **RESULTS:** Records of 358 air personnel were analyzed. Mean age was 31.1±11.4 years (range 18-60), mean BMI 24.43±2.82 (range 17.6 – 34.4) with a male predominance (93.6%). Levels of 25(OH) D were normally distributed around a mean value of 27.14 ± 7.07 ng/mL (range 6.4-48.4 ng/mL), median of 31.25 ng/mL and interquartile range of 8.8.ng/mL. Vitamin D levels had a negative weak correlation with age, with a Pearson's correlation coefficient $\rho = -0.22$ (P value < 0.001). There was no statistical significant gender difference. **DISCUSSION:** With sufficiency levels at 30, 20, and 12 ng/mL, the percentage of subjects with sufficient vitamin D levels would be: 65%, 86%, and 99% respectively. Given our population's health, youth, and sunny country residence, we argue the vast majority should have sufficient values. With a normal distribution around a mean of 27.14 ng/mL, 95% (2SD) of our population falls between the values of 13.00 and 41.28 ng/mL. Our findings align with previous studies, suggesting that a threshold of 30 ng/mL is possibly excessive for the Israeli population.

Learning Objectives

1. Mean vitamin D [25(OH)D] level for IAF air personnel is 27.14 ng/mL. Sufficiency levels fall between 13 and 41.28 ng/mL.
2. Previous values of 25(OH)D (40-100 ng/mL) used in the IAF appear to be too high.

[209] INCREASING NEED OF ORTHOPEDISTS FOR ASTRONAUTS IN SPACE MEDICINE, DEFINING FUTURE STANDARDS, AND REVIEW OF PERI-FLIGHT MUSCULOSKELETAL INJURIES

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(Original Research)

INTRODUCTION: The space sector is growing fast. Its value is expected to increase from $447 billion in 2022 to $2.7 trillion by 2040. This encompasses the increase of start-ups, active satellites, launches per year, space hotels, private funding, and astro-tourism. As the demand for astronauts and astro-civilians grows, so will musculoskeletal (MSK) injuries during pre-flight training, in-flight, and post-flight. This increase requires a greater demand of orthopedists in space medicine. The role of orthopedists in space medicine is sparsely reported in literature and standards of care for astro-civilians are not well established. This study establishes the current prevalence of peri-flight MSK injuries in astronauts and discusses standards of care for astro-civilians. **METHODS:** A systematic review using PubMed, MEDLINE, and NASA Technical Report Server databases was performed to identify original research containing MSK injuries in astronauts. The number of peri-flight injuries and their bodily locations documented were used to determine their prevalence from 1959 to 2023. **RESULTS:** The prevalence in 2388 documented injuries of pre-flight is 46.5%, in-flight is 37.0%, and post-flight is 16.5%. The prevalence in 2081 documented injury locations of the upper extremity is 32.4%, shoulder is 31.4%, back is 26.4%, lower extremity is 5.5%, and neck is 2.3%. **DISCUSSION:** Common peri-flight injuries involve the shoulder, back, and hand. Muscle atrophy decreases at rates between 9-11% during 17 day space missions. Astronauts lose up to 1 to 2.4% bone mineral density in the hip and lumbar spine per month and have an incidence rate of 4.3 times for herniated discs compared to individuals who have not undergone spaceflight. It is critical to consider MSK injuries for the growing space sector. Space tourism's estimated market value is $23 billion by 2030. As public interest grows, costs related to space are expected to decrease such as space stations from $110 to $5 billion and heavy launches from $1,500 to $100 per kilogram. Private companies want 5 million space tourists in 2030 and to make space travel commercially available. Deceased costs increase the accessibility to space and consequently the risk of MSK injuries. Space adaptation back pain has an occurrence rate of 52% in astronauts. Millions could develop space adaptation back pain. Rising MSK injuries will increase the demand for orthopedists in space medicine and standards of care need to be established.

Learning Objectives

1. The audience will learn about pre-flight, in-flight, and post-flight musculoskeletal injuries obtained by astronauts and the most common types of injuries.
2. The audience will learn about the prevalence of astronaut peri-flight musculoskeletal injuries and their bodily locations.
3. The audience will learn about the goals of the space sector and its increasing growth, astro-civilians and astro-tourism, and a need for developing new standards of care in space medicine due to a likely increase in astronautic musculoskeletal injuries.

[210] RADIATION SHIELDING: THE PAST, THE PRESENT, AND THE FUTURE

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(Education - Program/Process Review)

BACKGROUND: With NASA's Artemis program underway and commercial spaceflight growing, astronauts will live in space for longer

than ever outside the protective shell of the Earth's geomagnetic field and atmosphere. During extended spaceflight, EVAs, and missions to live on the lunar and Martian surfaces, astronauts have the potential for long-term exposure to the harmful effects of radiation in the form of solar particle events (SPEs) and galactic cosmic rays (GCRs). With current shielding materials, it is estimated that a mission to Mars would result in an effective radiation dose of approximately double the recommended lifetime radiation exposure for astronauts (600mSv) . This article will review existing literature on past, current, and near-future shielding technologies, which can be broadly divided into passive and active shielding. **OVERVIEW:** For passive shielding materials, as the thickness is increased, there is a resulting decrease in the effective dose for many traditional types of radiation. However, the high mass and energy (HZE) radiation of GCRs can paradoxically increase effective dose through collisions with shielding materials and scattering of secondary neutrons and other forms of radiation from the shielding materials. This article will examine literature classifying the properties of shielding materials, including their stopping power, total nuclear fragmentation cross-section, and ability to absorb neutron radiation. By combining various materials, it might be possible to synergize the shielding properties and produce superior shielding. For active shielding technologies, electromagnetism is employed to provide shielding akin to Earth's geomagnetic field. While technical challenges for implementation exist, this represents an exciting area of study, with early tests showing significant reductions in dose equivalents of radiation. Hybrid approaches, which combine active and passive shielding technologies to further reduce the equivalent radiation dose, will also be examined. **DISCUSSION:** Newer and more effective shielding strategies are essential for the success of long-term spaceflight and exploration. Current methods in use limit exploration; fortunately, near-future implementation of new passive shielding materials and effective active shielding will greatly reduce the risk, pushing the boundary of exploration even further. This work is relevant to the current climate of Mars exploration and commercial space exploration.

Learning Objectives

1. The reader will be able to effectively understand current and future shielding technologies in place to mitigate Space radiation exposure.
2. The reader will be able to understand why shielding is essential to further human exploration and key to the success of a mars mission/commercial space/longterm space habitation.
3. The reader will be able to understand the challenges we face today in implementing future shielding technology and work being done to overcome it.

[211] EXTREME REDUCTIONS IN BODY MASS INDEX AS AN ANALOG FOR WEIGHTLESSNESS TO EXAMINE VOLUMETRIC CHANGES IN THE BRAIN

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(Original Research)

INTRODUCTION: MRI measurements from spaceflight participants after extended weightlessness show significant enlargement of cerebral ventricles, with some studies demonstrating reduced total brain volume. Although modeling the complete loss of body weight is not possible on Earth, bariatric surgery produces a rapid reduction in body weight that may serve as a partial analog. This study investigated whether extreme weight loss leads to changes in brain volumes similar to those seen after spaceflight. **METHODS:** Data were used from a prior study which collected MR scans on bariatric surgery patients and non-treated controls of comparable obesity. All subjects were right-handed, nonsmokers, otherwise healthy, and on no medications affecting bodyweight. This study selected six subjects with a BMI reduction ^{3} 10 and six random control subjects with no BMI change. Scans were acquired for each subject preoperatively, and again four months after surgery. Total brain and ventricular volumes were then segmented using ITK-SNAP, and analyzed with a rmANOVA using weight loss (WL) and no weight loss (NWL) as the grouping variable. **RESULTS:** Total brain volume decreased significantly in both groups (WL: $8.5x10^3$ to $7.9x10^3$ mm^3, NWL: $8.5x10^3$ to $8.3x10^3$ mm^3) (ANOVA, p=0.005), however total volume decreased significantly more in the WL group (8.1%) than in the NWL group (1.6%)(ANOVA, p=0.04). Ventricular volume increased in the WL group and decreased in the NWL group, but this interaction was not significant (ANOVA, p=0.33). When the ventricular volume changes were normalized to total brain volume, there was a trend toward a significant interaction (ANOVA, p=0.09). **DISCUSSION:** Total brain volume decreased significantly more after bariatric surgery among WL subjects compared to NWL subjects. The ventricular volume/brain volume ratio also trended toward being greater in the WL group. This provides evidence that significant weight loss is associated with decreased cerebral volume. Although we initially hypothesized this may be due to loss of body weight causing changes in tissue pressures or motor cortex neglect, it could also be due purely to a loss of body mass as astronauts typically lose body mass in space. These data suggest a need for further study on how to use weight loss as an analog for weightlessness.

Learning Objectives

1. The audience will understand the currently observed correlations between weightlessness in spaceflight and alterations in human brain volume.
2. The audience will be able to understand the utility of weight loss on Earth as an analog for weightlessness by which to study the effects of spaceflight on the human brain.

[212] OSTEOPATHIC MANIPULATIVE THERAPY "MONEY" TECHNIQUES FOR MANAGING COMMON MUSCULOSKELETAL CONDITIONS ON THE INTERNATIONAL SPACE STATION

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(Education - Program/Process Review)

BACKGROUND: Spaceflight associated musculoskeletal (MSK) complaints such as hand and shoulder overuse, shoulder impingement from extravehicular activity, and space associated back pain are well established complications of crewed spaceflight. MSK issues can affect crew performance and have the potential to impact operations. Osteopathic Manipulative Therapy (OMT) is set of manual medicine techniques which can be used to address MSK pain, compressive neuropathies, and many other complaints. MSK cases during spaceflight have shown improvement with OMT. **OVERVIEW:** For this project researchers sought to develop criteria and guiding principles for the creation of OMT techniques for use in microgravity. The most common MSK complaints for the upper body were selected as the focus of this project. Due to changes withing intervertebral discs in microgravity, High Velocity Low Amplitude (HVLA) techniques were excluded. Considerations for technique design included the modification of standard treatment mechanics due to microgravity, lack of specialized equipment, and development of appropriate techniques to be performed by astronauts not experienced providers. Additional challenges including the inability to utilize body weight as potential force and limited anchoring points within modules. Techniques also had to avoid imparting any unusual stresses to the craft. Direct, indirect, self and partner techniques were developed. Written and video instructional material were developed for use by astronauts in-flight and flight surgeons on console. Future considerations for OMT onboard the ISS include treatments for the lumbar spine, lower extremities, as well as non-MSK dysfunction including urinary retention, gut motility, and

proprioception. **DISCUSSION:** OMT is a therapeutic option for a variety of MSK and non-MSK complaints. It is ideal for the resource constrained environment of the ISS and future long term space missions. Benefits include minimal time required for treatment and relatively few contraindications or side effects. No special equipment is required and OMT as a treatment modality could reduce utilization of medical consumables while supporting continued operations. This project has potential impact on international space operations, both government sponsored and civilian.

Learning Objectives

1. The audience will understand some of the key considerations in developing OMT techniques for use in microgravity.
2. The audience will understand the benefits of non-pharmacological therapy in long duration space flight.

[213] A USE OF A SUPEROXIDE DISMUTASE MIMETIC TO PROTECT JOINT SOFT-TISSUE DURING SHORT AND LONG DURATION SPACEFLIGHT

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(Original Research)

INTRODUCTION: Reduced weight-bearing in microgravity damages musculoskeletal tissues, as previously identified in ground-based tail suspension models. Cartilage and meniscal degradation that occurred during spaceflight aboard the International Space Station for the Rodent Research-9 mission occurred with reduced antioxidant defenses and increased oxidative stress biomarkers, which indexes arthritic responses. We hypothesize that a superoxide dismutase mimetic, MnTnBuOE-2-PyP5+, can act as a countermeasure against microgravity induced joint damage during short and long duration spaceflight. **METHODS:** N=47 10-week-old C57BL/6 male mice were studied; n=23 were launched to the ISS for 35 days as part of the RR-18 mission (Launch Dec 2021). N=10 received either BuOE (n=5 FLIGHT35+BuOE, 1mg/kg/weekly) or saline vehicle (n=5, FLIGHT35) and returned live after 35d. N=13 remained aboard ISS until 75d for on-orbit sacrifice (n=6 FLIGHT75+BuOE; n=7 FLIGHT75). Both arms included ground controls (n=10 GC35; n=14 GC75). Intact knee joints, femoral heads, and tibiae were isolated from right hindlimbs for micro-CT analysis. Data was analyzed using 2-way analysis of variance (ANOVA). Animal use, study design, and ethics were approved by appropriate IACUCs. **RESULTS:** Meniscal volume was lower after 35d spaceflight vs control (-9.4% vs GC35); antioxidant administration attenuated this loss (FLIGHT35+BuOE -1.2% vs GC35). Tibial articular cartilage thickness was similar between FLIGHT35 and GC35, BuOE treatment alone increased thickness (+12.8% FLIGHT35+BuOE vs FLIGHT35, +16.6% GC35+BuOE vs GC35). In contrast, meniscal volume was unchanged from controls by 75d, regardless of antioxidant treatment. However, tibial articulate cartilage thinning occurred in FLIGHT75 vs GC75 (-11.6%), with BuOE failing to preserve the articular cartilage (-14.4% FLIGHT75+BuOE vs GC75). **DISCUSSION:** Treatment with BuOE protects against space flight induced meniscal degradation during short duration (35d) missions and promoted articular cartilage thickness in all groups after 35d. However, while meniscal degradation was similar between flight and ground control groups after 75d in orbit, articular cartilage thinning was observed in flight mice that was not prevented by the antioxidant countermeasure. Given the small sample size, further investigations are needed to understand the mechanism of BuOE treatment in mitigating soft-tissue joint damage during both short and long-term spaceflight.

Learning Objectives

1. The audience will learn about the deleterious effects of microgravity on joint health in relation to the pathophysiology of arthritis.
2. The audience will learn about pharmacologic strategies in mitigating microgravity induced joint degradation with applications both terrestrially and for long duration missions.

[214] VENOCONSTRICTIVE THIGH CUFFS: A SAFE AND EFFECTIVE COUNTERMEASURE TO REVERSE THE HEADWARD FLUID SHIFT

Sarah Ditelberg[1], Steven Laurie[2], Jason Lytle[2], Matthew Poczatek[3], Cambria O'Grady[4], Brandon Macias[5]
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(Original Research)

INTRODUCTION: The Braslet is a custom-built venoconstrictive thigh cuff (VTC) used by crewmembers flying on the Soyuz spacecraft to reduce symptoms associated with the headward fluid shift during the adjustment to spaceflight. However, crew traveling to the International Space Station (ISS) on commercial vehicles do not have access to VTCs. NASA's Cardiovascular and Vision Lab at Johnson Space Center, in collaboration with Clemson University, has developed VTCs similar in form and function to the Braslet but in small to extra-large size ranges with the ability to measure the applied pressure. The purpose of this project was to develop sizing protocols and document thigh circumference ranges for each size VTC, characterize the VTC pressure at which femoral venous blood flow is restored, and assess the magnitude of fluid shift reversal. **METHODS:** Thigh circumference was measured at VTC placement in 21 healthy participants (13M, 8F), and VTC sizing was determined based on ability to achieve the target pressure of 50 mmHg. Doppler ultrasound was used to assess femoral venous flow with and without VTC use and with plantarflexion across decreasing pressure intervals. We also assessed effectiveness of daily VTC use for six hours to reverse the headward fluid shift during a head-down tilt bed rest (HDTBR) study. This project was approved for human subjects research by NASA JSC's IRB. **RESULTS:** Thigh circumference at VTC placement for small and medium sizes were 57.6±2.5 and 64.0±3.7 cm, respectively. Most participants restored venous flow at 10 mmHg, and all restored flow during plantarflexion at 50 mmHg. Use of the VTC increased thigh circumference, reduced cardiac output, and decreased IJV area; these findings did not occur in control subjects who did not use VTCs. **DISCUSSION:** While further testing is needed to evaluate larger VTC size ranges, additional work is needed to understand if loss of leg volume during spaceflight will necessitate different sizing. Additionally, universal return of flow upon plantarflexion highlights that venous blood flow is not completely occluded, and would be expected to intermittently flow past the VTC as crew conduct normal activities throughout the ISS, thus minimizing risks of potential clot formation. These data suggest the VTCs are safe to use for up to six hours, are effective at trapping fluid in the legs and reducing the headward fluid shift, and should be considered as a countermeasure for use during spaceflight.

Learning Objectives

1. The audience will be able to explain what venoconstrictive thigh cuffs are and what their intended purpose is.
2. The audience will be able to describe outcomes documenting the effectiveness of VTCs as a countermeasure to the headward fluid shift.

[215] CAFFEINE CONSUMPTION ABOARD THE INTERNATIONAL SPACE STATION

Zachary Glaros[1], Rachel Jansen[1], Alisa Braun[2], Sara Zwart[1], Scott Smith[1], Erin Flynn-Evans[1]
[1]*NASA, Mountain View, United States;* [2]*San Jose State University, San Jose, CA, United States*

(Original Research)

INTRODUCTION: Caffeine is the most widely used performance-enhancing drug on Earth and astronaut crews have access to caffeine pills and liquid coffee. While caffeine is a potent countermeasure to improve alertness and performance, it also interferes with sleep. This leads to performance deficits on the following day, driving a cycle of caffeine use to counter the effects of caffeine-induced sleep disruption. Caffeine availability may be limited during future Artemis and Mars missions. As a result of mission constraints, it is critical that we 1) determine the prevalence of caffeine use among crews, 2) characterize the impact of caffeine on performance, and 3) characterize the impact of caffeine on sleep. Our aim in this study is to describe the use of caffeine aboard the ISS and begin to look at the relationship between caffeine use and sleep outcomes. **METHODS:** Data consisted of calculated amounts of daily caffeine consumed based on daily food and beverage intake for 25 astronauts on the International Space Station. On average, crew collected dietary data for 179.68 days inflight (SD =68.61). **RESULTS:** Across all crew, individuals consumed an average of 96.99 mg (SD = 92.29 mg) of caffeine per day. All astronauts in this study consumed caffeine (25/25) at some point during spaceflight, though the frequency, amounts, and regularity differed across crewmembers. Approximately a quarter of crewmembers were regular caffeine consumers (6/25), i.e., they ingested at least 90 mg (equivalent to one cup of coffee) on 90% of inflight days. **DISCUSSION:** Our findings demonstrate that caffeine is regularly consumed by crewmembers, though consumption patterns vary across individuals. Future analyses will involve combining these data with sleep outcomes to determine the relationships between caffeine consumption and sleep. This information will provide us with an understanding of how caffeine is being used inflight to help guide countermeasure use in future missions.

Learning Objectives

1. This research shows that caffeine is regularly used by astronauts aboard the ISS.
2. This research shows that more data regarding caffeine consumption is needed.

[216] HEMORRHAGE CONTROL METHODS FOR SPACE FLIGHT: LESSONS FROM RURAL TRAUMA CARE

Jace Bradshaw, Imelda Muller, Mark Shelhamer
Johns Hopkins University, Baltimore, MD, United States

WITHDRAWN

Tuesday, 05/07/2024 ***4:00 PM***
Grand Ballroom CD South, EF

[S-40]: PANEL: A MODEL FOR A DEPARTMENT OF MEDICAL OPERATIONS AT A COMMERCIAL SPACE COMPANY

Sponsored by Axiom Space Inc

Chair: Michael Harrison

PANEL OVERVIEW: *This panel will highlight the numerous considerations that may be considered when establishing a medical operations department at a commercial space company. Traditionally, these support services have been provided by governmental assets but, with the rapid expansion of commercial human spaceflight and the ambitions to establish a sustained human presence in commercial space, the future will require commercial resources and support. We present an outline of how one company providing orbital flight opportunities approached these tasks - from staffing and team composition to development of medical standards to adjunct support services such as search-and-rescue and console support - and integrated into a larger system that included other governmental and commercial spaceflight organizations.*

[217] AD ASTRA: ONE COMPANY'S APPROACH TO MEDICAL SUPPORT FOR COMMERCIAL SPACEFLIGHT OPERATIONS

Michael Harrison[1], Melinda Hailey[2], Ted Duchesne[2], Rachel Fowler[1], John Suffredini[1], William Powers[1]
[1]*Axiom Space Inc & Hercules Medical Group, Houston, TX, United States;* [2]*Axiom Space Inc, Houston, TX, United States*

(Education - Program/Process Review)

BACKGROUND: The dawn of the commercial space industry provides opportunities for individuals and organizations that have traditionally not been able to engage in spaceflight. The medical infrastructure required to support commercial crews and their missions differs across multiple companies. This panel will introduce the audience to the broad spectrum of commercial space mission types as well as specific details at one commercial space company flying commercial crews to the International Space Station (ISS). **DESCRIPTION:** Commercial space missions differ based upon the provider and the vehicle. Mission lengths range from hours to days to weeks across the spectrum of suborbital to orbital and undocked to docked. Crew composition can vary from wealthy private individuals to governmental astronauts from non-traditional countries. The missions may terminate at the same facility from which they launched or with a landing or splashdown at a more remote location. The processes by which crews are selected, trained, medical certified, and supported for each of these missions differs. Axiom Space Inc has flown two crews to the ISS while building the first commercial space station. Axiom is developing and refining processes for medical standards, behavioral health evaluation and support, and allied-health services including support for physical fitness, nutritional and dietary, payload, and training needs that will be standard for all Axiom missions including the development of spacesuits and station modules. **DISCUSSION:** While drawing heavily on historical lessons learned and the associated experiences, the requirements and capabilities necessary to support Axiom's missions are a departure from those employed by governmental space agencies. Axiom's goal is to create a thriving home in space that benefits every human, everywhere. The medical department at Axiom endeavors to make space accessible for all while not sacrificing safety for the crew or the mission. Achieving both of these goals requires a deliberately responsible and comprehensive multidisciplinary approach that spans the preparatory, execution, and recovery stages of each mission. This panel will provide details of our approaches and successes with lessons that may benefit other individuals or organizations in the realm of commercial space.

Learning Objectives

1. Increase awareness of the differences in mission type and scope among different commercial space companies.
2. Introduce the numerous considerations required to support a safe commercial space mission to the ISS.

[218] STAFFING A MEDICAL DEPARTMENT AT A COMMERCIAL SPACE COMPANY

Melinda Hailey[1], Ted Duchesne[1], Rachel Fowler[2], John Suffredini[2], William Powers[2]
[1]*Axiom Space Inc, Houston, TX, United States;* [2]*Axiom Space Inc & Hercules Medical Group, Houston, TX, United States*

(Education - Program/Process Review)

BACKGROUND: The individual members of any team are an important determinant in the efficacy and success of that team. Commercial space companies face significant challenges in determining who to include in their teams and how to develop a plan for

growth. This presentation will outline the process at Axiom Space during the progression from a newly formed company through its first International Space Station (ISS) mission to present day – repeated ISS missions, suit development, and space station planning. **DESCRIPTION:** Commercial space companies are leaner than governmental space agencies and can operate with more corporate flexibility. In the early days, the medical department relied heavily upon a small group of employees and the support of contractors. The small group of employees exhibited a balance of experience with an innovative approach and often included a positive reputation within the industry. These key positions included leadership, operational, flight surgeon, and biomedical engineer roles that may have lacked redundancy. The contracted support personnel augmented the capabilities in areas of physical fitness, nutritional, or behavioral health support; redundancy to full time personnel was often a contract position (i.e. console flight surgeon). The growth and success of the company would provide future opportunities for positions previously held by contractors to transition to full time company hires. While generally a positive event, growing pains should be expected and addressed as they present. **DISCUSSION:** The medical team of a commercial space company engaged in human spaceflight missions requires individuals who are carefully selected not only for their training and experience but also for their ability to be innovative and customer-service oriented. The company-specific mission differs from both the scope of the mission of governmental agencies but also from the scope of the mission of other entities within commercial space community. A clear corporate vision, strong leadership, and selective hiring processes with transition planning (e.g. contractor to full time) are crucial in navigating from theoretical to start-up to established commercial spaceflight provider.

Learning Objectives

1. Identifying the stages associated with a commercial space company growth.
2. Identifying the key personnel required in a medical department to support a safe and successful human spaceflight.

[219] MEDICAL STANDARDS, MEDICAL CLEARANCE AND INTERNAL/EXTERNAL RELATIONSHIPS FOR A COMMERCIAL SPACE COMPANY

William (Ed) Powers[1], Michael Harrison[1], John Suffredini[1], Rachel Fowler[1], Melinda Hailey[2], Ted Duchesne[2]
[1]*Hercules Medical Group/Axiom Space, Houston, TX, United States;* [2]*Axiom Space, Houston, TX, United States*

(Education - Program/Process Review)

BACKGROUND: From the beginning of space exploration, candidates identified as being highly qualified for spaceflight were required to be in excellent health. The paradigm is changing as space exploration evolves into a commercial enterprise with candidates representing a wide range of age, wealth status, medical status, political and international backgrounds. Aerospace medicine physicians are challenged with mitigating the medical risk associated with flying these individuals. **OVERVIEW:** Evaluation of medical risk of various conditions is essential to protect the individual and to assure success of the mission. The establishment of medical standards provides an evidence-based approach to risk acceptance. Many commercial space astronauts are self-selected due to their ability to afford the cost of the trip and may have a multitude of underlying medical issues. Each issue is considered using medical standards. Discussion of risk mitigation is undertaken based on the mission duration, activities planned during the mission, and supplies required. Other commercial space astronauts may come from international governments and are expected to fly multiple times. Selection assistance is provided to assure that career astronauts are acceptable. Consideration must also be given to the mission specific details including collaboration with NASA, international partners, and other commercial space companies. Risk acceptance is shared among those entities. **DISCUSSION**: Medical evaluation and careful consideration of medical risk mitigation involves many factors. Relationships both internally and externally are critical to risk evaluation and acceptance. Partnering with local healthcare providers for medical evaluation and specialty consultation is utilized to provide data necessary to make decisions. Presentation to and acceptance by a certifying board is the final step in the process of clearing a commercial astronaut for spaceflight.

Learning Objectives

1. Identifying the factors associated with medical certification of a commercial space astronaut.
2. Identifying the factors that influence the development of medical standards to minimize risk to the individual and the mission.

[220] MISSION CONTROL AND OTHER OPERATIONAL SUPPORT RESOURCES AT A COMMERCIAL SPACE COMPANY

Ted Duchesne[1], Alexander Rubin[1], Melinda Hailey[1], Michael Harrison[2]
[1]*Axiom Space Inc, Houston, TX, United States;* [2]*Axiom Space Inc & Hercules Medical Group, Houston, TX, United States*

(Education - Program/Process Review)

BACKGROUND: It takes hundreds of people to support one astronaut during a spaceflight mission. A commercial astronaut draws on resources across multiple organizations including governmental space agencies and partner commercial space entities but, in some cases, traditionally available government support resources are not an option. A commercial space mission represents an opportunity to innovate, integrate, and iterate the operational support paradigm that is crucial to the safety and success of human spaceflight. **DESCRIPTION:** The most common support resource that is associated with human spaceflight is the mission control center (MCC). Commercial space missions at Axiom Space have required the integration of an internal MCC with those of NASA and SpaceX across multiple sites during dynamic mission phasing. Upcoming missions have added the requirements to integrate further with the MCC of an international partner within the current system. Search and rescue (SAR) and hyperbaric resources for human spaceflight have traditionally been provided through inter-agency governmental cooperation, specifically between NASA and the Department of Defense (DOD). Commercial spaceflight missions are not eligible for this level of DOD support and commercial companies are required to contract civilian SAR and hyperbaric resources. These assets may have their own MCC and will require integration within the larger MCC network during, at a minimum, the launch and landing phases of the mission. These items represent select high-profile examples but multiple other aspects of mission support including but not limited to payload coordination, flight-hardware certification, exercise devices and prescription, and crew and family psychological support also represent opportunities to change how support is provided to human spaceflight in the age of commercial operations. **DISCUSSION:** The model of integrated operational support for human spaceflight is changing at a rapid pace from that employed by governmental space agencies to those provided by commercial companies. Many of the resources that may be taken for granted require commercial companies to develop and refine their own capabilities and processes. This represents a very important and deliberate undertaking to maximize mission success and crew safety.

Learning Objectives

1. The audience will learn about the integration that is required to support a commercial space mission to the ISS.
2. The audience will be able to identify aspects of spaceflight mission support that also need to transition from government to commercial sectors beyond the launch vehicle provider.

[221] MEDICAL DEPARTMENT INTEGRATION WITHIN A COMMERCIAL SPACE ORGANIZATION

Lindsey Hieb
Axiom Space Inc, Houston, TX, United States

(Education - Program/Process Review)

BACKGROUND: A physician trained in Aerospace Medicine, with the relevant clinical knowledge and medical authority, is required for direct patient care. However, fully applying that knowledge and authority where needed across a commercial space organization requires effective integration of the medical operations group with the rest of the organization. **OVERVIEW:** From the earliest days during the establishment of a medical operations department, there will be situations where a representative from medical needs to weigh in as a stakeholder regarding potential impacts to human health or the exchange of medical data, as well as provide information where medical industry knowledge is required to make operational, planning, or design decisions. Considerations for the scope of that work as the company grows may include writing and verifying requirements; designing or sourcing and testing hardware; and developing and documenting processes, standards and procedures. In an operations environment, needs may also include review of mission products from a medical perspective. The medical operations department should also weigh in on the handling of medical data and development of processes associated with human research payloads. This integration requires effectively interpreting and relaying information between physicians and the operations and engineering communities within an organization, to name a few, while balancing differing priorities. It may require human health related content development tailored to fit certain applications, and participation in working groups or boards where multiple departments work together to create integrated products or make decisions. **DISCUSSION:** A highly functioning medical department is not based on the possession of specialized clinical knowledge and expertise alone. Effectiveness is dependent upon using that knowledge while participating in the right conversations across an organization, wherever those conversations are occurring. It is best to establish an integrated presence as early as possible to open up lines of communication and create productive relationships.

Learning Objectives

1. The audience will learn about likely interfaces between medical operations and other departments in a commercial space organization.
2. The audience will be able to identify examples of tasks or products requiring integrated participation from medical operations.

Tuesday, 05/07/2024 ***4:00 PM***
Grand Ballroom A

[S-41]: SLIDES: BONES, MUSCLES AND CENTRIFUGES - OH MY

Chair: Jennifer Fogarty
Co-Chair: Megan Gallo

[222] HEAD DOWN TILT BED REST STUDIES AND EYE EXAMINATIONS FOR TEST SUBJECTS SAFETY

Claudia Stern, Stefan Kremers, Maren Pittius, Doris Mittelstaedt, Steffen Stupp, Laura de Boni, Edwin Mulder, Scott Ritter
German Aerospace Center, Cologne, Germany

(Education - Program/Process Review)

BACKGROUND: Prolonged head-down tilt bed rest (HDTBR) is frequently employed as an analog to study the human physiology changes that occur during spaceflight, particularly Spaceflight Associated Neuro-ocular Syndrome (SANS). We conducted four HDTBR campaigns to investigate ocular changes and potential SANS countermeasures. To ensure the safety of test subjects and the quality of data, we established specific exclusion criteria and implemented safety examinations. **OVERVIEW:** 39 test subjects underwent a 30-day period of strict HDTBR. Comprehensive ocular assessments were conducted at baseline and during the immediate recovery phase following HDTBR. This included measurements of visual acuity, refraction, visual field, applanation tonometry, slit lamp, optical coherence tomography (OCT) and fundoscopy. Measurement of intraocular pressure (IOP) and near visual acuity was added at day 2, 4, 17 and 30 of the HDTBR period. One test subject developed a retinopathia centralis serosa and was subsequently excluded during baseline examination. Another showed a retinal hole in the periphery which was detected with dilated fundoscopy during baseline examination and was treated by laser before bedrest started. Two eyes of two participants showed a reduction of two and three lines of near visual acuity at day 2 of bed rest. After bed rest, near visual acuity of one eye showed one line of reduction, while the other eye was back to baseline. There was no significant hyperopic shift in refraction and no optic disc edema in these eyes. For all participants, IOP during bed rest had a range of 12.2 to 27.6 mm Hg, with the highest values at day 4 and 17. **DISCUSSION:** The observed increase in IOP highlights the importance of IOP safety measures during HDTBR. Near visual acuity testing does not give enough information concerning hyperopic shift and reduced eye length due to different influences on near vision and a lack of hyperopic shift in bed rest. We emphasize of conducting a comprehensive eye examination with visual acuity testing, applanation tonometry, visual field testing, OCT, slit lamp and dilated fundoscopy. Additionally, the exclusion of eye pathologies is important to ensure test subjects safety during HDTBR.

Learning Objectives

1. The audience will learn about recommended ocular safety measurements in head down tilt bed rest studies.
2. The audience will learn about the results of near visual acuity and intraocular pressure measurements during head down tilt bed rest studies.

[223] PREVENTION OF VISUAL SYMPTOMS DURING CENTRIFUGE-SIMULATED SUBORBITAL SPACEFLIGHT

Ryan Anderton[1], Thomas Smith[2], Ross Pollock[2], Joseph Britton[3], Nicholas Green[3], Daniel Hendriksen[3]
[1]UK Civil Aviation Authority, Gatwick, United Kingdom; [2]King's College London, London, United Kingdom; [3]RAF, Henlow, United Kingdom

(Original Research)

INTRODUCTION: Previous centrifuge research has identified that during a centrifuge simulated suborbital spaceplane launch involving +4Gz and up to +4.5Gx, ~70% of individuals experienced greyout, increasing to ~80% on re-entry, assuming an upright seated posture. Furthermore, blackout and G-induced loss of consciousness (G-LOC) have been observed during the same profiles. A potential means to mitigate this risk is to instruct passengers/crew to tense their legs/abdominal muscles in a similar manner to that performed during the anti-G straining maneuver. The aim of the current study was to determine whether pre-tensing of the lower body muscles can prevent visual symptoms during suborbital acceleration profiles, thereby reducing the risk of G-LOC. **METHODS:** 13 participants (10 males, 3 females, age range 34-82, mean age 53 (SD= 15)) who had previously experienced G-induced visual symptoms during a centrifuge suborbital spaceflight acceleration study were invited to take part. The acceleration profile used was the most provocative suborbital profile identified in a prior study, mimicking spaceplane launch and re-entry in an upright seated position. Participants experienced acceleration while relaxed and when performing lower body muscle tensing, initiated ~10 seconds prior to peak acceleration. Participants were asked to depress a marker button while they experienced any visual symptoms to record onset and duration. The study had favorable opinion from the UK Ministry of Defence Research Ethics Committee. **RESULTS:** Pre-tensing completely prevented greyout on launch in participants who had previously experienced greyout during suborbital profiles when relaxed, and on re-entry it prevented greyout in 54% of participants. The time to onset of greyout in those who experienced re-entry symptoms was delayed by muscle tensing. The effectiveness of pre-tensing was not related to age. Pre-tensing was well tolerated. **DISCUSSION:** Greyout can be common during launch and re-entry phases of centrifuge-simulated suborbital spaceflight in a seated spaceplane profile. Pre-tensing was found to be well tolerated and feasible for suborbital spaceplane participants and should be considered as a mitigation during

routine operations. Even with pre-tensing, individuals may still experience G-related visual symptoms, indicating that the risk of G-LOC remains.

Learning Objectives

1. The audience will learn about the effectiveness of muscle tensing in preventing visual symptoms in a centrifuge-simulated upright seated spaceplane profile.
2. The audience will learn that the effectiveness of pre-tensing in this study and simulated spaceplane profile was not related to age.

[224] TOLERANCE OF CENTRIFUGE-SIMULATED SPACEFLIGHT IN INDIVIDUALS WITH DIABETES

Samantha King, Rebecca Blue
UTMB, Galveston, TX, United States

(Original Research)

INTRODUCTION: There is increasing interest in the screening and evaluation of individuals with underlying medical conditions such as diabetes for participation in commercial spaceflight. Limited data exist regarding tolerance of centrifuge-simulated spaceflight in diabetics. Of concern, diabetes and glycemic control medications may risk incapacitation through hypoglycemic or hyperglycemic events. This study evaluated the tolerance of simulated spaceflight in diabetics. **METHODS:** Layperson volunteers were recruited for centrifuge studies simulating spaceflight in both capsule and fixed-wing vehicles. All centrifuge studies were approved by the University of Texas Medical Branch Institutional Review Board. Prior to participation, volunteers were required to provide medical screening documentation. Diabetic exclusion criteria included HbA1c >8% or preprandial blood glucose average >250mg/dL. Twenty (3 female) diabetic volunteers met screening criteria for inclusion. Diabetic participants utilized various methods of glycemic control including diet, oral medications, and insulin. Participants underwent ≤7 centrifuge spins over 1-2 days. Monitors collected vital sign data prior to and during centrifuge spins; subjects completed post-spin symptom questionnaires. **RESULTS:** Diabetic subjects demonstrated similar hypergravity tolerance compared to non-diabetic laypersons. Two diabetic participants did not complete all pre-determined centrifuge runs, in one case secondary to motion sickness and the other for scheduling constraints. Glycemic control methods (insulin vs non-insulin) were not associated with differences in tolerance. There were no statistical differences in vital signs or symptoms between diabetics and the general cohort. Diabetic participants were more likely to report nausea than laypersons (35% versus 16.7%) though not a statistically significant difference. One participant on a sulfonylurea had a transient suspected hypoglycemic event after a centrifuge spin in the setting of decreased oral intake prior to participation. **DISCUSSION:** Diabetes poses a risk of incapacitation in high performance environments due to the risk of hypo- or hyperglycemia. However, these data suggest that, with appropriate screening and stratification, diabetic individuals can successfully tolerate spaceflight hypergravity exposures. Further research into the effects of other aspects of spaceflight on diabetics may allow for inclusion of such individuals in future flight.

Learning Objectives

1. The participant will understand the hemodynamic impacts of simulated spaceflight hypergravity exposures in diabetic individuals.
2. The participant will understand the impact of methods of glycemic control on diabetic individuals in simulated spaceflight hypergravity exposure.

[225] WHAT YOU NEED TO KNOW ABOUT THE MUSCULOSKELETAL SYSTEM IN MICROGRAVITY

Vaishnavi Rathod[1], Darshankumar Raval[2], Shahin Khan[3], Shashwat Mallik[3], Musharrafah Ansari[3], Het Contractor[3], Milauni Dave[3], Devang Gohel[3], Kajal Patel[3], Leigh Speicher[4]
[1]*Parul Institute of Medical Sciences, Vadodara, India;* [2]*Mayo Clinic, Jacksonville, FL, United States;* [3]*Government Medical College, Baroda, Vadodara, India;* [4]*Mayo Clinic, Jacksonville, FL, United States*

(Education - Tutorial/Review)

INTRODUCTION: Microgravity in space has significant detrimental effects on the musculoskeletal system (MSK), including bones, muscles, and intervertebral discs (IVD). Studies on astronauts, bed-rest patients, and animals have consistently shown a decrease in trabecular and cortical bone density, muscle atrophy, and an increased risk of IVD herniation. **TOPIC:** The bone density loss is more evident in weight-bearing bones, especially those of the lower limb. This is attributed to imbalances between osteoblast and osteoclast activity, changes in integrin signaling mechanisms, and mitochondrial disruption. Moreover, microgravity leads to imbalances in calcium-phosphorus homeostasis, with increased urinary calcium and bone resorption markers, and decreased bone formation markers. These changes are also heavily influenced by the duration of microgravity. Muscle atrophy is another consequence of microgravity, affecting various muscle groups, especially the multifidus and ankle extensors. Changes in muscle volume are attributed to a reduction in the Daily External Loading Stimulus and altered metabolism of muscle fibers, along with a decrease in the capillaries supplying each fiber. Long-term exposure to microgravity also results in a reduction of muscle strength, with calcium levels in muscle fibers playing a critical role. IVDs experience changes in volume and hydration due to unloading in microgravity. Hence, astronauts are 4.3 times more likely than the general population to experience disc herniation. Fluid flow and nutrition to the discs are affected, similar to the degeneration seen in aging discs. Diurnal changes in fluid flow are disrupted in space. Previous high-performance jet pilot training seems to be protective. **APPLICATION:** Countermeasures, like exercise protocols, are essential to mitigate the adverse effects of microgravity. Aerobic and resistive exercises, especially personalized cycling exercises, have been found effective in preserving muscle mass, muscle strength, and bone density. However, it remains challenging to expel excess fluid from intervertebral discs in a microgravity environment. Newer exercise regimes are required because even though the current ones are effective, they are not adequate as our astronauts continue to suffer from MSK pathologies post-flight. Further research is needed to better understand the mechanisms underlying these effects and to develop targeted countermeasures to protect the MSK during spaceflight.

Learning Objectives

1. The audience will understand the impact of microgravity on bones, muscles, and intervertebral discs.
2. The audience will know about the current status of countermeasures, and whether they are effective in protecting the musculoskeletal system of astronauts.

[226] MECHANICAL ANALYSIS OF A 3-D PRINTED EXTERNAL FIXATOR DESIGN FOR LONG DURATION SPACE FLIGHT FRACTURE CARE VERSUS INDUSTRY STANDARD EXTERNAL FIXATORS

Nathan Skelley[1], Lisa MacFadden[2], Clint Boerhave[3]
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(Original Research)

INTRODUCTION: External fixation is a critical component of orthopaedic fracture management and can treat a diverse range of complex bone fractures. However, medical grade external fixators can cost between $4,000-$6,000. The availability, equipment size, and high cost of external fixation devices are a concern, especially in long duration space flight missions. In these settings, it would not be practical to transport an entire orthopaedic surgical suite and the associated equipment and implants for all possible fracture types. 3-D printing technology has shown promise as a method for reducing costs, customizing fracture treatment, and improving accessibility to external fixation devices. The purpose of this study was to evaluate the mechanical properties of a fully 3-D printed desktop external fixation device and compare the results

with the mechanical properties of commonly used, clinically available external fixators. **METHODS:** A fully 3-D printable external fixator was designed and printed in polylactic acid at two infill densities, 20% and 100%. The mechanical properties of the 3-D printed external fixators and several commercially available fixators were tested according to applicable sections of the American Society for Testing and Materials F1541 standard protocol in axial, medial-lateral, and anterior-posterior orientations. The primary outcomes measured included failure load, safe load, rigidity, and yield load. The mean differences between experimental and control groups were calculated using one-way ANOVA and Tukey tests. **RESULTS:** The 20% infill 3-D printed construct performed poorly compared to commercially available external fixators in all testing conditions and across most variables. The 100% infill 3-D printed construct was comparable or superior to all commercially available devices in most testing conditions. The cost for printing a single 3-D printed 100% infill external fixator was $14.49. The entire external fixator could be printed in less than two days. **DISCUSSION:** This study demonstrates that a low-cost desktop 3-D printer can create an entirely 3-D printed external fixator that resists clinically relevant forces similar to medical grade industry standard external fixators. This device can be printed on demand and customized to various fracture types. The findings of this study support the potential for customizable and low-cost external fixators to be manufactured with desktop 3-D printing for use in long duration space flights.

Learning Objectives

1. Can a novel low cost desktop 3-D printer create an external fixator for fracture management that meets the same mechanical criteria for fracture stabilization as a medical grade carbon fiber and stainless steel construct?
2. How can 3-D printing improve storage, print-on-demand, and reuse for medical equipment in long duration space flight?
3. What are common fractures that astronauts are at risk of sustaining that can be treated with an external fixator device?

[227] BONE DENSITY CHANGES IN MICROGRAVITY: A SYSTEMATIC REVIEW

Darshankumar Raval[1], Shashwat Mallik[2], Shahin Khan[2], Dana Herrigel[1], Leigh Speicher[1]
[1]*Mayo Clinic, Jacksonville, FL, United States;* [2]*Government Medical College, Baroda, Vadodara, India*

(Original Research)

INTRODUCTION: Research into bone alterations in microgravity has primarily focused on two key aspects: bone mineral density (BMD) and the markers of bone formation and resorption. The aim of this review, therefore, is to determine the effects of natural or simulated microgravity on BMD of different bones, and the biochemical bone markers, along with recommendations for exercise regimes or pharmacotherapies. **METHODS:** A literature search was carried out using the PubMed database, which yielded 626 results. The following inclusion criteria were applied: (1) either the BMD or the bone formation/resorption markers were reported, (2) the data collected was primary, that is, only original articles, case reports, and case series, (3) the population of the study was humans, (4) the study was conducted in microgravity, either natural or simulated. **RESULTS:** A total of 54 articles were included in the final systematic review. Twenty-eight of these were observational studies while 26 involved some sort of intervention - particular exercise regimens, strict diets, supplements, or pharmacological agents. Twenty-three studies were conducted during spaceflight, while simulated microgravity was used in 29. Two employed both spaceflight and bed rest to derive results. DEXA Scan (n=27) and quantitative-CT (n=12) were commonly used to determine the BMD. Twenty-five studies measured urinary calcium and bone formation/resorption markers to determine bone resorption. The lumbar spine and hip were the most common sites for BMD measurement, and both showed significant losses in microgravity. The radius was largely unaffected. Resistance training was the most commonly employed intervention, but the effectiveness of bisphosphonates (n=7) and supplements (n=3) was also studied. **DISCUSSION:** Prolonged exposure to microgravity, during spaceflight and bed rest, results in significant losses of BMD in weight-bearing bones, but not in non-weight-bearing areas of the upper limb. The changes in bone markers occur earlier than radiologically detectable BMD loss, but they also recover rapidly once the exposure to microgravity ends, and thus, cannot be surrogate markers during recovery. The current exercise protocols are only partially effective at preventing microgravity-induced osteoporosis, and hence, we recommend more rigorous training regimes combined with pharmacotherapies like bisphosphonates and omega-3 fatty acids.

Learning Objectives

1. The audience will understand the impact of microgravity on human bones.
2. The audience will learn about the number of observational and interventional studies conducted on human bones in microgravity.
3. The audience will understand the types of bones involved and the interventions aimed at preventing bone density loss.

Tuesday, 05/07/2024 ***4:00 PM***
Grand Ballroom B

[S-42]: PANEL: INTERNATIONAL AEROSPACE NEUROSCIENCES CONSORTIUM (IANC)- PATENT FORAMEN OVALE (PFO), FROM ONE END OF THE ROPE SCORE TO THE OTHER

Chair: Joseph Connolly
Co-Chairs: Roger Hesselbrock

PANEL OVERVIEW: *TITLE: International Aerospace Neurosciences Consortium (IANC)- Patent Foramen Ovale (PFO), From one end of the RoPE Score to the other Panel Chair: Joseph Connolly III, DO, MPH Panel Co-Chair: Roger Hesselbrock, MD Panel Type: Educational Review and Case Studies BODY: Patent Foramen Ovale (PFO) is a congenital heart finding seen in approximately 25% of the population and often benign. However, PFO has been implicated in embolic disease processes to include cerebrovascular accident (CVA), neurological decompression sickness, and migraine with aura. In aircrew these outcomes can lead to sudden incapacitation and long-term disability. Closure of the PFO has short and long-term implications that must guide aeromedical disposition. This panel will include a tutorial on patent foramen ovale (PFO). Following the tutorial, a variety of cases of aircrew (predominantly pilots) with neurological events who were found to have PFO will be presented. These case presentations will include diagnostic decision making regarding the event of concern and its etiology including whether or not the PFO was implicated. The actual and potential complications of PFO, PFO closure, and other management options will be presented. Finally aeromedical implications, waiver recommendations and certification decisions will be discussed. Cleared: AFRL-2023-5373*

[228] PATENT FORAMEN OVALE IN AIRCREW – IMAGING, DIAGNOSIS AND GRADING.

Eddie Davenport
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Tutorial/Review)

INTRODUCTION: Patent Foramen Ovale (PFO) is a congenital heart process seen in approximately 25% of the population and often benign. However, PFO has been implicated in embolic disease processes to include cerebrovascular accident (CVA) and peripheral vascular processes such as headache. In aircrew these outcomes can lead to sudden incapacitation. Closure of the PFO has short and long-term implications that must guide aeromedical disposition. **TOPIC:** The latest published recommendations for imaging and treatment options for PFO will be discussed in detail. Actual PFO images will be presented so the audience may view a PFO and learn the diagnostic criteria and grading. Recently published

data regarding long term risk of PFO closure will also be discussed to include development of atrial fibrillation and atrial flutter. Finally, current aviator specific diagnostic and management guidance will be discussed. **APPLICATION:** PFO is a common finding on echocardiogram and seen in approximately 25% of the population. Understanding the diagnosis, treatment options, risk vs benefit, and long-term implications of closure of PFO is necessary for proper aircrew disposition.

Learning Objectives

1. Describe the characteristics of a Patent Foramen Ovale. What is it and how does it look on echocardiogram.
2. Learn the pathological processes associated with a PFO and their aeromedical implications.
3. Understand the treatment options for PFO and their aeromedical implications.

[229] HOW MUCH ROPE? A CASE STUDY OF PILOT WITH A TIA AND PFO.

Christopher Skinner
University of Ottawa, Ottawa, ON, Canada

(Education - Case Study)

This case presentation reviews the clinical decision-making process associated with a 46-year-old transport pilot who experienced a left hemisphere TIA and was found to have a moderate-sized PFO. The TIA was characterized by a fall and left leg weakness following prolonged sitting while driving. The event lasted approximately 30 minutes. Neurological exam showed no residual focal deficits. There was no infarct on MRI imaging, the CTA showed a bihemispheric left dominant ACA. The stroke workup was negative except for a positive bubble study showing a moderate PFO at rest. Given the history of prolonged travel/relative immobility in the setting of a moderate PFO, the most likely mechanism of his stroke was thought to be a paradoxical embolism. This was supported by a ROPE score of 7 points which conferred a 72% likelihood of PFO being the causative mechanism. His ROPE score is also in keeping with a 6% chance of future vascular event in the next 2 years. The recommendation was made to close the PFO which was successfully completed and the pilot has been returned to flight status. The presentation will discuss the decision-making process associated with the management of this case. There will be a discussion on how the ROPE scale is used and how it does not consider the environmental stresses and risks associated with the aerospace environment. There will also be a discussion on what modifications might be recommended to current practices to provide guidance to Aviation Medical Examiners and Flight Surgeons.

Learning Objectives

1. Present a case study of a pilot with a TIA and a PFO.
2. Discuss the decision making process associated with the management of case.
3. Discuss the ROPE scale and how it may not consider the environmental stresses associated with the aerospace environment.

[230] ISCHEMIC STROKE AND PFO CLOSURE IN A HIGH-PERFORMANCE AVIATOR

Aven Ford
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Case Study)

INTRODUCTION: This case report describes a military single-seat high-performance pilot who suffered an ischemic stroke and was found during the evaluation to have a patent foramen ovale which was subsequently closed with a Gore Cardioform® device. **BACKGROUND:** Ischemic stroke (IS) is uncommon in young patients, with adults aged 18-50 years of age accounting for only 10-15% of all strokes. However, IS is associated with significant morbidity and mortality at any age. Evaluation and treatment is targeted at finding a reversible or treatable cause of IS in order to decrease the risk of future stroke. Cardiac sources, including patent foramen ovale (PFO), account for approximately 20% of all ischemic strokes in young patients. In aviators, outcomes of concern include recurrent stroke, seizure, and arrhythmia. In addition, there are G-related concerns in the high-performance aviator that include device migration or failure. **CASE PRESENTATION:** The subject is a single-seat, high-performance pilot in his mid-thirties with a total of 900 flying hours who presented to the ER with incoordination and numbness in his left hand and spurred speech in the morning after awaking. His symptoms resolved within 16 hours. MRI showed findings consistent with an embolic IS. Transthoracic echocardiogram showed a PFO with intracardiac shunting. The PFO was closed with a Gore Cardioform® device several weeks after the event. Follow-up brain MRI showed residual gliosis and hemosiderin deposition in the right postcentral gyrus. He has had no new or recurrent symptoms and no episodes concerning for seizure. Neurologic examination findings have consistently been noted as normal. An EEG was unremarkable. He is now 30 months post-stroke. **DISCUSSION:** PFO closure remains a topic of some controversy. PFOs are a common incidental finding in the general population and it cannot be proven as a cause of any single IS. With his PFO closed, at the time of his evaluation, his annualized risk of stroke is well under 0.5% (approximately 0.2% annually). However, his combined risk of stroke and seizure was estimated to be approximately 1-2% per year. His risk of device failure and device migration in high-performance flight could not be estimated, as these devices have not been studied in high-Gz in human subjects or animal models. He was recommended for a 1-year waiver restricted to non-high performance, multiplace airframes.

Learning Objectives

1. The participant will understand how to approach the aviator with ischemic stroke and PFO.
2. The participant will understand the appropriate restrictions of aviators after ischemic stroke and PFO closure.
3. The participant will understand the rationale for observation periods following ischemic stroke.

[231] EMBOLIC ISCHEMIC CORTICAL STROKE IN A 28-YEAR-OLD FLIGHT INSTRUCTOR WITH A SMALL PATENT FORAMEN OVALE

Anthony Rengel[1], Christian Gericke[2]
[1]*Royal Flying Doctor Service, Kalgoorlie, Australia;* [2]*University of Queensland Medical School, University of Newcastle School of Medicine and Public Health, and Calvary Mater Hospital, Newcastle, Australia*

(Education - Case Study)

INTRODUCTION: This case describes a young flight instructor who suffered an embolic ischemic stroke with punctate lesions in his right motor and superior parietal cortex. Investigations revealed a small patent foramen ovale (PFO). **BACKGROUND:** Stroke in young patients is frequently associated with a PFO. Controversy exists over whether the PFO is a cause, a risk factor, or an incidental finding in these cases. Estimating the individualised risk of stroke recurrence is difficult to ascertain. This has implications for medical certification for pilots following recovery. **CASE PRESENTATION:** A 28-year-old male recreational flight instructor held a Commercial Pilot Licence with approximately 2000 hours of flight experience. He presented to the hospital with sudden onset left-sided facial paraesthesia, left hand weakness and blurred vision, accompanied by gradual onset, moderate severity, bilateral headache. The cranial symptoms resolved within 30 minutes. The left hand weakness persisted for three days. MRI revealed two punctate ischemic foci in the right precentral gyrus and superior parietal lobe. Vasculitis and thrombophilia screen, CT angiography, lower limb Doppler, 7-day Holter monitoring, and stress echocardiogram were normal. Transesophageal echocardiogram revealed a PFO with small bidirectional shunt. The cardiologist and neurologist opined that the PFO was unlikely to have caused his stroke and estimated an annual recurrence rate of <1.8%. The pilot was placed on life-long aspirin and atorvastatin. He was offered PFO closure but declined. Under

Recreational Aviation Australia rules, he was able to return to flying light sport aircraft. However, an enduring co-pilot restriction for general aviation activities was placed on his Class 1 and 2 Aviation Medical by the Australian Civil Aviation Safety Authority. Following a review two years later, the restriction was upheld despite no stroke recurrence. **DISCUSSION:** This case highlights the difficulty in determining individualised risk for pilots recovering from a stroke associated with a small PFO. Whilst treatment with aspirin and a statin or PFO closure reduces the risk of stroke recurrence, these treatments carry a risk of side effects. Further evidence is required to better individualise risk for stroke patients with a small PFO to determine optimal treatment options and to stratify their suitability for medical aviation re-certification.

Learning Objectives

1. Understand the relevance of the finding of a patent foramen ovale following ischemic stroke in young patients.
2. Appreciate the current difficulties in stratifying and individualising stroke recurrence risk in patients with patent foramen ovale and the implications this has on aeromedical re-certification following recovery.
3. Develop an awareness of different aeromedical certification standards based on activity type and jurisdiction.

[232] PFO, ATRIAL FIBRILLATION AND STROKE IN A COMMERCIAL PILOT

Roger Hesselbrock, Richard Murphy, Farhad Sahiar
FAA, Oklahoma City, OK, United States

(Education - Case Study)

INTRODUCTION: This case report describes a pilot who experienced neurologic symptoms and was found to have subcortical infarctions. Patent foramen ovale (PFO) was identified during evaluation, was felt contributory, and was later percutaneously closed. Atrial fibrillation was noted following PFO closure and was felt a peri-procedural complication. **BACKGROUND:** Cryptogenic stroke and embolic stroke of undetermined source (ESUS) are frequently assessed diagnoses on initial stroke evaluation. Paradoxical embolization through a PFO is a commonly-implicated etiology. Undiagnosed atrial fibrillation is also a concern with cryptogenic stoke or ESUS. Guidance on medical management of PFO and indications for PFO closure have historically varied. **CASE PRESENTATION:** A 57 year old nonhypertensive, nondiabetic, nonsmoker pilot had a previous episode of transient arm numbness and weakness that had not been evaluated. Three months later he had more extensive symptoms, including cognitive dysfunction, and was treated with thrombolysis. Brain MRI showed two small areas of subcortical posteromedial thalamic infarction. Vascular imaging and hypercoagulability assessments were negative. Echocardiography showed PFO with atrial septal aneurysm and intracardiac shunting. Risk of Paradoxical Embolism (RoPE) score was 6, indicating 62% likelihood of PFO-attribution. PFO closure and implantable loop monitor (ILR) insertion were done two months after the stroke. Atrial fibrillation was noted on initial ILR reports, with latest occurrence 46 days following PFO closure, and was managed with anticoagulation. No further atrial fibrillation was noted on ILR reports. **DISCUSSION:** This case highlights challenges in managing PFO in the setting of stroke. Determination of stroke etiology and potential contribution from PFO can be difficult. Utility of the RoPE Score tool in PFO management will be discussed. Peri-procedural atrial fibrillation is a common complication following PFO closure and has different implications than otherwise discrete atrial fibrillation regarding future stroke risk. FAA medical certification requirements will be presented and discussed.

Learning Objectives

1. The audience will have increased understanding of the association and implication of atrial fibrillation detected after PFO closure.
2. The audience will have increased understanding on the utility of the RoPE score in PFO management.

[233] I GOT BENT; BLESS YOUR HEART: A CASE STUDY

Roy Hoffman
U.S. Navy, Dayton, OH, United States

(Education - Case Study)

INTRODUCTION: This is a case of type II decompression sickness (DCS) in a military diver with a patent foramen ovale (PFO) discovered during their post event evaluation. **BACKGROUND:** Type II DCS is a rare event with reported incidence among commercial divers ranging from 1.5 - 10 per 10,000 dives. PFO is present in approximately 30% of the normal population and produces a 2.5 times increase in the odds ratio for developing type II DCS. A vascular gas embolism can arterialize through a PFO with sufficient circumstances to include large amounts of gas emboli, PFO grading, straining maneuvers, and delayed desaturation. Routine screening for PFO in military dive physicals does not occur but are performed if DCS occurs with neurological symptoms. **CASE PRESENTATION:** The subject is a 50-year-old female military diver with 21 years of experience who after a hyperbaric chamber "dry dive" of 130 feet for 20 minutes awoke symptomatic in the middle of that night. She first noticed bilateral numbness of the extremities, then global weakness and ataxia. On exam she had hyperreflexia, clonus, personality changes, and cognitive deficits to include inability to perform serial sevens and draw a proper clock face. She had 7 treatments of hyperbaric oxygen using a Navy Table 6. On further evaluation a PFO was found and subsequently the patient elected to have it closed. MRI revealed thoracic abnormalities. **DISCUSSION:** This case highlights the know DCS risk factor of PFO and reveals that many hours and years of dive experience should be used to rule out the presence of a PFO in any case with type II DCS. It also reveals that a diver does not have to get wet to experience a significant case of DCS and that onset of symptoms can be slow to develop. While the incidence of type II DCS in the military does not support PFO screenings, the evaluation of a diver after a case of type II DCS should include a bubble study regardless of the diver's hours or prior experience. A diver can recover from an event and be granted a waiver after a type II DCS event even if sequelae remain.

Learning Objectives

1. The audience will understand that PFO is a risk factor for type II DCS.
2. The audience will understand that DCS can occur in a diver with an unknown PFO after many dives and years of diving experience.
3. The audience will understand that the symptoms of type II DCS can occur many hours later and progress over time.

Tuesday, 05/07/2024 ***4:00 PM***
Grand Hall J

[S-43]: SLIDES: ADVERSE ENVIRONMENTS AND HUMAN PERFORMANCE

Chair: Paul Young
Co-Chair: Justin Lafreniere

[234] ANALYSIS OF HELICOPTER AIR AMBULANCE AVIATION SAFETY REPORTING SYSTEM (ASRS) DATA

Hannah Baumgartner[1], Justin Durham[2], Rebecca Didomenica[2], Peter Hu[2]
[1]*FAA, Oklahoma City, OK, United States;* [2]*Cherokee Nation Support, Services, & Solutions, Oklahoma City, OK, United States*

(Original Research)

INTRODUCTION: Helicopter air ambulance (HAA) operations are associated with unique risks and human factors considerations due to the on-call nature of the work, low altitude operations, and routes to novel locations. Assessing events voluntarily reported to the Aviation Safety Reporting System (ASRS) database provides important information

about precursors to risk in these operations. **METHODS:** The National Aeronautics and Space Administration's (NASA) ASRS database was queried for reports that related to 14 C.F.R. Part 135 and HAA operations between 2013 and 2023. Reports were then filtered to include only those referencing rotorcraft. Narratives, synopses, and event data were evaluated for overall trends across reports. Trends were identified with a coding scheme that iteratively examined organizational factors, event and personnel data, errors, and unsafe conditions. **RESULTS:** A total of 97 ASRS reports were analyzed. Most reports were flightcrew related (*n* = 84; 87%), while others documented issues with maintenance (*n* = 17) or Air Traffic Control (ATC; *n* = 12). The most frequently reported issue was lack of situation awareness or the ability to perceive, understand, and respond to events (n = 57), followed by pilot/ATC communication challenges (*n* = 35), judgment/decision-making errors (*n* = 24), and errors adhering to procedure (*n* = 21). Organizational factors related to policy/procedural issues (*n* = 15), commercial performance pressures (*n* = 13), and safety culture issues (*n* = 6) were also identified. The most frequently reported consequence was on aircraft systems or components (*n* = 24), followed by near mid-air collisions (*n* = 14), loss of control (*n* = 3), or impacts to patient outcome (*n* = 7). **DISCUSSION:** Analyses of ASRS reports related to HAA operations identified a range of risk factors and safety critical areas to address in Part 135 and HAA operations. Findings suggest that training and interventions related to situation awareness, communication between pilots and ATC, and maintenance operations would be useful in mitigating future accidents or incidents. Other organizational factors identified included policy issues, procedural issues, and commercial pressures, which suggest room for growth in HAA operations to improve safety outcomes.

Learning Objectives

1. Understand current safety risks in helicopter air ambulance operations using voluntary safety reporting data.
2. The audience will learn about current human factors considerations in helicopter air ambulance operations.

[235] RISK CHARACTERIZATION OF POLARIS DAWN EVA DEPRESS PROFILE IN NASA'S 20FT CHAMBER

Marissa Rosenberg[1], Andrew Abercromby[2], Amran Asadi[1], Diana Dayal[1], Edgar Lichar Dillon[3], Patrick Estep[3], Alejandro Garbino[3], Monica Hew[3], Esther Putman[1], Brett Siders[3], Jaime Mateus[1]
[1]*Space Exploration Technologies, Hawthorne, CA, United States;* [2]*NASA, San Luis Obispbo, CA, United States;* [3]*NASA/KBR, Houston, TX, United States*

WITHDRAWN

[236] ACCURACY AND PRECISION OF PULSE OXIMETERS IN EXTREME HIGH-ALTITUDE HYPOXIA SIMULATION

Jon-Arild Kjeserud[1], Harald Vikne[1], Nils Henrik Holmedahl[1], Gjøvåg Terje[2], Jon Ingolf Medbø[3], Jan Ivar Kåsin[1], Willy Westgaard[1]
[1]*Norwegian Institute of Aviation Medicine, Oslo, Norway;* [2]*Oslo Metropolitan University, Oslo, Norway;* [3]*Western Norway University of Applied Sciences, Sogndal, Norway*

(Original Research)

INTRODUCTION: In military hypoxia recognition training, participants often experience severe hypoxia, with oxygen saturation levels nearing 50%, as measured by pulse oximeters. However, clinical standards for pulse oximeter validation require only measurements between 70% and 100% oxygen saturation. This study aims to assess the accuracy and precision of four pulse oximeters when measuring oxygen saturation below 70%. **METHODS:** Seventeen healthy adult volunteers (7 women and 10 men) were sitting at rest and exposed to varying oxygen concentrations (8 – 21%) in the inspired air to establish stable arterial oxygen saturation levels between 55% and 100%. We collected 3-5 simultaneous measurements from four pulse oximeters and of arterial blood samples using a reference hemoximeter for each oxygen concentration. Data analysis involved assessing bias and variability using the Bland-Altman Limit of Agreement method (LoA) and root mean square error (RMSE) within three saturation intervals: 55-70%, 70-85%, and 85-100%. **RESULTS:** At the 85-100% saturation range, all pulse oximeters demonstrated minimal bias (ranging from -0.3% to 2%) and moderate variability (LoA between +/- 2.8% and 3.8%). In the 70-85% range, biases ranged from -3% to 3.8%, and variability increased (LoA range +/- 3.9% – 5.7%). At 55-70% saturation, biases varied from -2.5% to 5.0%, with expanded LoAs (+/- 5.2% to 8.2%). The RMSE between pulse oximeters was 1.4% to 2.6% at 85-100%, 1.9% to 4.7% at 70-85%, and 3.4% to 6.5% at 55-70% saturation. **DISCUSSION:** All four pulse oximeters demonstrated reduced precision as arterial O_2-saturation decreased, evidenced by increased LoA and RMSE values. According to RMSE values, three out of four pulse oximeters performed satisfactorily, showing lower variability than ISO recommendations (3%-points) in the 70-85% and 85-100% saturation intervals. However, below 70% saturation, all pulse oximeters exceeded the 3%-point RMSE threshold. This study highlights a decrease in the precision of pulse oximetry below the 70% O_2-saturation levels used for medical validation. These findings can be of value for researchers studying severe hypoxia and healthcare professionals involved in hypoxia recognition training for aircrews.

Learning Objectives

1. Are pulse-oximeters as accurate below 70% as above 70% saturation?
2. How low can the O_2 saturation fall during hypoxia familiriazation training?

[237] USING CLOSED-LOOP MODELS TO UNDERSTAND MANUAL CONTROL ADAPTATIONS TO GRAVITATIONAL TRANSITIONS

Tara Nibhanupudy[1], Kassia Love[2], Marissa Rosenberg[3], Raquel Galvan-Garza[4], Torin Clark[5], Faisal Karmali[2]
[1]*Massachusetts Eye and Ear; Boston University School of Medicine, Boston, MA, United States;* [2]*Massachusetts Eye and Ear, Boston, MA, United States;* [3]*SpaceX, Hawthorne, CA, United States;* [4]*Lockheed Martin, Arlington, VA, United States;* [5]*University of Colorado Boulder, Boulder, CO, United States*

(Original Research)

INTRODUCTION: Humans control vehicles by continuously sensing orientation and motion, then making motor commands to the vehicle. Sensory feedback is altered in various situations, such as changes in G-level. While the brain has been shown to have a remarkable ability to adapt, in some situations, this is fundamentally limited. Furthermore, the mechanisms by which adaptation occurs are not completely understood. In this study, we used closed-loop models of human-vehicle systems to examine changes in strategy after a G-level transition. We hypothesize that transitioning to hypogravity leads to increased manual control variability secondary to vestibular signals of decreased amplitude, and post-transition adaptation is fundamentally limited by sensory signal-to-noise ratio (SNR). **METHODS:** Our model predictions use published data from a studied head-centered roll-tilt manual control task (Rosenberg et al, 2018). Healthy experimental subjects were recruited and screened via EMR and vestibular testing, with approval by local human studies committees at MEEI and MIT. Subjects (n=10, 27.9±6.0yr) aimed to maintain a perceived-upright position while experiencing passive, pseudorandom, head-centered roll-tilt perturbations in a centrifuge simulating a transition from 1G to a 0.5G. Model free parameters included bias and Kp (subject control effort). We characterized manual control performance using chair position variability. **RESULTS:** Subjects demonstrated a statistically significant increase in roll-tilt manual control variability when transitioning from the final 1G trial to the first 0.5G trial ($p < 0.001$). Variability slightly decreased over 6 successive 0.5G trials, with an associated increase in Kp. In the final 0.5G trial, subjects did not completely return to their baseline 1G performance variability

($p < 0.001$). **DISCUSSION:** Roll-tilt manual control becomes significantly more variable upon immediate transition from 1G to 0.5G. Some adaptation was observed, with modest improvement in manual control variability over repeated testing post-transition to hypogravity. Subject effort may contribute to this adaptation. Full adaptation to 1G performance quality may not be possible given diminished SNR in hypogravity, which has significant implications for Moon and Mars landings. Further study of manual control behavior during gravitational transitions will inform training protocols and/or countermeasures to facilitate adaptation and optimize performance.

Learning Objectives

1. Understand how roll-tilt manual control performance quality changes immediately after transition from 1 G to a novel 0.5 G environment.
2. Assess whether roll-tilt manual control performance quality has the potential to adapt over repeated trials in an altered gravity environment through changes in manual control strategy

[238] REVIEW OF AIRCRAFT CREW BREATHING SYSTEMS ALLOWABLE CHEMICALS

Christin Duran, Mitchell Rubenstein
Air Force Research Laboratory, Wright-Patterson AFB, OH, United States

WITHDRAWN

[239] HYPOXIA AND EXTENDED TIME ON TASK: EFFECTS ON DYNAMIC STEREOSCOPIC DEPTH TRACKING

Leonard Temme, Paul St Onge, Bobby Bowers, Kevin Andres, Aaron McAtee, Ryan Mackie
U.S. Army Aeromedical Research Laboratory, Fort Novosel, AL, United States

(Original Research)

INTRODUCTION: Army regulations permit aircrew of unpressurized aircraft to fly up to an altitude of 10,000 feet (ft) for an essentially unlimited duration without supplemental oxygen. The scientific literature documents the degradation of static stereo acuity (SSA) with hypoxia below 10,000 ft but is less clear about hypoxia effects on dynamic stereo acuity (DSA). Moreover, aircrew perform visually demanding, precise tasks for extended periods of time, which may be fatiguing and disruptive of binocularity when stereopsis is crucial, such as during formation flight, aerial refueling and so forth. This report describes a study of SSA and DSA in the presence of hypoxia and fatigue. **METHODS:** Reported here is a within-subject, repeated measures, two factor experiment with all subjects ($N = 24$) experiencing all conditions. One factor is the percent oxygen (O_2) of inspired air with two levels, normoxia (21% O_2) and a normobaric hypoxic approximation to a 10,000 ft altitude (14% O_2). The second factor is testing duration with four time periods, Epochs 1-4. Each Epoch included 10 minutes of a surrogate workload task, the Multi Attribute Task Battery (MATB) and 15 minutes of vision testing that included SSA and DSA measures for a total exposure duration of 108 minutes. The primary DSA results are reported as root mean square error (RMSE) arcseconds while the SSA results are stereoacuity in arcseconds. **RESULTS:** The distribution of DSA RMSE values was bimodal, with 8 subjects having RMSE values approximately 56% larger than the other 16 subjects. For both groups of subjects, hypoxia significantly increased ($p <= 0.006$) the RMSE of DSA by about 7%. The group of 8 subjects with larger RMSE values showed an improvement (RMSE decreased) over testing Epochs, however, when hypoxic, this improvement reversed during the Epoch 4, suggesting the possible impact of fatigue combined with hypoxia. Neither hypoxia nor test duration had a statistically significant effect on SSA. **DISCUSSION:** Importantly, SSA was not correlated with the DSA RMSE; performance on one task did not predict the other. For selection standards, one cannot be used as a surrogate of the other. Results are discussed in terms of physiological stressors.

Learning Objectives

1. To describe stereoscopic depth tracking as distinct from static stereopsis.
2. Describe the impact of hypoxia and the extended performance of a demanding task on these different types of depth perception.

Tuesday, 05/07/2024 ***4:00 PM***
Grand Hall K

[S-44]: PANEL: RESIDENT IN AEROSPACE MEDICINE (RAM) GRAND ROUNDS III

Chair: Jonathan Elliot
Co-Chairs: Paul Newbold, David Miller

PANEL OVERVIEW: *Resident in Aerospace Medicine (RAM) Grand Rounds consists of 6 clinical case presentations. Each case is presented by current RAMs who will review the clinical case, diagnosis, treatment pathway and current policies from different agencies. The aviator's aeromedical disposition and waiver or special issuance outcome (if applicable) will be discussed. These unique case presentations describe clinical aviation medicine as well as policy updates for common medical and/or mental health conditions encountered in the practice of Aerospace Medicine.*

[240] WAVES OF ILLNESS: PSEUDO DECOMPRESSION SICKNESS IN AN ACTIVE DUTY NAVAL AVIATOR.

Gordon Salgado
Naval Aerospace Medical Institute, Pensacola, FL, United States

(Education - Case Study)

INTRODUCTION: This case report describes the management of a Naval Aviator who experienced pressure fluctuations in the cockpit and later developed a constellation of symptoms concerning for decompression sickness. **BACKGROUND:** Loss of pressure at altitude poses risk of decompression sickness, a medical emergency rarely seen in aviation. The evaluation and management of decompression sickness is not widely known, or commonly practiced outside the dive medical community. **CASE PRESENTATION:** A previously healthy male Naval Aviator presented to evening sick call with concern for possible decompression sickness. He described symptomatic pressure fluctuations in the cockpit followed by the gradual development of generalized fatigue and malaise, headache, a mildly pruritic rash, myalgias and arthralgias with waxing and waning neuropathic symptoms in the right lower extremity. An Undersea Medical Officer was consulted. A quick calculation revealed the pressure changes posed no risk. The pilot was reassured, and provided with a variety of palliative measures. On serial follow up, all symptoms resolved confirming multiple etiologies occurring concurrently. **DISCUSSION:** This case highlights the import of familiarity with decompression sickness, reiterates the pathophysiology and management of this rare medical emergency, proposes the calculation of pressure differential exposure as a clinical decision making tool, and restates the value of a broad differential.

Learning Objectives

1. The audience will learn about the pathophysiology of decompression sickness.
2. The audience will learn about the presentation and clinical assessment of decompression sickness.

3. The audience will learn a valuable clinical decision making tool for the triage of potential decompression sickness cases.

[241] HIDING IN PLAIN SIGHT: ASYMPTOMATIC COATS' DISEASE IN AN AIRCREW CANDIDATE

Alexander Haley, David Tindle
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Case Study)

INTRODUCTION: This case report describes an aircrew candidate found on initial aircrew screening to have Coats' disease, despite lacking symptoms, and subsequently recommended for disqualification from all flying duties due to unacceptable aeromedical risk. **BACKGROUND:** Coats' disease is a sporadic, congenital, nonhereditary ocular disease characterized by retinal telangiectasis leading to exudative retinopathy and detachment. Coats' disease is very rare, with an incidence of 0.9 per 100,000 and prevalence estimated at fewer than 200,000 individuals in the United States. It exhibits a bimodal distribution with peaks in young males under 4 and males in their 50s. Younger age at presentation typically correlates with increased disease severity. **CASE PRESENTATION:** During routine initial ophthalmologic screening at the U.S. Air Force School of Aerospace Medicine's Medical Flight Standards, the candidate was found to be plano sphere both eyes with uncorrected distant and visual acuity of 20/20 both eyes. The candidate had no history of ocular symptoms, retinal detachment, or ocular surgery. However, his right eye was noted on ophthalmoscopy to have a moderate-sized area of distal arterial beading and retinal blot hemorrhages in the temporal periphery without exudates, retinal detachment, or vitreoretinal traction. The Aeromedical Consultation Service confirmed these findings, and the candidate was referred to a civilian retinal specialist who confirmed the diagnosis of Coat's disease. An aeromedical waiver was not recommended, and the candidate was disqualified from all flight duties. **DISCUSSION:** Coats' disease is aeromedically significant due to high risk of sudden incapacitating visual loss from retinal detachment. Other ocular concerns include widespread exudation even away from the area of telangiectasia with a predilection for the macula, ischemia of the retina in areas of telangiectasia, and intra- and subretinal hemorrhage. These events can lead to degraded stereopsis, decreased contrast sensitivity, visual field loss, and permanent vision loss. Critically, only 12% of patients maintain better than 20/50 vision long-term. While the disease is rare, it can be missed without rigorous screening, since affected aircrew candidates may be asymptomatic with normal visual acuity. This case highlights the importance of robust ophthalmologic aircrew screening and physician awareness of this disease entity and its aeromedical risks.

Learning Objectives

1. Gain awareness and understanding of the typical demographics, presentation, and symptoms of Coats' disease, the aeromedical risks associated with even mild or asymptomatic cases, and the importance of robust ophthalmologic screening for aircrew candidates.
2. Apply understanding of pathology and features of Coats' disease and its aeromedical risks to current aeromedical certification standards from civil and military aviation organizations to optimize aeromedical disposition of individuals with Coats' disease.

[242] DOUBLE URETERAL TROUBLE: A CASE REPORT ASSESSING THE AERONAUTICAL RISK OF CONGENITAL DUPLICATION OF THE RENAL COLLECTING SYSTEM

Patrick Edwards, Shana Hirchert
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Case Study)

INTRODUCTION: This case report describes a high-performance pilot-in-training with a duplicate renal collecting system and severe hydroureteronephrosis. **BACKGROUND**: Complete or partial duplication of the renal collecting duct, is the most common congenital anomaly of the urinary tract with a prevalence of 0.8 to 5.0%. This anomaly is thought to be duplication of the ureteric bud in utero with one ureter connected to the upper pole of the kidney and the other with the lower pole. Duplication can be partial or complete, but partial is more common. Most cases remain asymptomatic. Specialist evaluation is required if there is evidence of obstruction or infection. **CASE PRESENTATION**: A 31-yr-old male high-performance student pilot was seen for flank pain in the emergency department and discharged. A computed tomography identified a right duplicated renal collecting system with severe hydroureteronephrosis of the upper pole and calcifications. Urology performed a cystoscopy, showing that the upper collecting duct did not insert distally and that the calcifications likely would not pass. A computed tomography urogram and Lasix renal scan showed the duplication was complete, patent and insertion of the upper pole ureter was inferomedial to the lower pole insertion. The Aeromedical Consult Service reviewed the case, and a waiver for non-high-performance Flying Class (FC) IIC was granted. Later, elective removal of the right superior renal moiety and collection system resulted in an unrestricted FC II waiver, with intraoperative findings clarifying the upper pole insertion to be in the prostatic urethra. **DISCUSSION**: This patient had two prior episodes of flank pain evaluated and released from the emergency department but had never had flight surgeon follow-up. Testing concluded that the atrophic right upper pole moiety only contributed 8.2% of total renal function. The primary aeromedical concern is the intermittent and debilitating pain during critical phases of flight. The treating nephologist considered the partial nephrectomy adequate mitigation of this risk. After surgery and recovery, the case was reevaluated and the Aeromedical Consult Service granted an unrestricted FC II waiver, allowing return to high-performance training.

The views expressed are those of the authors and do not reflect the official guidance or position of the U.S. Government, the Department of Defense, the U.S. Air Force, the U.S. Space Force, the Canadian Government, or the CAF.

Learning Objectives

1. Understand the prevalence of duplex kidney in the general population and how this condition might present.
2. List the safety of flight concerns that exist because of a duplex kidney.
3. Understand the complications that can arise but may be asymptomatic in this condition.

[243] CRACKING SKULLS TO GET A WAIVER: CASE REPORT

Casey Naumoff, Dane Newell
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Case Study)

INTRODUCTION: This case describes an aviator with a skull fracture and the process to an unrestricted Flying Class (FC) II waiver. **BACKGROUND:** Traumatic brain injury (TBI) is prevalent with an annual incidence around 2.5 million in the United States. TBIs carry an elevated seizure risk at different stages following injury as well as functional and neurological deficits. Following a mild TBI, relative risk of seizures remains elevated for five years and ten years in moderate to severe TBIs compared to the normal population. **Case Presentation:** A 30-yr-old male pilot sustained a non-displaced basilar skull fracture after slipping and falling on bathroom floor. There was no LOC, or any immediate neurological symptoms. The following morning, spouse noticed bruising around eyes and insisted a visit to the Emergency Room. Non-contrast head CT showed a non-displaced basilar skull fracture, with no other concerning findings and continued to deny symptoms. Neurological evaluation two months later and follow up MRI brain was normal. Due to mild nature of injury without neurological symptoms, waiver was submitted at month 4 prior to the required 6-month waiting period. An FC IIC restricted waiver

for non-high performance, dual-piloted aircraft with another qualified pilot present during aircraft operations was approved 5 months post injury. Waiver renewal at 12 months was accomplished and an indefinite unrestricted FC II waiver was approved, and the pilot is now a T-6 instructor pilot where he continued to have no symptoms or neurological deficits. **DISCUSSION:** This case emphasizes the importance of why TBIs require mandatory grounding wait periods, depending on severity, and the elevated risk to the flight environment. Prompt identification and advocating for the aircrew member to obtain a waiver as soon as practical is an important aspect to consider with every case. This case highlights the importance for both aviators and flight surgeons understanding of TBI seizure risks.

Disclaimer: The views expressed are those of the authors and do not reflect the official guidance or position of the U.S. Government, the Department of Defense, or the U.S. Air Force.

Learning Objectives

1. Describe the aeromedical concerns following TBI, appropriate observation timelines for the military aviator, and timeline for return to baseline risk for seizure occurrence.
2. Describe the Federal Aviation Administration processes for special issuance (SI) in the civilian aviator.

[244] MONOARTICULAR RHEUMATOID ARTHRITIS IN A USMC AIRCREW MEMBER

Kristopher Randall
Naval Aerospace Medical Institute, Pensacola, FL, United States

(Education - Case Study)

INTRODUCTION: This case report describes a USMC aircrew member with a rare presentation of rheumatoid arthritis (RA). **BACKGROUND:** Rheumatoid arthritis is a systemic, inflammatory, autoimmune, polyarthritis characterized by persistent synovitis, systemic inflammation, and autoantibodies. RA can affect any joint but is usually found in the interphalangeal joints and occasionally in the wrist, knees, and spine. Monoarticular variant RA is an uncommon presentation and presentation in the elbow is exceedingly rare. If left untreated, RA will have progressive inflammatory cartilage breakdown, joint deformity, stiffness, and pain. **CASE PRESENTATION:** This case report describes a 21-year-old female USMC Aircrew member with a few months of atraumatic right elbow pain. Initial exam was unremarkable and x-ray imaging was negative. The patient was prescribed a typical conservative treatment course but returned with complaints of worsening pain and restricted range of motion. An MRI was obtained and showed near complete cartilage loss as well as associated joint effusion and synovitis. Inflammatory arthritis work- up showed positive rheumatoid factor (366 IU/ml) and positive anti- CCP antibody assay (144 u/ml). The patient was diagnosed with monoarticular variant RA, underwent orthopedic synovectomy surgery for symptom management, and started disease modifying anti-rheumatic (DMARD) therapy with methotrexate. **DISCUSSION:** This case highlights an exceedingly rare presentation of an autoimmune arthritis that can lead to lifelong disability if left untreated. There are numerous aeromedical risks with this condition and can occur as a result of the disease itself and/or as treatment side effects. Progressive joint deformity and range of motion loss can impair flight performance. Joint instability, especially atlantoaxial instability seen in spinal RA, poses hazards with high performance aircraft and G- force stresses. Side effects associated with the common DMARD methotrexate, including ataxia and pneumonitis, are not acceptable in the aviation environment. Aeromedical standards for return to flight status varies by agency. RA is a CACI condition for asymptomatic patients well controlled on medication(s) while the Navy may rarely grant a waiver on a case-by-case basis. Early recognition and treatment of RA is essential to prevent disease progression and increase the chance for an aviator to return to a flying status.

Learning Objectives

1. Understand the presentation, diagnosis, and treatment of rheumatoid arthritis including typical and atypical presentations.
2. Discuss the aeromedical implications of rheumatoid arthritis as well as aeromedical standards for flight status of civilian and military agencies.

[245] RARE GENETIC MUTATION IN PRESENTATION OF PORTAL VEIN THROMBOSIS

Edwin Manley
Naval Aerospace Medical Institute, Pensacola, FL, United States

(Education - Case Study)

INTRODUCTION: This case report describes the presentation of a Marine Corps Aviator who presented with an acute portal vein thrombosis. **BACKGROUND:** Venous thromboses are not necessarily uncommon findings in aviators, especially if certain conditions predispose, such as long periods of venous stasis. However, presentations of splanchnic vein thromboses are much more rare, and usually in settings of underlying liver pathology, mainly cirrhosis or acute liver failure. Far less common is the genetic mutation of JAK2, especially in a setting where there does not appear to be a concomitant myelodysplastic syndrome. **Case Presentation:** An experienced 40-year-old Marine Aviator presented to his Flight Surgeon with acute low-grade left upper quadrant pain. While initially thought to be upper GI related in etiology, a conservative course of observation and treatment for dyspepsia was prescribed. During this time, the patient presented to a local emergency department with a severe exacerbation of pain. A subsequent CT scan demonstrated a large portal vein thrombosis with associated splenomegaly. Initial differential diagnosis included the possibility of cirrhosis secondary to alcohol abuse. While this may be the most common cause of acute PVT, it did not fit with the patient's history. A subsequent hematology workup revealed a rare JAK2 mutation that would predispose to splanchnic vein thromboses. At this time, the patient has been placed on chronic anticoagulation and will require further work up for myelodysplastic syndrome. **DISCUSSION:** At the most basic level, this case highlights the presence of venous thrombosis in aviators requiring chronic anticoagulation. Although the treatment aims at preventing a catastrophic propagation and migration of the clot to the pulmonary system, the underlying etiology of this aviator's presentation may pose further implications into their health and flying status given the concern for development of a chronic hematologic syndrome.

Colaizzo, D *et al* (2006). The JAK2 V617F mutation frequently occurs in patients with portal and mesenteric venous thrombosis. *J Thromb Haemost*. 2007 Jan;5(1):55-61.

Kiladjian, J *et al* (2008). The impact of JAK2 and MPL mutations on diagnosis and prognosis of splanchnic vein thrombosis: a report of 241 cases. *Blood* Vol 111, Issue 10

Learning Objectives

1. The participant will be able to understand uncommon genetic mutations that involve presentations of venous thrombosis.
2. The audience will be able to understand the common, and not so common, etiologies specific to portal and splanchnic vein thrombosis.
3. The participant will be able to understand myelodysplastic syndromes.

Tuesday, 05/07/2024 ***4:00 PM***
Grand Hall GH

[S-45]: PANEL: APPLICATIONS OF ARTIFICIAL INTELLIGENCE (AI) TO COMBAT AVIATION MISHAPS

Chair: Merrill Rice

PANEL OVERVIEW: *BODY: The applications for AI regarding Aerospace Medicine are broad and have the potential to dramatically improve safety*

by recognizing hazards and preconditions that may predispose aviators to mishaps. Some of the ways AI may assist aviators in the cockpit include predictive analysis, machine learning for pilot training, data analysis, sensor fusion, real-time monitoring, alert systems, and accident investigation. The panel will provide an overview of the existing research that has utilized AI in extreme environments. The authors will further propose a framework by which investigators may follow to identify cognitive performance decrements from common aeromedical hazards such as hypoxia, spatial disorientation, and fatigue and transition the technology to the operational environment. The second presentation of this panel will describe generally employed computer programs such as principal component analysis (PCA) to "clean" data and reduce variance, effectively transforming data so that it may be utilized effectively by AI. The third presentation will be a description of how commonly employed AI algorithms such as decision tree, Naïve-Bayes, and Neuronet can be utilized in conjunction with PCA to increase sensitivity and specificity in identifying notable aviation hazards of concern. Finally, the panel will describe AI techniques to analyze recent aviation mishaps to more reliably identify human factors that are associated for preventing future aviation mishaps.

[246] A METHODOLOGY FOR USING ARTIFICIAL INTELLIGENCE (AI) TO IDENTIFY COGNITIVE PERFORMANCE DECREMENTS IN AVIATION OPERATIONAL ENVIRONMENTS

G. Merrill Rice[1], Dallas Snider[2], Steve Linnville[3]
[1]*Naval Safety Command, Norfolk, VA, United States;* [2]*University of West Florida, Pensacola, FL, United States;* [3]*Naval Aerospace Medicine Research Laboratory-Dayton, Dayton, OH, United States*

(Education - Program/Process Review)

BACKGROUND: The applications for AI regarding aerospace medicine are broad and have the potential to dramatically improve safety by recognizing hazards and preconditions that may predispose aviators to mishaps. How may aeromedical researchers leverage this emerging technology to combat the most common human pre-conditions that contribute to aviation mishaps? **OVERVIEW**: Upon review of the cited human pre-conditions involved in naval aviation mishaps between 2012 to 2022, some of the most common contributing pre-conditions involved were fatigue, spatial disorientation, visual illusions, hypoxia and hyperventilation. Recently, both fatigue and spatial disorientation have been evaluated in simulated aviation environments with semi-dry and dry EEG systems. Lee et al. (2023), utilized a semi-dry 30 channel head-set, during simulated flight and were able to identify abnormal mental states, such as fatigue, high workload and distraction, finding 9 EEG indices that were significantly different with varied flight tasks. Likewise, Geva, et al. (2023), utilized a 32 channel dry-eeg, during Barani chair induced spatial disorientation and noted a 52% reduction in theta power complemented by nystagmus in 72% of the trials. What was lacking in both studies, as demonstrated by relatively low accuracy was a method of cleaning their EEG data and reducing the variance within specific bandwidths. Realizing the need for real-time sensors on cognitive performance in military aviation, Rice (2019) evaluated dry-electroencephalogram (EEG) technology ability to detect hypoxia. Their research suggested that a reduction in overall dry-EEG power could identify hypoxia in lieu of aviators not recognizing their own meaningful decreases in oxygen saturation and cognitive performance. Linnville (2021) and Snider (2022) respectively advanced this work further by reducing the variance of the data sets through principal component analysis (PCA) and then applying three common AI algorithms. By doing so, these researchers increased the sensitivity and specificity of dry-eeg technology to detect hypoxia to greater than 97%. **DISCUSSION**: This presentation will provide a framework for future researchers to investigate and mitigate the most commonly associated preconditions for aviation mishaps with AI. The ultimate goal being to provide the aviator a useful real-time, helmet embedded sensor to prevent mishaps in our next generation aircraft.

Learning Objectives

1. The participant will be able to identify the common pre-conditions associated with aviation mishaps that may potentially be identifiable through the acquisition of data obtained through multi-dimensional biosensors such as electroencephalogram (EEG) and electrocardiogram (EEG) and subsequently analyzed utilizing artificial intelligence algorithms.
2. The participant will understand broadly common computer programs and artificial intelligence algorithms to clean and produce models that accurately predict and identify common human preconditions that are associated with aircraft mishaps.

[247] PRINCIPAL COMPONENT ANALYSIS (PCA) A METHODOLOGY FOR "CLEANING" MULTIDIMENSIONAL TIME SERIES BIODATA FOR ARTIFICIAL INTELLIGENCE (AI) MODELING

Steven Linnville
Naval Medical Research Unit-Dayton (satellite office), Pensacola, FL, United States

(Education - Program/Process Review)

BACKGROUND: In 2010, the Naval Safety Command identified between 1990 and 2008 fatigue was the leading cause of mishaps and hazard reports (n=150), and spatial disorientation as the second leading cause of mishaps (n = 78). Years later, the Command, repeated the analysis and fatigue (n=159) and spatial disorientation (n=90) continued to be the top 2 leading mishap causes between 2011 and 2018. This 40-year history points to a need to monitor a pilot's performance closely while in flight. Current crash avoidance systems in the cockpit monitor a plane's performance but not a pilot's. A variety of time series biodata (e.g., electroencephalogram [EEG], electrocardiogram, galvanic skin response, blood oxygen saturation, & eye movements) can be recorded indexing multidimensional sensory input and "interpreted" mathematically in machine learning as a biofeedback alert system to the pilot. This presentation discusses a method to simplify such input for AI use. **OVERVIEW:** Time series data can be multidimensional and difficult to analyze and interpret. To simplify the data, a dimension reduction procedure can be performed. One way is the application of PCA. This presentation will describe in "layman" terms theory and methodology behind the use of PCA and will be part of a panel that will provide an overview of the use of AI in extreme environments. This discussion will propose a framework by which investigators may follow to clean and interpret physiological measures that could impact cognitive performance in common aeromedical hazards (hypoxia, spatial disorientation, and fatigue) to transition this technology to the operational environment. The discussion of PCA will be based on dry-EEG data to reliably detect hypoxia in the lab with the goal such application could be used with any multidimensional biodata for AI input and use. **DISCUSSION:** Presently, there is an absence of strategies other than pharmacological methods (caffeine or amphetamines) to maintain pilot performance in extreme environments. This presentation is a step into aviation preventive measures with the eventual goal of pilots wearing sensors with live data streaming into real time AI use.

Learning Objectives

1. The audience will learn a user-friendly understanding of how to identify the most important features in the their data for further analysis into machine learning.
2. The audience will learn that the data excluded simplifies the data while not losing the most important features for further analysis into machine learning.

[248] A THEORETICAL ASSESSMENT OF THE USE OF GENERATIVE ARTIFICIAL INTELLIGENCE TO AUTOMATICALLY CATEGORIZE MISHAP REPORT DATA

Jefferson Grubb
Naval Safety Command, Norflok, VA, United States

(Education - Program/Process Review)

BACKGROUND: Mishap investigators compile their findings into reports so that others can avoid factors that led to previous mishaps. The narrative portions of these reports provide detailed information about what happened in individual mishaps. However, for safety professionals to track trends and assess hazards across multiple mishaps, these narrative data must first be summarized according to categorical coding systems. Within the U.S. Department of Defense (DoD), investigators from different Services receive different training, operate under different reporting instructions, and report using different business rules. These differences reduce the reliability with which investigators assign standardized codes, such as those of the Department of Defense Human Factors Analysis and Classification System (DoD HFACS). Moreover, periodic changes to DoD coding systems further degrade the longitudinal comparability of such coded data. These factors interfere with the DoD's ability to use mishap data to prevent future mishaps. **OVERVIEW**: Natural language processing facilitated by Large Language Models (LLMs), a type of generative artificial intelligence, may provide a logistically feasible, standardized way to categorically analyze mishap narratives. Such models are trained on large corpora of written materials and are subsequently more able to semantically assess target texts than are other approaches to natural language processing. In this presentation, the author examines both the technical and non-technical feasibility of two potential uses of LLMs to analyze human factors contributions to mishaps. First, can LLMs automatically code mishap narratives according to DoD HFACS? Second, can LLMs answer requests for human factors information independent of DoD HFACS coding? **DISCUSSION**: Although both use cases may be technically feasible, each use case faces a host of programmatic and cultural hurdles. The author argues that in the long-run, the second use case has more utility. However, it will be easier to overcome the non-technical hurdles in the first use case. The DoD should therefore explore a phased approach in which LLMs are initially used to apply DoD HFACS codes to mishap narratives. If successful, safety professionals can use the resulting models and infrastructure to explore using LLMs to categorize mishap narratives according to terms that are specific to individual information requests.

Learning Objectives

1. Recognize the limitations of categorically coded data in Department of Defense mishap reports.
2. Understand how large language models can be used to mitigate some limitations of categorically coded data in Department of Defense mishap reports.

[249] AI 101 FOR THE AEROSPACE MEDICINE SPECIALIST

Dallas Snider
University of West Florida, Pensacola, FL, United States

(Education - Program/Process Review)

BACKGROUND: Since 2014, researchers at Naval Air Station Pensacola have evaluated the feasibility of using commercial-off-the-shelf wearable sensors for monitoring the health of aviators in-flight. With each successive study, the complexity of the sensors used, and the physiological measurements have increased. Studies have examined heart rate, g-forces, the effect of hypoxia on brain waves, and cognitive performance utilizing wearable sensor data. With advances in wearable sensors and their data collection and processing software, the researchers are investigating the ability to detect fatigue and spatial disorientation (SD), which have been the top two leading causes of aviation mishaps since 1990. The aviation industry is behind in developing pilot performance monitoring compared to the automobile industry's driver performance monitoring. The latter has developed algorithms to detect driver fatigue and lane departures using on-board sensor suites with communication channels open to the public and access to cloud-based artificial intelligence (AI). However, systems to prevent human-induced aviation mishaps in tactical aircraft will require self-reliant technology that with smaller volume and weight. **OVERVIEW:** Machine learning (ML) is the foundation of AI. There are various ML algorithms, each with their own pros and cons. Some algorithms work well for controlled clinical trials, but not well in a real-time environment. To build a system that can detect physiological hazards such as fatigue, cognitive impairment, and SD, multiple sensors and the proper ML algorithms will be required. The disparate sensor data needs to be cleaned, fused, and input into the ML algorithms to train individualized, multidimensional models optimized for each pilot. In flight, the collected data needs to be processed and classified in real-time to determine if the pilot is in danger. **DISCUSSION:** While the capabilities of AI and deep learning are receiving attention in news, advertising, and social media; cloud-based AI solutions are not feasible in a tactical fighter jet. Any AI solution must be self-contained within the sensor system. In this presentation, we will present a primer on ML and AI, separate fact from fiction about what is currently feasible in ML and AI, and what could be possible in a few years.

Learning Objectives

1. The participant will be able to explain which machine learning algorithms are best suited for real-time, artificial intelligence applications.
2. The participant will be able to explain the knowledge discovery in data process.

Tuesday, 05/07/2024 ***4:00 PM***
Grand Hall I

[S-46]: SLIDES: ASTRONAUT GAS ISSUES

Chair: Kathleen Samoil
Co-Chairs: Tom Hoffman

[250] RISK OF AIR GAS EMBOLISM WITH LOW PRESSURE DIFFERENTIALS IN SPACEFLIGHT

Craig J. Kutz, Amy J. Kreykes, Rebecca Blue
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(Original Research)

INTRODUCTION: As the focus of space exploration evolves to include longer duration missions, more extensive extravehicular activity (EVA) capabilities and variable intravehicular environments will be required. An abrupt ambient pressure change with a closed glottis poses well-documented risk in diving literature for pulmonary overinflation syndrome and air gas embolism (AGE), conditions that can propagate to permanent disability or death. Variable pressure changes are not insignificant, and injury can occur even at low-pressure differentials and rapid closed-system volume variations. The exact minimum pressure threshold posing risk, however, is not clearly defined. The goal of this study was to review current literature and collate minimum pressure changes placing astronauts at risk for barotrauma during space operations. **METHODS**: A literature review of published research and case reports was conducted to gather data related to low ambient pressure changes resulting in pulmonary barotrauma or AGE. 124 publications were reviewed for relevance. Pressure differentials in operational space environments were extrapolated to characterize risk for conditions leading to theoretical alveolar rupture. **RESULTS**: Twenty cases of human barotrauma due to ambient pressure changes below 5.0 psid were identified, with 7 cases below 2.0 psid, or the equivalent of diving below 4 feet of saltwater (fsw). An AGE diagnosis comprised 85% of the

cases, including 3 fatalities. Six animal studies and one cadaver study were also identified as contributing to mathematical modeling of alveolar tissue limits in transpulmonary pressure. **DISCUSSION:** Severe decompression barotrauma, such as AGE, poses a substantial risk to crew and mission safety, as intravascular bubbles can lead to significant disability, or death. The delta pressures identified in the literature reviewed are highly relevant to space operations, in both EVA and intravehicular environments. Given the high consequences and difficulty in treating disabling decompression injuries during a mission, mitigation via robust vehicle and suit design remains the best strategy for risk reduction. The results identified theoretical, experimental, and observational parameters for delta pressure variables of concern that may be referenced to identify the risk of barotrauma for crew safety and mission success.

Learning Objectives

1. The audience will understand the significance of lower pressure changes in space operations as they relate to the risk of air gas embolism and pulmonary overinflation barotrauma.
2. Audience members will learn about published literature and case reports on theoretical, experimental, and observational parameters for delta pressure variables reported in barotrauma.
3. The audience will understand the implications and risk of barotrauma in space operations for crew safety and mission success.

[251] CARDIOVASCULAR DOSE-RESPONSES TO LOWER BODY NEGATIVE PRESSURE AND IMPLICATIONS FOR COUNTERMEASURE DESIGN

Ana Diaz-Artiles[1], Richard S. Whittle[2]
[1]*Texas A&M University, College Station, TX, United States;* [2]*University of California, Davis, Davis, CA, United States*

(Original Research)

INTRODUCTION: Lower body negative pressure has been posited as a long-duration countermeasure to reverse the fluid shift caused by the removal of hydrostatic pressure gradients in microgravity. Both the risk of spaceflight associated neuro-ocular syndrome (SANS) and the concern of venous thromboembolism (VTE) are believed to be related to this fluid shift. The aim of this study was to generate dose-response curves for the cardiovascular system when subjected to graded LBNP, then use the curves to quantify LBNP's potential as a countermeasure to reverse the effects of a cephalad fluid shift. **METHODS:** Twenty-four subjects (12M, 12F, age 28.5±4.7 years, height 169.6±12.0 cm, weight 74.5±21.0 kg) were exposed to LBNP from 0 mmHg to –50 mmHg (in 10 mmHg increments) in supine and 15° head-down tilt (HDT) postures. Dose-response curves of systemic cardiovascular variables, autonomic indices, and cephalad parameters including intraocular pressure (IOP), ocular perfusion pressure (OPP) and IJV flow pattern were constructed using Bayesian multivariate hierarchical modeling. **RESULTS:** All measured parameters exhibited a linear response to LBNP across the range measured. The largest positive effect sizes were found in the increase in total peripheral resistance and myocardial oxygen supply:demand index with increasing negative pressure. The largest negative effect sizes were found in the decrease in cardiac and stroke index with increasing negative pressure. In contrast, parameters related to the head and neck (IJV cross sectional area and pressure, IOP) were the variables most influenced by the cephalad fluid shift caused by 15° HDT. Dose-response curves for supine and HDT were combined to estimate the LBNP required to reverse a fluid shift induced by 15° HDT. **DISCUSSION:** Systemic cardiovascular parameters and autonomic indices require a range between –3.7 mmHg to –14.3 mmHg to reverse the effect of a fluid shift induced by 15° HDT. Parameters related to the head and neck require a higher LBNP between –14.7 mmHg (IJV flow pattern) to –45.5 mmHg (IJV cross-sectional area) to reverse the same fluid shift. LBNP appears to reduce IOP but not OPP. LBNP may help to reverse microgravity-induced IJV flow stagnation but its application in the context of SANS require further investigation.

Learning Objectives

1. The audience will understand the quantitative effects of LBNP on all aspects of the cardiovascular system.
2. The audience will understand the potential implications of these dose-response curves with respect to LBNP as a spaceflight countermeasure.

[252] SURVEILLANCE FOR JUGULAR VENOUS THROMBOSIS IN LONG-DURATION SPACE FLIGHT: FINDINGS FROM TWENTY-EIGHT U.S. ASTRONAUTS

Ashot Sargsyan[1], James Pavela[2], Aaron Everson[1], Deepak Bedi[3]
[1]*KBR, Houston, TX, United States;* [2]*NASA JSC, Houston, TX, United States;* [3]*University of Texas MD Anderson Cancer Center, Houston, TX, United States*

(Original Research)

BACKGROUND: Given the high incidence of internal jugular vein (IJV) flow anomalies aboard the International Space Station and a case of thrombosis, the National Aeronautics and Space Administration (NASA) instituted an occupational surveillance program to evaluate astronauts for venous thromboembolism (VTE). Current findings of the program are presented. **METHODS: NASA astronauts undergo** pre- and in-flight VTE surveillance examinations using a standardized vascular ultrasound protocol, which includes evaluation for bilateral IJV compressibility, filling, flow, and spontaneous echo contrast (SEC). **RESULTS:** Twenty-eight NASA astronauts had terrestrial baseline examinations and at least one in-flight imaging session. The reduction of in-flight peak IJV flow-speeds was significant and more pronounced on the left. Comparing the first in-flight measurement to the terrestrial baseline, peak flow speeds were reduced from 90.1±41.9 cm/s (average ±SD) to 62.1±31.6 cm/s on the right and from 76.9±41.8 cm/s to 26.8±18.2 cm/s on the left. Seven astronauts showed stagnant or retrograde flow in the left IJV. Fourteen developed appreciable SEC in the left IJV (7 greater than mild); none developed significant right-sided SEC. All IJVs were fully compressible and free from thrombi. **DISCUSSION:** Bilateral IJV flow speed reduction is observed in microgravity, possibly due to the multitude of available flow redistribution paths for cranial drainage. In a subset of astronauts, significant flow anomalies develop that may facilitate thrombus formation through changes in blood viscosity and speed, especially if combined with other thrombogenic factors. These findings warrant attention to the interplay between individual vascular configurations and the dynamic properties of blood as a non-Newtonian fluid in the reduced-shear flow environment of microgravity.

Learning Objectives

1. The audience will learn about the published evidence supporting surveillance for venous thromboembolism (VTE) in International Space Station (ISS) astronauts.
2. The participants will learn about the methodology, schedule, and current findings of the VTE surveillance in ISS U.S. crewmembers.
3. The participants will learn about the essence and role of the non-Newtonian properties of blood in venous hemodynamics.

[253] QUANTIFYING THE RISK OF VENOUS AIR EMBOLISM FROM IV FLUIDS IN MICROGRAVITY AND ASSESSING THE STABILITY OF AIRLESS IV BAGS FOR EXPLORATION MISSIONS

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(Original Research)

INTRODUCTION: Commercial off-the-shelf (COTS) intravenous fluids (IVFs) bags contain residual air, introducing the risk of venous air embolism (VAE). VAE occurs when air displaces blood flow in vasculature.

The danger from residual air is often negligible in terrestrial settings, where gravitational forces generate buoyancy, pushing residual air to the top of the IVF bag. However, in microgravity there is no buoyancy to separate liquid and gas layers. We performed an experiment to quantity the amount of air in COTS IVFs (Experiment #1) and assess air removal as a risk mitigation strategy (Experiment #2). **METHODS:** Experiment #1: Residual air was quantified across varying volumes (100, 250, 500, and 1000 mL), bag design, and manufacture (B Braun, Baxter, ICU Medical, and Grifols) of 0.9% NaCl COTS IVFs. Experiment #2: 1000 mL 0.9% NaCl bags, from three manufactures, were filled with either A) 100% saline or B) 95% saline and 5% air by volume. Bags were stored for 84 days at 25°C or 40°C. The bags were optically imaged to determine if air bubbles evolved within the solutions. **RESULTS:** Experiment #1: There was a trend towards greater residual air in larger bag sizes ($R^2 = 0.465$). The smallest air:volume ratio occurred in the Baxter 500 mL VIAFLO® Container (18.9 ± 3.8 mL air; 2.3% air by volume), while the largest ratio occurred in the B Braun 250 mL EXCEL® Container (55.0 ± 9.3 mL; 22.0% air by volume). Experiment #2: By day 84, 97% (33/34) of experimental bags had an increase in air compared to baseline. Bags placed in 40°C had a larger increase in air (14.19 ± 4.75 mL) compared to 25°C (3.09 ± 3.56 mL; $p < 0.001$). **DISCUSSION:** Residual air has a wide variety of volumes in COTS IVFs. The average amount of residual air is high enough to contribute to clinically significant VAEs If airless IV bags are produced for exploration missions, a progressive increase in the amount of residual air should be expected. Simple strategies can be taken to limit the risk of VAE during spaceflight.

Learning Objectives

1. Understand the impact of COTS IVF bag size and manufacturer on the air:volume ratio of residual air.
2. Understand the impacts of temperature and COTS IVF bag manufacturer on re-accumulation of residual air after production of airless bags.
3. Understand the implications of residual air and airless bag production on exploration space missions.

[254] UNDERSTANDING THE RELATION BETWEEN INTRACRANIAL PRESSURE AND SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME (SANS)

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(Original Research)

INTRODUCTION: Since 2011, neuro-ocular findings, such as globe flattening, optic disc edema or choroidal and retinal folds, have been one of the major concerns when talking about astronauts' health. These findings are, nowadays, called Spaceflight Associated Neuro-Ocular Syndrome (SANS). This systematic review aims to discuss the possible mechanisms involved on SANS' pathogenesis, such as intracranial pressure (ICP) variation, cerebrospinal fluid (CSF) compartmentalization and environment influence. We hypothesize that there is a relation between the variation of ICP and SANS development. Therefore, the question we want to answer is "Is the variation of ICP in astronauts who undergo long-duration spaceflights related to the development of SANS?". **METHODS:** This systematic review was structured according to PRISMA 2020 checklist and based on the PICO method. The search was conducted in five databases, Pubmed, Web of Science, Scopus, Google Scholar and Wiley Online Library. The 852 results were then imported to RAYYAN for duplicate removal. Based on the eligibility criteria previously defined, two reviewers, independently and with blinding, screened the remaining 738 results, and together, after a final discussion, chose 240 results to be fully analyzed. The ones that didn't make a relation between the findings and SANS and/or ICP were excluded. To assess the risk of bias, each included study was evaluated, with specific tools, according to the type of study. **RESULTS:** Twenty studies were reviewed. Nine establish a relation between the variation of ICP (increase, reduction or both) and SANS. Seven explain the existence of CSF compartmentalization after LDSF/analogs, where four defend that the glymphatic system is the responsible for this mechanism. Additionally, five correlate hypercapnia and/or exercise with SANS, while one suggests a direct association with intracranial venous congestion. Finally, one explores astronauts' genetics. **DISCUSSION:** We believe that the studied theories are not mutually exclusive and that SANS has a multifactorial etiology, where ICP variation and its relation with CSF shifts, CSF compartmentalization and environmental factors have an important influence on the development of neuro-ocular changes. Despite some limitations, this work gives an interesting view on the development of this syndrome and it is a step forward to better understand it.

Learning Objectives

1. This systematic review contributes to the understanding of SANS multifactorial pathophysiology.
2. It is essential to find new diagnostic tools to use in astronauts and better understand SANS pathophysiology.

[255] MODELING THE INFLUENCE OF ALTERED-GRAVITY AND ORTHOSTATIC STRESS ON THE CARDIOVASCULAR SYSTEM

Richard S. Whittle[1], Ana Diaz-Artiles[2]

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(Original Research)

INTRODUCTION: Computational modeling techniques allow us to expand beyond the limits imposed by human experimentation. Lumped-parameter models of the cardiovascular system can be used to simulate the effects of altered-gravity environments and therefore, to make predictions on the risk of orthostatic intolerance, the efficacy of countermeasures, and the variation in responses elicited by different individuals. **METHODS:** In this study, we extended an existing 21-compartment lumped parameter model to incorporate a more detailed simulation of blood circulation in the head and neck. Further, we adapted the model to account for hydrostatic gradients caused by body tissue weight. We used this model to simulate four different altered-gravity conditions on 50th percentile male and female subjects: tilt (head-up and head-down), lower body negative pressure (LBNP), short-radius centrifugation, and entry to microgravity. **RESULTS:** Simulated scenarios were compared to dose-response curves constructed from previously collected experimental data for tilt and LBNP, as well as to historic data for centrifugation and microgravity. Lumped-parameter models can capture the effects of orthostatic stress well across most scenarios but may require further considerations in extreme hypergravity or severe head-down tilt. Further, the introduction of body tissue weight into a lumped-parameter model allows for correct prediction of the changes that occur on entry to microgravity, notably a decrease in central venous pressure compared to the terrestrial 1g supine position. **DISCUSSION:** Modeling expands our understanding of the cardiovascular effects of altered gravity by predicting the pressures, volumes, and flows throughout the body (i.e., in different body compartments) rather than just overall systemic measurements. Model parameters can also be individualized based on a few determined preflight measurements to predict individual responses to altered-gravity or spaceflight countermeasures. Our results contribute to the understanding of cardiovascular responses to unavailable gravity environments (e.g., the Martian environment) and more broadly to the development of countermeasures.

Learning Objectives

1. The audience will understand the use of lumped-parameter modeling to simulate physiological systems in aerospace environments.
2. The audience will learn about the importance of tissue weight in the cardiovascular response to altered-gravity.

Tuesday, 05/07/2024 ***4:00 PM***
Grand Suites 2 & 3

[S-47]: POSTERS: HYPERBARICS AND AEROSPACE MEDICINE

Chair: Allen Parmet
Co-Chair: Aubrey Florom-Smith

[256] VALIDATION OF AN AUTOMATED AI-DRIVEN SMARTPHONE-BASED PUPILLOMETRY DEVICE IN A HYPERBARIC ENVIRONMENT

Doug Campbell[1], Dr. Shawna Pandya[2], Kyle Foster[3], Paul Bakken[4], Dr. Joe Dituri[5], Ivo John[6], Aleksander Bogucki[6], Radoslaw Chrapkiewicz[6], Sanjay Manohard[6]
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WITHDRAWN

[257] MYOCARDIAL BRIDGING DIAGNOSIS AND MANAGEMENT IN A STUDENT PILOT CANDIDATE

Zakaria Iloughmane[1], Mohamed Chamsi[2], Houda Echchachoui[2], Meryem Zerrik[2], Mouna El Ghazi[2], Fahd Bennani Smires[2], Sidi Mohamed El Khalifa[2]
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(Education - Case Study)

INTRODUCTION: This case report describes the discovery of a myocardial bridging in a 24-year-old student pilot candidate. **BACKGROUND:** Myocardial bridging (MB) is a congenital coronary anomaly in which a segment of the epicardial coronary artery traverses through the myocardium for a portion of its length. Typically benign and asymptomatic, myocardial bridging may impair coronary blood flow on exercise, depending on the length and depth of the tunneled artery, and have relevant aeromedical ramifications and exceptionally be responsible for serious life threatening complications. **CASEPRESENTATION:** A 24-year-old student pilot candidate came to the Aeromedical Expertise Center of Rabat (CEMPN) for medical evaluation. He had no previous medical comorbidities and was asymptomatic. The physical examination was unremarkable,the electrocardiogram revealed repolarization disorders in the anterior area, the transthoracic echocardiography shows no abnormality. The exercise stress testing was negative clinically and suspicious electrically (ST depression regressing in recovery). Coronary computed tomographic revealed non-calcified coronary arteries, with long intramyocardial path of the middle and distal left anterior descending (LAD) coronary artery responsible for tight stenosis. Coronary angiography shows non-atheromatous coronary arteries, important milking of the distal LAD, downstream the artery is of very small caliber, the right coronary is dominant and of large caliber and ensure the vascularization of the apex in place of the LAD. **DISCUSSION:** The true prevalence of MB is not accurately known it varies depending on the research method ranging from 2% in coronary angiography and 19% in Coronary computed tomography up to 42% at autopsy. The prevalence among active civil aircrew (pilot and cabin crew) monitored at the CEMPN is 0.4%, all revealed by electrocardiogram abnormalities, the ECG is systematically carried out each medical evaluation. The aviation environment may expose aircrew to additional physiological stressors (such as hypoxia, hypobaria and potentially sustained acceleration (+Gz)), and present a risk if associated with cardiovascular abnormalities and lead to incapacity to fly. Cardiovascular pathologies constitute the second cause of unfitness in the occupational periodic medical examinations. In our case the decision was an unfitness given the significant modification of the vascularization of the heart.

Learning Objectives

1. Cardiovascular pathologies in aviation medicine can be source of incapacity in flight.
2. The diagnosis of myocardial bridge is not always easy, especially if it is asymptomatic.
3. fitness decision is made on a case-by-case basis.

[258] A REVIEW OF THE EFFECTS OF SPACEFLIGHT ON SPINAL ANATOMY AND FUNCTIONAL IMPLICATIONS FROM A PHYSIATRIST'S PERSPECTIVE

Hannah Uhlig-Reche, Aditya Raghunandan
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(Education - Program/Process Review)

BACKGROUND: Optimal spine health is critical to functional performance. As longer duration space flight (SF) is planned, it is necessary to understand the physiological changes of the spine in prolonged microgravity. This has important implications for function and injury risk during and after long duration spaceflight (LDSF). **OVERVIEW:** LDSF is associated with spinal changes including muscular atrophy, bone remodeling, and disc degeneration. By understanding the physiologic changes that occur during LDSF, physiatrists can optimize astronaut function during and after spaceflight. Establishing effective and feasible countermeasures is imperative. **DISCUSSION:** LDSF is associated with atrophy of spinal muscles including multifidus (MF), paraspinals, and quadratus lumborum. High muscle spindle density in MF plays an important role in proprioception and biomechanics. Disruption of MF directly affects spinal segmental kinematics. There is an increased incidence of herniation within the first year following SF compared to matched controls. In a prospective cohort study of astronauts, reduced MF quality, defined as reduced percentage of lean muscle, following SF was associated with increased incidence of new disc herniation. Risk of lumbar disc herniation after SF is 4.3 times higher in astronauts compared to the general population and risk of cervical herniation is nearly 36 times higher. Although there is a disrupted diurnal cycle of disc compression, disc swelling in microgravity appears to play a lesser role in herniation than muscle atrophy. Discs also undergo molecular changes such as reduction in glycosaminoglycan and changes in extracellular matrix composition. Symptomatic disc herniation may present as axial or radicular pain and may lead to associated neurologic changes or increasing risk of functional decline. Increased bone resorption, particularly of trabecular bone, in prolonged microgravity increases fracture risk associated with acute high physical load demand (i.e., G force changes) or chronic underloading leading to osteoporotic fractures. These spinal changes can significantly affect astronauts' overall function and performance. A combination of exercise, nutrition, and bisphosphonates is effective in countering some of the musculoskeletal changes due to microgravity in LDSF. Additional research is needed to investigate the optimal type, duration, and intensity of exercise required to counteract these physiologic changes of the spine during LDSF.

Learning Objectives

1. Understand an overview of the physiological consequences of long duration space flight on the spine.
2. Be able to describe the risk of intervertebral disc herniations after prolonged exposure to microgravity.
3. Appreciate the functional implications of reduced spinal integrity after long duration space flight.

[259] MILITARY TOXIC EXPOSURES - A HYBRID TWO-WEEK CURRICULUM FOR VETERANS AFFAIRS-BASED INTERNS AND RESIDENTS

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[1]*Yale University, New Haven, CT, United States;* [2]*Veterans Affairs, West Haven, CT, United States*

(Education - Program/Process Review)

BACKGROUND: Curriculum about occupational and environmental exposures is not frequently incorporated into medical training. With recent media events covering environmental disasters and spills, and expansion of healthcare and benefits for Veterans exposed to toxic substances following passage of the August 2022 PACT Act, patients will likely have more questions about environmental exposures. Medical providers need to be well-versed in health effects related to toxic exposures to respond to the needs of patients and society at large. **OVERVIEW:** A hybrid two-week curriculum was developed to help resident physicians explore the relationship between toxic exposures and health outcomes especially with respect to deployment-related environmental exposures and illnesses. Additional goals include acquiring the skills to take a thorough exposure history, and appreciating the role of environmental health registries for tracking and monitoring the health of groups exposed to specific environmental hazards. This course implements a combination of methods found to be successful in prior OEM courses, especially in achieving learning objectives, improving attitudes towards OEM, and improving self-reported learning efficiency and quality of practice, including use of web-based models with active learning strategies and patient contacts. Active learning strategies include case-based activities (such as generating histories from the perspective of a patient, and developing targeted treatment plans through evidence-based medicine). Patient contacts include conducting Veteran Affairs (VA) environmental health registry exams which includes obtaining occupational/environmental histories, ordering relevant testing, and administering appropriate counseling. Activities are supplemented with additional curricula and examination through the American College of Preventive Medicine, enabling residents to complete the elective with a board-supported certification in military toxic exposures. **DISCUSSION:** This course helps providers understand pathways to benefits, how to elicit information about workers exposed to hazardous exposures, and how to monitor workers through surveillance and biomonitoring practices. The knowledge and practical skills developed in this course can be extrapolated to other settings, equipping medical providers with an expanded approach to health and disease prevention and management by including occupation and natural and built environments.

Learning Objectives

1. The audience will learn about a course-development project that teaches resident physicians about toxic exposures and health outcomes, especially with respect to deployment-related environmental exposures and illnesses.
2. The audience will learn about a course-development project that teaches resident physicians to take a thorough exposure history, especially with respect to military exposures.
3. The audience will learn about a course-development project that teaches resident physicians about environmental health registries.

[260] ARTIFICIAL INTELLIGENCE MODELS IN AEROSPACE MEDICINE: A SYSTEMATIC REVIEW

Najmeh Sadeghian[1], Hossein Akbarialiabad[2]
[1]*Mazandaran University of Medical Sciences, Sari, Iran, Islamic Republic Of;* [2]*NVH Global Health Academy, Nuvance Health, and the University of Vermont Larner College of Medicine, VT, United States*

WITHDRAWN

[261] PHYSIOLOGICAL AND COGNITIVE RESPONSES TO THE COMBINED EFFECTS OF DEHYDRATION AND HYPEROXIA

Mary Nimmer[1], Christopher Rock[2], Julia Milo[3], Nicole Beasley[1], Kevin Novak[4]
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(Original Research)

INTRODUCTION: Military aviators may adopt methods of tactical dehydration and experience heat stress, then subsequently breathe hyperoxic (HO) gas. Research has shown cognitive and physiological decline in response to hypohydration (HH) and HO separately, with both cited as potentially contributing to physiological episodes. Their combined effects have not previously been studied. **METHODS:** N=23 participants (17 male) between 18-45 years old participated in five visits. A within-subjects 2x2 factorial design was used to test four conditions, HO (73% oxygen) or normoxic (NO) and euhydrated (EH) or HH. HH was induced via fluid restriction and sweating from exericse in an environmental chamber (30-32℃, 30% relative humidity). Blood and urine were collected to assess hydration and inflammation (blood only). Cognitive and physiological tests were given, including the Performance Assessment Tool (PAT), hand-eye coordination, grip strength, orthostatic tolerance, pulmonary function, and ventilatory response to exercise. For cognitive testing, repeated-measures ANOVA were used to determine interaction significance, and follow-up t-tests were run. For preliminary serum analysis, a linear mixed-effects model was used to analyze hydration, oxygenation, and their interactions; these variables were considered fixed effects and participants random effects. This protocol was approved by the NAMRUD IRB (NAMRUD.2022.0015). **RESULTS:** PAT total score yield significant interactions between hydration and oxygenation ($F(1,20)=6.049$, $p=.023$, $\eta p2=.232$). This significance is primarily due to increased score for the EH/HO condition compared to the EH/NO condition ($t(20)=3.340$, $p=.003$, $d=.729$). The improved interaction effect is similarly observed in the math ($t(20)=2.821$, $p=.011$, $d=.616$) and manikin ($t(20)=2.678$, $p=.014$, $d=.584$) subtasks. Preliminary analysis of blood markers yielded no significance differences. **DISCUSSION:** This study explored acute combined effects of dehydration and hyperoxia on physiological and cognitive responses. Results showed significant cognitive enhancement, particularly in the EH/HO condition. Specific subtasks, like math and spatial orientation, benefitted from HO. Certain tasks improved even under dehydration when combined with HO, pointing to the nuanced interactions between hydration and oxygenation. These findings have implications for military aviators, suggesting that proper hydration when breathing HO gas may maximize cognitive performance.

Learning Objectives

1. The audience will understand the combined physiological and cognitive impacts of dehydration and hyperoxia, especially within the context of military aviation scenarios.
2. The audience will learn to analyze the specific cognitive tasks, such as mathematical processing and spatial orientation, that are particularly influenced by changes in hydration and oxygenation levels.
3. The audience will be able to recognize the practical implications of the study's findings for professionals, emphasizing the potential for maximizing cognitive performance through appropriate hydration in hyperoxic conditions.

[262] A REVIEW OF DISPARITIES IN THREE POTENTIALLY DISQUALIFYING CONDITIONS IN FEDERAL AVIATION ADMINISTRATION MEDICAL CERTIFICATION

Anaelle Ndoye[1], Julian Maceren[2], Lorna Evans[3], Andrew Lam[4], Curran Varma[5]
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(Original Research)

INTRODUCTION: Diabetes requiring hypoglycemic medications, epilepsy, and myocardial infarction (MI) are some medical conditions that may disqualify aviators during Federal Aviation Administration (FAA) medical certification. Because chronic conditions can affect different demographic groups unevenly, we reviewed epidemiological literature to identify racial or sexual disparities in these specific conditions. This would allow us to target certain groups for intervention to improve population health outcomes and increase the pool of healthy aviators. **METHODS:** Data were collected from pre-existing literature to elucidate the prevalence or risk ratios of diabetes, epilepsy, and myocardial infarction (MI) in the US according to different demographic factors. We identified more than 30 research papers via online database searches. We employed an age-range criteria of 18-50 years old and searched for figures for Non-Hispanic Black (NHB), Non-Hispanic White (NHW), male, and female populations. **RESULTS:** Our review revealed that the prevalence of diabetes for NHB people is 12.1% whereas the prevalence for NHW people is 7.4% ($p<0.05$). The prevalence of active epilepsy varied by race and ethnicity, with NHB individuals having a 1.6% prevalence and non-Hispanic adults who identify as multiracial having a 0.6% prevalence ($p<0.05$). For patients between the ages of 35-84, age-adjusted risk ratio for first acute MI is 1.49 comparing Black men with White men and 1.65 comparing Black women with White women ($p<0.05$); the risk ratio is yet higher when examining recurrent acute MI **DISCUSSION:** We have found that in three disqualifying conditions for FAA medical certification, racial disparities exist that impact minority populations in the US. With this knowledge, we can potentially intervene in these populations to increase the pool of healthy aviators. For example, with ample research demonstrating that patient-physician racial and gender concordance significantly impact patient outcomes, increasing physician diversity to better match that of the general population can reduce disparities. Addressing social determinants of health like education and access to healthcare may further improve health inequities. More research is needed to determine the best strategies to improve health for all our potential aviators.

Learning Objectives

1. The audience will learn about racial and secual disparities in the prevalence of diabetes, epilepsy, and myocardial infarction.
2. The audience will learn how to increase the population of healthy aviators through addressing social determinants of health and increasing patient-physicial racial and gender concordance.

[263] ONE DATABASE TO RULE THEM ALL AND IN THE AIRSPACE BIND THEM: NAVAL AVIATION OPERATIONAL INJURY DATABASE (NAVOID) PROGRESS UPDATE

LCDR Travis Doggett, Dr. Bethany Shivers, Juan Diaz-Rijos
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(Original Research)

BACKGROUND: Musculoskeletal injuries associated with naval flight environment directly impact flight personnel, readiness, and cost. Aviation-centric acute and chronic injury data relative to operational exposures are critical to providing focused solutions to the fleet and is a knowledge gap. Access to individually-linked operational and medical data would allow identification of exposure/outcome trends across a broad range of reported issues such as back pain/injury, better enabling focused solution development for the fleet. **METHODS:** The external databases identified for initial inclusion are the Navy's Sierra Hotel Aviation Readiness Program (SHARP) and Aeromedical Electronic Resource Office (AERO) flight waiver system. Contact was established and agreements made to access data. The specific medical question investigated was flight waivers and suspensions resulting from low back pain. **RESULTS:** The SHARP data consisted of >20,000 records since 1 JAN 2020 for pilots, naval flight officers (NFO), or aircrew with greater or equal to 100 flight hours. AERO was queried for records with the IDC-10 code M545 low back pain between 1 JAN 2020 – 31 MAY 2023. This search yielded 258 records representing 213 unique individuals. An individual may have between 1 and 3 records (multiple physicals diagnosing, treating, or issuing a waiver for low back pain). An unforeseen problem arose in that AERO uses social security (SS) numbers vice DODID for SHARP. In order to collate the records, the names of the individuals in AERO was used to identify their corresponding record in SHARP and their DODID. However, a severe mismatch became evident in that 133 (>50%) of the records in AERO did not have a corresponding flight record in SHARP. **DISCUSSION:** With less than 50% of the 258 AERO records being linked to SHARP, it is impossible to draw any meaningful relationships between low back pain and operational factors (g-forces, maneuvers). Until the records can be linked with a high degree of accuracy, our question cannot be answered. However, this failure highlights a severe capability gap within Navy and DoD Medicine. While DODID has been mandated since 2015 to reduce PII being compromised, the services continue to use SS for medical records. Updating AERO for DODID is critical to facilitate cross-analysis between databases; focusing research of mitigation strategies and clinical treatment parameters crucial to performance, survivability, and lethality of aircrew.

Learning Objectives

1. The participant will be able to understand the difference between medical conditions and operational factors.
2. The audience will learn about the different reporting systems for medical flight waivers vice operational flight records.
3. The audience will learn that Navy and DOD medical communities continue to use PII as patient identifiers vice more secure and ambiguous methods like DODID.

[264] RNA-TARGETED DRUG REPURPOSING PIPELINE FOR AEROSPACE MEDICINE

Bianca Cerqueira[1], Justin Reese[2], Diego Galeano[3], Afshin Beheshti[4], Luca Cappelletti[5], Kim Cates[6], Harry Caufield[2], Timothy Smith[7], Holly Chapapas[1], Meghan Robinson[8], Paul Sherman[9]
[1]KBR, Lackland AFB, TX, United States; [2]Lawrence Berkeley National Laboratory, Berkeley, CA, United States; [3]Universidad Nacional De Asunción, San Lorenzo, Paraguay; [4]Blue Marble Space Institute of Science, Moffett Field, CA, United States; [5]Università di Milano, Milan, Italy; [6]KBR, Lexington Park, MD, United States; [7]KBR, Beavercreek, OH, United States; [8]KBR, Houston, TX, United States; [9]U.S. Air Force 59th Medical Wing, Lackland AFB, TX, United States

(Original Research)

INTRODUCTION: New pharmaceuticals take on average 12 years to develop and receive FDA approval. However, there is abundant data in the public domain that can identify existing FDA-approved drugs that can be repurposed. Our goal was to develop graph-based ML and chemical structural-based ML models in a DoD-approved HIPAA compliant cloud environment to identify drugs and small molecules that can address biomedical impacts of high-altitude flight based on mRNA and miRNA signatures obtained from miniature swine high-altitude models. **METHODS:** We leveraged tooling to ingest, extract, and load databases into ARDIS cloud computing environment (AWS GovCloud IL4, HIPAA compliant, Defense Health Agency – verified system). This tooling allows the efficient construction and remixing of knowledge graphs targeted for drug repurposing and application of modern machine learning algorithms to generate a ranked list of relevant small molecules. For this knowledge graph (KG), we semantically integrated data related to drugs, drug targets, microRNAs, protein pathways, and protein-protein interactions, along with several important biomedical ontologies that provide background biological information. We then investigated a graph machine learning model to predict drug – miRNA interactions. We then used the SM2miR database to train a second ML model using miRNA data and extracted chemical structure from PubChem using CIDs. To visualize and provide explainability to the ML results, we developed a visualization component that displays nodes of interest and their relationships in the KG. **RESULTS:** In total, 36 links were predicted between drugs and any of differentially expressed pig genes and human homologs in high-altitude conditions. Broad classes of drugs with predicted links were statins/HMG-CoA reductase

inhibitors, anti-cancer/neoplastic drugs, anti-infective drugs, and analgesic drugs. **DISCUSSION:** We created a knowledge graph environment and applied multiple ML models to identify drugs and small molecules that target differential gene expression associated with high altitude exposure. This platform can be applied to identify candidate marketed drugs for off-label use or repurposing for new indications. The next steps to validate drug predictions would be in vitro/in vivo studies with identified small molecules or retrospective analysis of clinical data sets to confirm therapeutic effects.

Learning Objectives

1. The audience will learn about differential gene expression found in an animal model of high altitude flight.
2. The audience will learn about machine learning algorithms that can be applied to drug repurposing.
3. The audience will learn predicted links between classes of drugs and differential gene expression found in high altitude exposure.

[265] DETECTION OF ABNORMALITIES IN THE HUMAN LUNGS USING MEDICAL IMAGE PROCESSING

Kashif Sherwani, Munna Khan
Jamia Millia Islamia, New Delhi, India

WITHDRAWN

[266] A STUDY OF TOBACCO USE BEHAVIOR AND PERCEPTION OF HEALTH RISKS AMONG AVIATION WORKERS IN NORTH INDIA

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[1]*Adesh Medical College and Hospital, Kurukshetra, India;* [2]*DGCA, New Delhi, India*

WITHDRAWN

[267] VARIABILITY IN AEROSPACE MEDICINE MEDICAL TRAINING GLOBALLY AND ITS IMPLICATIONS

Lela Okromelidze, Kamal Shair
Mayo Clinic, Jacksonville, FL, United States

WITHDRAWN

[268] OPTIMIZING A DRONE NETWORK TO RESPOND TO MEDICAL EMERGENCIES

Daniel Cox[1], Jinny Ye[1], Chixiang Zhang[1], Lee Van Vleet[2], João Nickenig Vissoci[1], Daniel Buckland[1]
[1]*Duke University, Durham, NC, United States;* [2]*Durham County Emergency Medical Services, Durham, NC, United States*

(Original Research)

INTRODUCTION: Administration of emergency medications in the field is related to medic response time. Delays in response time could potentially be overcome with drones to deliver rescue medications efficiently to the scene for bystander use. Our objective was to evaluate a mathematical optimization simulation for geographical placement of drone bases in reducing response time to scene. To study this, we chose to focus on opioid overdoses because they are frequent in our area and have a potentially life-saving intervention that can be given by bystanders. **METHODS:** Using retrospective data from a local EMS database from January 2016 to February 2019, we created a geospatial drone network model based on current technological specifications and potential base locations. Genetic optimization was then used to maximize county coverage by drones and the number of overdoses covered per drone base. From this model, we identified base locations that minimize response time and number of drone bases required. **RESULTS:** In a drone network model with 2,327 opioid overdoses, as the number of modeled drone bases increased the calculated response time decreased. In a geospatially optimized drone network with 4 drone bases, response time compared to ambulance arrival was reduced by 4 minutes 38 seconds and covered 64.2% of the county. **CONCLUSION:** Our analysis found that in a mathematical model for geospatial optimization, implementing a few drone bases could reduce response time of 911 calls for opioid overdoses. Therefore, drones can theoretically improve time to delivery of emergency medications in the field. This work can be used to show that use of carefully placed drone stations in areas with difficult terrain or the battlefield could reduce response time to those in need of medical attention.

Learning Objectives

1. The audience will learn about the possible use of drone technology for the delivery of medical care in operational environments.
2. The audience will learn about the use of genetic optimization to assist in the appropriate placement of drone bases to save resources and decreased the response times to medical emergencies. This tool takes a set of inputs and helps determine the best solution for the desired parameters.

[269] RELEVANCE OF CARDIAC, PULMONARY AND CAROTID ARTERY FINDINGS IN A NEW COMBINED CLINICALLY JUSTIFIED VOLUME CT PROTOCOL IN PILOTS AND ASTRONAUTS

Hans Jürgen Noblé[1], Paul Martin Bansmann[2]
[1]*German Air Force Centre for Aerospace Medicine, Köln, Germany;* [2]*Hospital Porz am Rhein, Köln, Germany*

(Education - Tutorial/Review)

INTRODUCTION: With increasing mean age of active pilots and planned extension of maximum age of active pilots early diagnosis and risk stratification of coronary artery disease (CAD) is crucial. The purpose of this study is to evaluate relevance of cardiac, pulmonary and carotid artery findings in clinically justified CT scans of pilots and astronauts with regard to fitness to fly. **TOPIC:** A prospective case review was carried out for 20 consecutive German air force pilots and ESA astronauts at Hospital Porz am Rhein, Cologne, Germany. In cooperation with our institutions we established a clinically justified combined CT protocol consisting of a 3D volume CT coronary angiography (CTCA) including CT-FFR analysis (HeartFlow, Redwood City, CA) to assess coronary artery disease, plaque composition and hemodynamic effects of diagnosed stenoses. In the same protocol a high resolution pulmonary perfusion measurement was performed to exclude structural pulmonary changes and silent chronic pulmonary embolism followed by a spiral CT angiography of both carotid arteries on a 256-slice CT System (GE Revolution Apex). Structured analysis of findings with regard to fitness to fly and incidental findings as well as radiation dose were assessed. **APPLICATION:** Advantages of a clinically justified new combined CT protocol in an aging pilot/astronaut population with increasing prevalence of CAD are presented. Therapeutic or aftercare effects of clinical and incidental findings have to be discussed in interdisciplinary boards. The combined CT protocol of CTCA including CT-FFR analysis, lung perfusion and CTA of carotid arteries allows for detailed risk stratification at very low radiation doses. Randomized prospective multicenter studies are needed to further examine the effects of this new clinically justified screening protocol with regard to fitness to fly

Learning Objectives

1. New clicnically justified screening methods in pilots and astronauts with regard to fitness to fly.
2. Examples of incidental findings in screening CTs in aging astronauts and pilots.

[270] SUBJECTIVE AND NEUROHORMONAL COMPARISONS OF A VIRTUAL REALITY VERSION OF THE OPTOKINETIC-NYSTAGMUS DRUM

Taylor Casey[1], John French[2], Diego Garcia[2]
[1]*University of Pittsburgh Medical Center - Harrisburg, Harrisburg, PA, United States;* [2]*Embry Riddle Aeronautical University, Daytona Beach, FL, United States*

(Original Research)

INTRODUCTION: The Optokinetic Nystagmus (OKN) drum has been used to induce nystagmus and symptoms of motion sickness for many decades. The advent of virtual reality (VR) goggles made it possible to virtually create the traditional drum stimulus patterns at less cost and with more stimulus control. The current experiment compared subjective symptoms and neurohormonal responses from the traditional OKN drum experience with those from Vive VR goggles. **METHODS:** Healthy college students (n=12) were exposed to the drum and VR-OKN in a crossover design. Half the students received OKN drum exposure first and half received the VR OKN exposure first before the crossover. Comparisons of symptoms and responses were measured before, during, and after exposures using the standard SSQ and salivary assays of cortisol and melatonin. Friedman's test was used to determine if a difference existed between SSQ results and ANOVA was used to evaluate differences in neuroendocrine results, between the two exposures. Additionally, the VR-OKN was presented to the 12 participants in a non-repeated, non-crossover design as either the typical horizontal drum stripes pattern (n=6) or in a vertical stripes pattern (n=6). **RESULTS:** The drum and VR OKN exposures were not statistically different in any segments from any measures. Both drum and VR OKN were significantly different during the exposure segment compared to the pre-exposure and after segments on SSQ. There were no differences between the horizontal or vertical OKN exposures on the SSQ. Exposure to the drum OKN or the VR OKN, significantly reduced the SSQ scores on the crossover results, the VR OKN or the drum OKN, respectively. **DISCUSSION:** The lack of difference between drum and VR OKN measures implies VR-OKN could be used in place of the traditional drum OKN. This is advantageous because traditional methods are unavailable to many clinicians and researchers due to cost and testing inconvenience and far more stimulus presentation options are available with VR. The crossover results suggest that pre-exposure to VR or drum OKN may reduce symptoms on subsequent exposures, perhaps for desensitization to motion sickness. VR-OKN holds promise for reliably and quickly inducing nystagmus in various clinical and research applications.

Learning Objectives

1. The audience will learn about the underlying physiologic principles of optokinetic-nystagmus.
2. The audience will learn about a cheaper, more efficient alternative to testing nystagmus in the setting of diagnosing brain injuries.

[271] BASELINE VESTIBULAR FUNCTION OF AIR FORCE CANDIDATES

Dana Berger[1], Aya Ekshtein[1], Maya Avni[1], Yuval Kozlov[2], Oded Ben-Ari[1]
[1]*Aeromedical Center, Israeli Air Force, Ramat-Gan, Israel;* [2]*Hebrew University of Jerusalem, Jerusalem, Israel*

WITHDRAWN

WEDNESDAY, MAY 08, 2024

Wednesday, 05/08/2024 ***8:30 AM***
Grand Ballroom CD South, EF

[S-48]: PANEL: BEHAVIORAL HEALTH AND PERFORMANCE OPERATIONS AND RESEARCH IN HUMAN SPACEFLIGHT

Chair: Stephen VanderArk

PANEL OVERVIEW: *BODY: Optimizing behavioral health and performance of astronauts as they prepare for and complete spaceflight missions is a team effort for research and operations. The Behavioral Health and Performance (BHP) Operations Group and BHP Laboratory at NASA Johnson Space Center (JSC), in collaboration with NASA Ames Research Center's Fatigue Countermeasures Laboratory, have a shared goal of promoting optimal performance during all mission phases. This goal is demonstrated by the bi-directional relationship of operations informing research questions, and research results providing guidance to operational work with astronauts. The BHP Operations team within the Space Medicine Division is active in astronaut selection, training, behavioral healthcare services, and work-rest schedule development. The BHP Laboratory is engaged in research in space and analog platforms to address the risks and other challenges associated with future exploration missions beyond low earth orbit. The NASA Ames group works closely with both operations and research at NASA JSC to inform fatigue management services for astronauts and flight controllers and leads circadian desynchrony research. This panel will provide details of recent work by these groups and will demonstrate their shared goals, and contributions toward, optimizing performance, and maintaining the behavioral health and well-being of astronauts during all mission phases. One presentation will discuss the behavioral competency work being completed by NASA and its International Partners to select and train their astronauts using a common model. A second presentation will discuss one example where NASA Operational Psychologists implement this competency work in field trainings with Astronaut Candidates (ASCANs) and assigned crews, with the goal of teaching expeditionary skills, including Teamwork, Communication, Leadership, and Self-care. A third presentation will discuss the relationship between schedule changes and predictions made about crew alertness and performance, which is important data for the BHP Operations and Flight Surgeons to inform their pre-flight and in-flight work with crews. The panel will also include two presentations discussing research by the BHP Laboratory within ISS and spaceflight analogs that use a common set of measures to characterize the behavioral health and performance risks related to exploration missions—providing foundational work for future BHP work to train and monitor astronauts.*

[272] COGNITIVE PERFORMANCE IN ISS ASTRONAUTS ON 6-MONTH LOW EARTH ORBIT MISSIONS

Sheena Dev[1], Alaa Khader[2], Sydney Begerowksi[1], Millennia Young[3], Suzanne Bell[3], Gilles Clement[1]
[1]*KBR, Inc/NASA JSC, Houston, TX, United States;* [2]*JESTech/NASA JSC, Houston, TX, United States;* [3]*NASA JSC, Houston, TX, United States*

(Original Research)

INTRODUCTION: The NASA Human Research Program has identified the risk of decrements to cognitive performance as a primary behavioral health concern. In this study, we systematically assessed

a wide range of cognitive domains among astronaut crew before, during, and after 6-month missions to the International Space Station (ISS). **METHODS:** Twenty-one astronaut crewmembers were administered the full Cognition Battery at five timepoints: baseline (BDC), early inflight, late inflight, one-week post-landing, and one-month post-landing. Speed and accuracy outcomes for each subtest were corrected for practice effects and z-transformed using the sample's BDC scores. Speed and accuracy scores were averaged to create respective summary metrics. Linear mixed models with random subject intercepts nested within gender determined the relationship between timepoint and performance. Age was included in the models as a covariate. Post-hoc pairwise comparisons using Tukey's HSD to correct for Type I error examined differences between each timepoint. **RESULTS:** Average z-scores across all outcome measures (range: -.53 to .17) varied mildly around the sample's baseline mean performance. However, approximately 12% of all individual observations were below 1 standard deviation of the full sample baseline mean (i.e., z-score < -1). Linear mixed models revealed a significant main effect of timepoint for the summary accuracy score ($\beta = -.06$, $p = 0.001$), such that accuracy was statistically lower at both post-landing timepoints (*p's* = .03) relative to BDC though the absolute differences were minimal (*z-score*'s = 0.22). Results across subtests varied. For example, there was no significant effect of timepoint on a subtest assessing sensorimotor speed, while in contrast performance on a risk-taking task ($\beta = -.33$, $p < 0.001$) suggested that crew demonstrated the greatest propensity for risk taking at early inflight and one-week post-landing timepoints relative to BDC. **DISCUSSION:** As a group, astronaut crew on 6-month ISS missions demonstrated very mild transient changes in cognitive performance. Future directions include an examination of contextual factors that may contribute to low scores (i.e., fatigue) and validation against operationally relevant outcomes to characterize meaningful change. Taken together, these and future findings can inform operational strategies to optimize crew performance.

Learning Objectives

1. The audience will be able to discuss the most recent data characterizing cognitive performance in spaceflight.
2. The audience will learn about behavioral health optimization in spaceflight by discussing how contextual factors may contribute to changes in cognitive performance.

[273] HUMAN FACTORS AND BEHAVIORAL PERFORMANCE EXPLORATION MEASURES IN SPACE AND SPACE ANALOG ENVIRONMENTS: ASSESSING ASTRONAUT RISK

Suzanne Bell[1], Sheena Dev[2], Steven Anderson[2], Lauren Landon[2], Jennifer Miller[3], Alaa Khader[3]
[1]*NASA JSC, Houston, TX, United States;* [2]*KBR, Inc/NASA JSC, Houston, TX, United States;* [3]*JESTech/NASA JSC, Houston, TX, United States*

(Education - Tutorial/Review)

INTRODUCTION: The Human Factors and Behavioral Performance Exploration Measures (HFBP-EM) suite is a set of standardized measures to assess behavioral health and performance risk related to future long duration space exploration (LDSE) class missions, and to support reduction of the Human Research Program's (HRP) Behavioral Medicine (BMed), Team, Sleep, and Human Systems Integration Architecture (HSIA) risks. The suite includes 1) surveys that assess team, psychosocial, and behavioral functioning, 2) tasks of cognitive functioning and operationally relevant performance, and 3) physiological biomarkers of sleep and heart rate. This presentation will provide an overview of the suite, describe implementation in spaceflight and terrestrial analogs, report on workload, fatigue, stress, and social support, and discuss the applicability of these results and the HFBP-EM suite in general to audience members. **TOPIC:** HFBP-EM is a research program designed to examine the validity and reliability of measures within the HFBP-EM suite, serve as a test bed for measures being considered for spaceflight, and used to test the efficacy of countermeasures. Each campaign of data collection also has additional specific aims such as the identification of thresholds or development or shorter forms for survey measures. To date, HFBP-EM has been collected in Human Exploration Research Analogs campaigns 4, 5, 6 and the SIRIUS19 and SIRIUS21 missions in the Russian Ground Based Experiment Complex. A subset of the HFBP-EM suite was collected during spaceflight. Data was collected from a total of 87 multinational astronaut and astronaut-like crewmembers (mean age: 39.3, SD = 7.8; 39% female; 92% advanced degrees). We will provide an overview of the HFBP-EM program; what the suite currently includes; results for workload, fatigue, stress, and social support; and next steps in the suite's development. We will also discuss the application to aerospace practitioners and researchers. **APPLICATION:** Astronaut teams selected for future LDSE missions will face challenges that pose significant yet unknown risks to their behavioral health and performance. The HFBP-EM suite provides a comprehensive assessment of behavioral health and performance in space analog and spaceflight settings. This suite can be applied to both operational and research settings to advance risk reduction research for LDSE missions.

Learning Objectives

1. The audience will learn about the Human Factors and Behavioral Performance Exploration Measures suite and its application to both operational and research settings to advance risk reduction research for future long duration space exploration class missions.
2. The audience will be able to describe trajectories of reported fatigue, stress, and social support across different spaceflight and spaceflight analog settings.

[275] IMPACT OF SLEEP SCHEDULE CHANGES ON SLEEP OUTCOMES AND PREDICTED CREW ALERTNESS ON THE INTERNATIONAL SPACE STATION

Rachel Jansen, Erin Flynn-Evans, Zachary Glaros
NASA, Moffett Field, CA, United States

(Original Research)

INTRODUCTION: Astronaut crews have historically averaged six hours of sleep per night. In recent years, ISS crew have had more stable schedules, with consistent bed and wake times. Despite these improvements, there remain uncontrollable operational events that require crewmembers to shift their sleep. It is unclear what impact these acute schedule changes have on sleep and performance outcomes. The aims of this analysis are to characterize approaches to sleep shifting, including shifting sleep earlier or later and splitting sleep, and to determine the impact on sleep outcomes and crew alertness and performance. **METHODS**: Crewmembers (n = 19) on the ISS were provided with actiwatches that they wore for two bouts of data collection before flight, inflight, and immediately upon return to Earth. We first characterized the impact of "split sleep," whereby a person attempts sleep on two separate occasions in a 24-hour period that are similar in length, and its impact on sleep outcomes. **RESULTS**: Nine crewmembers engaged in 14 episodes of split sleep while inflight. These periods surrounded six separate visiting vehicle events that interfered with their nominal sleep window (2130 to 0600). The first sleep opportunity typically took place during the afternoon before the disrupting event, while the second episode took place the following morning. On average, the first sleep opportunity was shorter than the second (M1=2.79±0.74 vs. M2=4.28±1.56), as were sleep duration (M1=2.65±0.81 vs. M2=4.11±1.57) and efficiency (M1=76.06±13.43 vs. M2=83.49±8.46). On inflight nights with no split sleep, these crewmembers averaged 6.71±0.52 hours of sleep per night with a sleep efficiency of 83.51±2.61. **DISCUSSION**: Next, we will compare the crewmembers' split sleep outcomes to those from other strategies to determine which yield the best sleep outcomes. We will use biomathematical modeling to analyze the predicted alertness on these schedules. Understanding these impacts will aid in decision making for future spaceflight operations and will inform on the impacts of various strategies to adjust sleep and help guide scheduling in future missions where consistent schedules may not be possible.

Learning Objectives
1. Participants will learn how sleep shifts impact crewmember sleep outcomes.
2. Participants will learn how sleep shifts impact predicted crew alertness.

[274] DEFINING COMPETENCIES NEEDED AT THE TIME OF SELECTION FOR ACTIVE AND NON-ACTIVE ASTRONAUT CREW MEMBERS

Alexa Doerr[1], James Picano[2]
[1]*KBR, Houston, TX, United States;* [2]*NASA, Houston, TX, United States*

(Education - Program/Process Review)

BACKGROUND: NASA has worked with international partners in developing and standardizing selection guidelines for minimal behavioral competencies needed upon selection. Spaceflight poses significant risk to crew and individual, and to mitigate risk, training should be provided on behavioral competencies required for spaceflight including those that are required but are not measured at selection. We provide an overview of the process of identifying competencies important to assess as part of a multi-method selection program for active and non-active astronauts. **OVERVIEW:** NASA, ESA, CSA, and JAXA agency representatives used their vast combined knowledge and experience to develop competency requirement standards that future selection programs should assess when selecting astronauts. The astronaut role is expanding to include astronauts whose purposes are quite varied. NASA and its international partners recognize the need to identify and standardize the competencies required for anyone who will be experiencing the incredible demands, risks, and unique circumstances associated with spaceflight. Competencies include those required for individual and team functioning within the isolated, confined, and extreme environment. This need grew out of greater commercialization of spaceflight and other budding spaceflight prospects. The process was as follows: 1. Each agency rated previously defined spaceflight required competencies (*not important 0, somewhat important .5,* or *extremely important 1)* to assess during selection. We did this for short duration (<14 days) and for long duration (>14 days) missions as some competencies appear to become of greater importance with longer duration missions. 2. Competencies for non-active crew were rated, and previous ratings for active crew were updated. 3. Agency ratings for non-active/active and short-duration/long-duration requirements were compared and discussed until consensus was reached. Ratings will be used to compile selection standards for active and non-active astronauts. **DISCUSSION:** Our working group has vast operational experience and knowledge of the risk factors present during spaceflight that can disrupt individual and team functioning. Selection is one of the most important countermeasures for mitigating risk to individual and team health and performance. Our work should inform future programs for selecting crewmembers for short- and long-duration spaceflight among active and non-active crews.

Learning Objectives
1. The audience will learn about our process of identifying behavioral competencies that can and should be assessed during selection of active and non-active astronaut crew members.
2. The audience will learn about the behavioral competencies that were identified as important to assess during selection of active and non-active astronaut crew members.

[35] STELLAR MINDS: BENEFITS OF INTEGRATING OPERATIONAL PSYCHOLOGISTS INTO ASTRONAUT FIELD TRAINING

Anna Cejka
KBR, NASA JSC, Houston, TX, United States

(Education - Tutorial/Review)

INTRODUCTION: Astronauts face a high degree of environmental challenge involving unknown and uncontrollable situations, resulting in complex skills and critical psychological characteristics necessary for optimal performance. As such, unique challenges exist when preparing astronauts for high-tempo, high-risk missions, particularly when opportunities for expeditionary training are limited to didactics. While didactics provide a foundation for understanding expeditionary skills, application during field training allows trainees to practice these skills in higher fidelity scenarios that echo the demands of the environments and mission objectives that crews will encounter in space. This presentation will describe the process and benefits of integrating operational psychologists into astronaut field training. **TOPIC:** Space missions demand key competencies, including cooperation with others, adaptability, judgment, motivation, physical ability and stamina, and initiative. As such, operational psychologists at NASA JSC ensure specialized technical and expeditionary competencies necessary to be effective on long-duration spaceflight missions. These competencies mitigate risks to team functioning and the overall mission by preserving crew cohesion, minimizing conflict, and enhancing communication. To ensure the successful application of technical and expeditionary competencies during spaceflight, operational psychologists engage in field training with astronaut candidates and crews. Their involvement facilitates observation of team dynamics, immediate feedback, skill reinforcement, and collaboration with specialists (e.g., survival trainers, geologists, etc.), ultimately allowing for the enhancement of psychologist-crew rapport, enabling timely interventions, fostering interdisciplinary collaboration, and bolstering skill retention. **APPLICATION:** The involvement of operational psychologists in astronaut field training is crucial to aeromedical professionals working with small, high-performing teams. Specifically, the integration of operational psychologists in training can guide professionals aiming to optimize individual and team performance in mission-critical, isolated environments.

Learning Objectives
1. The audience will learn about the benefits of including operational psychologists in astronaut field training.
2. The audience will learn techniques used by operational psychologists to train behavioral competencies during field trainings.

Wednesday, 05/08/2024 ***8:30***
AMGrand Ballroom A

[S-49]: PANEL: CHARACTERIZING THE EFFECTS OF VARIABLE RESPIRATORY DYNAMICS IN MILITARY AVIATION

Chair: Stephanie Warner
Co-Chair: Kara Blacker

PANEL OVERVIEW: *Over the past decade, tactical aviators have reported experiencing unexplained physiological symptoms, both on the ground and in-flight. These physiologic events or episodes (PEs) have caused temporary groundings, aborted missions, and in-flight mishaps, which led to PEs becoming the number one safety priority in Naval aviation. Recent emphasis was placed on characterizing the role of the aircraft life support system (LSS) and resultant changes to respiratory conditions as contributing factors to PEs. As a result, research efforts across the Department of Defense (DoD) have focused on the neurophysiological, cognitive, and performance effects of breathing varied combinations of pressure, flow, oxygen concentration, and fluctuations in gas delivery. This panel aims to highlight several studies that have utilized high fidelity testing equipment, actual LSS components, and behavioral, physiological, and neurophysiological measures of performance. This body of work will contribute to a better understanding of the complex human response to variable respiratory dynamics as experienced in tactical aviation. PANEL STRUCTURE The first presentation describes Naval Medical Research Unit Dayton's (NAMRU-D) development of a magnetic resonance imaging (MRI)-compatible, simulated aircrew LSS, test configuration as part of the DoD and Wright State University's (WSU)*

Center of Neuroimaging and Neuro-Evaluation of Cognitive Technologies (CoNNECT) to support several current and future DoD efforts evaluating respiratory dynamics. The second presentation describes an MRI-based research study completed by NAMRU-D and WSU in the CoNNECT facility investigating the neurophysiological markers of hyperoxia and non-standard oxygen delivery pressure. The third presentation describes a research study by NAMRU-D investigating the effects of repeated hyperoxia exposure on respiratory and physiological response. The fourth presentation from a 711th Human Performance Wing and NAMRU-D joint effort demonstrates the use of exhaled breath samples for detecting potential novel biomarkers of acute normobaric hypoxia. The final presentation describes a functional near-infrared spectroscopy (fNIRS) study by NAMRU-D investigating the effects of intermittent acute hypoxia exposure and breathing resistance.

[276] DEVELOPMENT OF AN MRI-COMPATIBLE SIMULATED AIRCREW LIFE SUPPORT SYSTEM FOR EVALUATION OF VARIABLE RESPIRATORY DYNAMICS IN MILITARY AVIATION

Stephanie Warner[1], Frank Robinson[1], Matthew Sherwood[2]
[1]*Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States;* [2]*Wright State University, Dayton, OH, United States*

(Education - Program/Process Review)

BACKGROUND: Mitigating physiological episodes is an ongoing priority for the aeromedical research community. Life support system (LSS) output can contribute to variable respiratory dynamics experienced by military aviators even while operating within requirements. To address the impact of this exposure, new research has focused on hyperoxia, hypoxia, low regulator inlet pressure, increased breathing resistance, and their interactions. Parallel work is underway to understand the neurophysiological and performance effects of these respiratory conditions. However, to elicit symptomology similar to that experienced in flight, a high-quality aviation LSS simulation is essential. Naval Medical Research Unit Dayton (NAMRU-D), Wright State University (WSU), and the 711th Human Performance Wing collaborated to create a high-fidelity magnetic resonance imaging (MRI)-compatible simulated LSS to evaluate variable respiratory dynamics in military aviation. **OVERVIEW:** The Department of Defense (DoD) and WSU partnered to acquire a 3-Tesla MRI for the new Center of Neuroimaging and Neuro-Evaluation of Cognitive Technologies (CoNNECT). The first research efforts utilizing the CoNNECT facility are evaluating the neurophysiological effects of respiratory dynamics in military aviation. Leveraging NAMRU-D's Hypoxia Ventilation Research Device and fabrication specialists, a fully-functional LSS configuration was designed and installed in the CoNNECT facility. This setup allows dynamic manipulation of gas content, pressure, and flow to simulate aviation breathing scenarios. Additionally, NAMRU-D coordinated with Eaton to provide two MR-compatible CRU-103 breathing regulators with and without safety pressure, as well as with Gentex to modify the MBU-20/P mask to be MR-compatible. **DISCUSSION:** Systems such as functional near-infrared spectroscopy, electroencephalography, and MRI are useful to evaluate the neurophysiological effects of variable respiratory dynamics. However, incorporation of actual LSS equipment, a precision gas delivery system, and appropriate task scenarios are key to simulate the aviation environment and capture the physiological changes with high fidelity. The DoD-WSU CoNNECT facility is the only MRI location with these custom testing capabilities. This robust research setup allows for rapid advancement of DoD imaging research and supports the understanding of the complex human response to variable respiratory dynamics in military aviation.

Learning Objectives

1. The audience will learn about a new custom MRI-compatible simulated aircrew life support system available to support research evaluating variable respiratory dynamics in military aviation.
2. The audiences will be able to identify components and testing capabilities of a new MRI-compatible simulated aircrew life support system used to elicit symptomology similar to that experienced in flight.

[277] EVALUATING THE NEUROPHYSIOLOGICAL EFFECTS OF HYPEROXIA IN A HEALTHY COHORT USING 3D PCASL PERFUSION AND 3D APTW MRI: A PILOT STUDY

Matthew Sherwood[1], Kelsie Pyle[1], Stephanie Warner[2]
[1]*Wright State University, Dayton, OH, United States;* [2]*U.S. Navy, Wright-Patterson AFB, OH, United States*

(Original Research)

INTRODUCTION: The neurologic response to hyper- and hypoxia is extremely complex and likely involves alterations of cerebral hemodynamics. The response to hypoxia has evolutionary implications but only recently have species been exposed to hyperoxic conditions, thus, a natural response mechanism may not exist. Hyperoxia, a regular component in military aviation, is considered safe; however, it can induce reduced CO_2 levels in the blood producing harmful effects. Thus, hyperoxia may be the source of cognitive and task fatigue that have been reported in military aviation. **METHODS:** Six healthy volunteers have completed 3 experimental sessions using a 3T magnetic resonance imaging (MRI). All subjects received 100% O_2 during the entire 90-minute scan procedure via a custom gas delivery system. This system delivered 100% O_2 to an aviation regulator (Eaton CRU-103) connected to a modified aviation mask (Gentex MBU-20/P). The scanning sequence was identical at each session: 30 minutes of baseline, 30 minutes of exposure where the pressure of O_2 or the CRU-103 was altered, and 30 minutes of recovery. This study is part of a larger program; however, the work presented here utilized all three MRI scans to assess the main effect of exposure time to hyperoxia. Images of amide proton transfer-weighted (APTw) and pseudocontinuous arterial spin labeling (pcASL) were acquired during baseline and recovery. Cerebral perfusion and APTw maps were evaluated to determine changes from baseline to recovery. **RESULTS:** Decreased APTw was observed in numerous regions including the right fusiform, amygdala and superior temporal gyrus. Frontal areas including the left superior frontal gyrus and right anterior cingulate cortex and middle frontal gyrus appeared with increased APTw. These changes suggest altered protein content in various regions of the brain associated with emotion, attention and executive function. pcASL findings were limited due to the small sample size at this time. **DISCUSSION:** Changes in the APTw signal, mostly restricted to white matter, may be indicative of altered cellular oxidative stress, neuroprotection and/or bioenergetics metabolism. These findings suggest that hyperoxia may initiate biochemical cascades leading to cortical hypoarousal and neuroinflammation and further behavioral implications. Recruitment in this study is on-going and the results will be updated as the sample increases.

Learning Objectives

1. Become knowledgeable of various advanced MRI sequences and their application in military aviation.
2. Understand the neurophysiologic conditions that alter signals in advanced MRI imaging such as 3D pcASL and 3D APTw.

[278] EFFECTS OF REPEATED HYPEROXIA EXPOSURE ON RESPIRATORY AND PHYSIOLOGICAL RESPONSE

Caitlin O'Guin, Barbara Shykoff, Kara Blacker
Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States

(Original Research)

INTRODUCTION: Fighter pilots are routinely exposed to high levels of oxygen. The U.S. Navy uses the on-board oxygen generating system's maximum output, nominally 94%, at all altitudes. However, the effects of repeated exposure to the oxygen partial pressures (PO_2) at this concentration have yet to be fully evaluated. This study explored some acute and cumulative effects of elevated PO_2 compared to air. The PO_2 of interest was that for 94% O_2 at 8,000 ft above mean sea level, equivalent to 73% O_2 in our laboratory. **METHODS:** This IRB-approved, between-subjects,

single-blinded study included 57 healthy adults ages 19 to 44 (median 29) years. Participants were randomized into two groups, 73% O_2 or 21% O_2. Participants completed five consecutive days of testing with a two-hour seated gas exposure in each of the first four days. Measurements were respiration during the exposures, grip strength, ventilatory response to exercise, spirometry, lung diffusing capacity, orthostatic tolerance, plasma erythropoietin concentrations, and a set of inflammatory markers. Each exposure day included pre- and post-tests of one variable. Not all variables were tested each day. **RESULTS:** Two-way, repeated measures ANOVA examined the effects of O_2 condition and time. Variables not listed here showed no significant effects. No interactions of time and condition were found. End-tidal CO_2 ($etCO_2$) showed a main effect of condition, $F(1, 47)=14.571$, $p<.05$; participants exposed to 73% O_2 had $etCO_2$ levels 8.7% lower than did those breathing air. Main effects of time were found for ventilatory response to exercise (minute ventilation per O_2 uptake rate, $V'_E/V'O_2$) [$F(3, 141)=4.020$, $p<.05$] and for some spirometry variables. $V'_E/V'O_2$ increased with time for both O_2 conditions. The spirometry variables decreased over time for both O_2 conditions while remaining within normal standardized ranges. **DISCUSSION:** The results indicate no acute or cumulative difference between O_2 conditions other than on $etCO_2$. Participants exposed to 73% O_2 hyperventilated slightly, as anticipated, without signs or symptoms. Time effects on spirometric variables and $V'_E/V'O_2$ may indicate fatigue or prolonged sitting, not O_2-related inflammation. Overall, the evidence indicates that repeated acute hyperoxic exposure has no substantive effect on the measured factors imperative to mission success.

Learning Objectives

1. This experiment explored exposure to acute hyperoxia as relevant to aviation and suggested that those conditions do not have a substantial effect on the measured physiologic factors.
2. This experiment suggested that pulmonary inflammation is not evident after single or repeated two-hour hyperoxic exposures to a PO2 of 500 Torr (94% O_2 at 8,000 feet MSL).

[279] BIOMARKER DISCOVERY IN CONTROLLED NORMOBARIC HYPOXIA EXPOSURES

Sean Harshman[1], Alena Vdigl[1], Anne Jung[1], Kiersten Weatherbie[2], Madison Stoner-Dixon[1], Aburianne Dash[1], Christopher Land[1], Julia Milo[2], Dylan Slizewski[1], Christina Davidson[1], Kara Blacker[3]
[1]*Air Force Research Lab, 711th Human Performance Wing, Wright-Patterson AFB, OH, United States;* [2]*Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States;* [3]*Naval Medical Research Unit - Dayton, Air Force Research Lab, 711th Human Performance Wing, OH, United States*

(Original Research)

INTRODUCTION: Hypoxia remains a source of significant concern for those piloting high performance aircraft within the Department of Defense. Therefore, the ability to detect and mitigate the risks associated with individuals who are hypoxic is of grave importance to pilot safety. However, options to non-invasively monitor pilots inflight remain low. As a result, exhaled breath has become a promising candidate to fulfill this role [1,2]. **METHODS:** To confirm and identify novel biomarkers of hypoxia, controlled mask free normobaric hypoxia, equivalent to 17,500ft., and sea level exposures were performed on 22 individuals over 45 minutes while analyzing exhaled breath and electroencephalogram (EEG) throughout the exposures. **RESULTS:** Preliminary results indicate hypoxia exposures induced a mean SpO_2 drop of 17.9% and an average 10bpm increase in heart rate compared to normoxic conditions. Exhaled nitric oxide illustrated an approximate 2.4 fold increase during the hypoxic exposure, compared to normoxia, and returning to baseline in a post exposure sample. Initial principal component analysis (PCA) of all global exhaled breath data by proton transfer reaction mass spectrometry, acquired throughout the two conditions, show approximately 40.2% of the overall variation in the data is represented by PC1 (25.4%) and PC2 (14.8%). The breath data suggest variation in the data based on the exposure condition. The EEG results indicate a reduction in the amplitude of the P3a component during hypoxia compared to normoxia, which is indicative of impairment in auditory reorienting of attention under hypoxic conditions. **DISCUSSION:** *Collectively, these data illustrate the potential for non-invasive sources, such as exhaled breath and EEG, as potential biomarkers of normobaric hypoxia.*

Learning Objectives

1. Understand the rationale for exhaled breath monitoring for hypoxic stress.
2. Understand the current state of the data analysis and the path moving forward.

[280] INVESTIGATING THE EFFECTS OF INTERMITTENT ACUTE HYPOXIC EXPOSURE AND BREATHING RESISTANCE

Frank Robinson[1], Jeremy Beer[2], Nathaniel Spencer[3], Barbara Shykoff[3], Zachary Kerns[2], David Freeman[2]
[1]*Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States;* [2]*KBR, San Antonio, TX, United States;* [3]*Naval Medical Research Unit - Dayton/Leidos, Wright-Patterson AFB, United States*

(Original Research)

INTRODUCTION: Research on the effects of hypoxia has traditionally focused on steady state exposures. Under certain conditions, however, aircraft On-Board Oxygen Generation Systems (OBOGS) may intermittently deliver gas that is insufficient to maintain normal blood oxygenation at altitude. In addition, aircraft life support systems may also impose breathing resistance. This study examined the effects of intermittent exposures to acute hypoxia, continuous exposure to breathing resistance, or both stressors simultaneously. **METHODS:** This study utilized a within subjects design. Six participants completed four visits in which they experienced normobaria plus 1) a control condition breathing 65% oxygen with no added breathing resistance; 2) intermittent acute hypoxia in which they alternated between one-minute periods of breathing 65% oxygen or 7% oxygen (simulated 25,000 foot altitude); 3) continuous breathing resistance slightly outside the allowed air standard with 65% oxygen; or 4) intermittent acute hypoxia and continuous breathing resistance together. Participants completed high and low workload variants of a color word Stroop task throughout each profile. We recorded pulse oximetry, fNIRS, end-tidal CO_2, respiratory dynamics, performance, and subjective symptom data. **RESULTS:** We observed experimental effects on multiple outcome measures. Breathing condition and workload both affected breathing period (both $p < 0.01$), tidal volume (both $p < 0.01$), and end-tidal CO_2 (both $p < 0.05$). fNIRS data identified mental activity in the prefrontal cortex when performing the Stroop compared to baseline ($p = 0.03$) but could not distinguish between periods of high and low workload within the Stroop task and failed to identify differences across breathing condition. **DISCUSSION:** Multiple outcome measures responded to differences in breathing condition. Notably, the effects of the intermittent hypoxia/resistance condition were often distinct from the response to either insult in isolation. We further observed that mental workload had a significant effect on several outcome measures. fNIRS was unable to detect multiple physiological and cognitive impacts of our manipulations, as revealed by other outcome measures. The unique effects of different respiratory stressors and the effect of cognitive task should be accounted for in the development of future cockpit sensors and alert systems for real-time aircrew monitoring.

Learning Objectives

1. Participants will learn the ways in which different types of respiratory and cognitive challenges may affect breathing patterns.
2. Participants will learn how various physiological indicators can be differentially responsive to respiratory challenges.

Wednesday, 05/08/2024 ***8:30 AM***
Grand Ballroom B

[S-50]: PANEL: OPHTHALMIC AEROMEDICAL WAIVER CASES

Chair: Micah Kinney
Co-Chair: Adam Preston

PANEL OVERVIEW: *TITLE: Ophthalmic Aeromedical Waiver Cases BODY: This panel will present unique ophthalmic aeromedical clinical cases and the return to flight or wavier adjudication process that followed. Vision and ophthalmic standards are often thought of as the most rigorous for aviation occupations. First, this panel will present an Army aviation candidate who presented with a presumed Congenital Simple Hamartoma of the Retinal Pigment Epithelium (CSHRPE). Next, a case on the forces of high G maneuver flight causing valsalva retinopathy in a student Naval aviator. The third, a series of cases which will discuss cranial nerve IV palsies and the unique presentations, etiology, and waiver decision of three aircrew. Fourth, a rare but relevant complication following LASIK called transient light sensitivity syndrome in a naval flight officer will be discussed. Finally, the FAA will present on the use of the Special Medical Flight Test (MFT) to verify performance and safety of flight, including two cases in which the MFT was performed for failure to meet visual acuity standards due to amblyopia, and one case in which the MFT was performed to remove the limitation for failed color vision testing for Class 1 medical certificate. Through advancements in clinical and operational research, data driven waiver decisions provide a method to retain aircrew or offer justification for disqualification.*

[281] TRANSIENT VISION LOSS IN A STUDENT NAVAL AVIATOR DURING A DYNAMIC MANEUVER TRAINING FLIGHT IN A MILITARY JET: A CASE REPORT

Stephen Jaggi, Makala Bascome
U.S. Navy, Meridian, MS, United States

(Education - Case Study)

INTRODUCTION: This case report describes a student naval aviator who experienced transient complete vision loss in her right eye during a dynamic maneuver training flight secondary to a Valsalva event. **BACKGROUND:** Military training jets are exceptionally agile and dynamic flights can lead to nausea and other physiological symptoms. The physiologic responses to a dynamic high-G flight environment (e.g., nausea, coughing, and Valsalva) compounded with using the anti-G strain maneuver, can lead to unique sequelae in the sensory system, including the eyes and visual system. The type of maneuvers executed during these training flights are typical of jet maneuvers during tactical missions, and awareness of unforeseen aeromedical complications should be recognized for increased situational awareness, safety, and mission accomplishment. **CASE PRESENTATION:** A 25-yr old female student naval aviator presented to sick call with the Flight Surgeon after loss of vision to right eye for ten minutes after performing dynamic high-G flight maneuvers. The patient denied pain or any other health concerns at that time and was seen by the Aerospace Optometrist the following morning. She reported that while flying, she felt nauseous, removed her mask, and coughed forcefully. She immediately experienced a complete loss of vision in her right eye, and subsequently began her return to base procedures. As she descended, her vision began to return, and returned fully to normal after 10 minutes. A comprehensive dilated eye exam was performed, and it was determined the student naval aviator had experienced Valsalva Retinopathy and was cleared for resuming flight duties after being monitored and completing an unremarkable follow-up with an ophthalmologist. **DISCUSSION:** This case highlights the potential for seldom discussed or considered conditions that may arise during or after dynamic flights with a high amount of +Gz exposure, or other dynamic maneuvers, as well as the operational importance of having easy access to trained aeromedical subspecialists. Other conditions will be discussed for familiarity of those performing the follow up care, and educating the aviators and flight crew of symptoms or conditions they may experience.

Learning Objectives

1. The audience will become more familiar with the potential for seldom discussed or considered conditions that may arise during or after dynamic flights with a high amount of +Gz exposure, or other dynamic maneuvers.
2. The audience will discover evidence of the operational importance of having easy access to trained aeromedical subspecialists.

[282] CN IV PALSY WAIVER CONSIDERATIONS AND RECOMMENDATIONS: CASE REPORT

Megan Rieman
Naval Aerospace Medicine Institute, Pensacola, FL, United States

(Education - Case Study)

INTRODUCTION: This presentation discusses three cases of CN IV palsy in members with varying Aviation Class and level of experience. **BACKGROUND:** Single, fused/stereoscopic, simultaneous binocular vision in all fields of gaze is a requirement for safe and effective flight duties. Congenital or acquired defects of ocular alignment as well as any surgery to correct ocular misalignment can cause mild to severe degradations to binocular vision and acuity and be a grave hazard in aviation. **CASE PRESENTATION:** Patient 1 was a 35YO male, senior USMC Major helicopter pilot, with 2000 total flight hours, 700 in combat, when his CN IV palsy was discovered in 2015. He exhibited normal stereopsis and intermittent suppression OS without diplopia. Patient 2 was a 26YO male with 300 total flight hours in the last phase of F-35 FRS training demonstrating long standing excessive vertical tropia due to his congenital CN IV palsy. The findings outside of standards were noted at an accession eye exam, but this information was not recorded in his initial flight physical and his condition was finally noted in May 2023. He exhibited reduced stereopsis and suppression OS, without diplopia. Patient 3 was a 21YO male, air traffic controller with 2 years of experience. Stereopsis and phorias are not mandatory elements of a screening for Class III aviators thus the condition went unnoticed until the flight surgeon observed a posture disparity at his annual physical. He demonstrated a large angle hypertropia with constant alternating suppression, therefore not diplopic. In the case of a well-experienced pilot, operating a dual-seated aircraft, a waiver was recommended, with the stipulation of SG3 as a safety precaution. With a pilot who is a novice in his aircraft-type, a single-seat jet, the assumption of risk is much greater, thus the member was not recommended to continue duties involving flight (DIF). For the air traffic controller, stereopsis is not required and the member was recommended for a waiver. **DISCUSSION:** These cases highlight the importance of a thorough ocular assessment and understanding of oculomotor deviations as they impact DIF. The concern of a decompensated phoria resulting in diplopia or suppression due to a long standing tropia is a critical finding when considering safety to conduct flight related operations but should be evaluated within the context of the member's experience and role in the aviation community.

Learning Objectives

1. The audience will learn about the importance of a thorough ocular assessment and understanding of oculomotor deviations as they impact duties involving flight.
2. The audience will learn about waiver considerations for CN IV palsies the context of an individual's experience and role in the aviation community.

[283] CONGENITAL SIMPLE HAMARTOMA OF THE RETINAL PIGMENT EPITHELIUM (CSHRPE) IN AN ARMY HELICOPTER PILOT CANDIDATE

Toan Trinh
U.S. Army Aeromedical Research Laboratory, Fort Novosel, AL, United States

(Education - Case Study)

INTRODUCTION: This case report describes a United States Army helicopter pilot candidate vision waiver for congenital simple hamartoma of the retinal pigment epithelium (CSHRPE). **BACKGROUND:** An Army helicopter pilot candidate must complete a flight physical, including a comprehensive ophthalmic exam before training begins. The candidate must have uncorrected distance vision no worse than 20/50 in either eye with normal color vision, cannot miss more than 2 plates on the Pseudoisochromatic Plate (PIP). Intraocular pressures no greater than 21mmHg and no less than 8mmHg. Stereopsis must be no worse than 40 seconds of arc. Also, no adnexal, anterior, or posterior segment pathologies on dilated fundus exam. The Exceptions to Policy may be granted on a case-by-case basis based upon potential prognosis of the condition. **CASE PRESENTATION:** A 24-year-old female, active-duty Army helicopter pilot candidate, presented for her flight physical prior to entrance into flight school. During her fundus exam of the right eye, a 1/6-disc diameter, sharply demarcated, dark circular lesion inferior to fovea; no macular edema, exudates, traction, or sub-retinal fluid were observed. Optical coherence tomography demonstrated an intense surface hyperreflectivity with complete shadowing of optical transmission through the choriocapillaris. Visual fields showed slight depression corresponding to the location of the retinal lesion without remarkable scotoma. The differential diagnosis includes choroidal nevi, hyperplasia, or adenocarcinoma of the retinal pigment epithelium (RPE), or CSHRPE. A retinal specialist was consulted, and the candidate was presumed to have a CSHRPE. Given the location of the CSHRPE, the patient was 20/20 OD, normal color vision and no visual significant scotoma. **DISCUSSION:** CSHRPE is a rare finding with low prevalence and usual found within the macular region. The lesion might have formed due to migration of RPE cells to the retinal surface during embryogenesis. With good vision and no visual deficits, the cones are most likely present in this lesion secondary to the unpacking effect of photoreceptors during development. The pilot candidate's ocular structures and functions are expected to remain stable, and no specific treatment is required, an Exception to Policy was granted to allow for entrance into flight school. The waiver requires an annual, comprehensive retinal examination to rule out vascular changes.

Learning Objectives

1. Inform about a rare case of Congenital Simple Hamartoma of the Retinal Pigment Epithelium (CSHRPE).
2. Discuss the vision exceptions to policy process for Army aviation.

[284] TRANSIENT LIGHT SENSITIVITY SYNDROME IN A NAVAL FLIGHT OFFICER

Micah Kinney
Naval Air Warfare Center Aircraft Division, Patuxent River, MD, United States

(Education - Case Study)

INTRODUCTION: Corneal refractive surgery (CRS) provides the opportunity for individuals to meet aviation vision standards who would otherwise be disqualified due to excessive refractive error. Generally, an individual who exceeds the refractive error requirements to be a naval pilot may be offered naval flight officer (NFO) positions which have more generous refractive error limits. Once designated, NFOs will seek CRS to reduce dependence on glasses or contacts while flying. This case presents a rare but operationally significant temporary complication in an NFO following laser in situ keratomileusis (LASIK). **BACKGROUND:** Transient light-sensitivity syndrome (TLSS) is an unusual and unpredictable complication following corneal refractive surgery. It is characterized by moderate-to-severe light sensitivity (photophobia) which becomes symptomatic two to eight weeks post-surgery. Typically TLSS is associated with inflammation of ocular structures without clinical signs of inflammation upon examination with a slit-lamp. **CASE PRESENTATION:** A 36 year old Caucasian male NFO underwent successful LASIK in each eye at a military surgical center. His 1 day and 1 week post-operative exams were unremarkable with no symptoms of photophobia and uncorrected distance visual acuity of 20/20 in each eye. At his three week post-operative visit, symptoms of mild photophobia were reported without any clinical signs of inflammation and no reduction in visual acuity. Five weeks post-surgery, the patient called the clinic reporting debilitating photophobia without any changes in visual acuity. Upon examination the patient was visibly disturbed by light and wearing sunglasses indoors. No ocular inflammation was observed and the patient restarted corticosteroid ophthalmic drops. After a series of follow up visits and slow taper of corticosteroid ophthalmic drops, the symptoms of photophobia subsided and the patient reported positive outcomes with ocular comfort and vision. An aeromedical summary was issued for return to flight duties at his 6 month post-operative visit. **DISCUSSION:** While CRS has revolutionized aircrew selection and the reduction in reliance on eyeglasses or contacts while flying, there are unique aeromedical concerns that may impact the return to flight operations. Careful ophthalmic examination and patient follow up is necessary during the post-operative period.

Learning Objectives

1. The participant will learn about corneal refractive surgery among U.S. military aircrew.
2. The participant will learn about ocular complications following corneal refractive surgery and their aeromedical concerns.

[285] FAA MEDICAL FLIGHT TEST USE FOR ABNORMAL VISUAL FUNCTION

Harriet Lester[1], Leo Hattrup[2]
[1]*FAA, Jamaica, NY, United States;* [2]*FAA, Washington, DC, United States*

(Education - Case Study)

INTRODUCTION: The special medical flight test (MFT) is used to help determine if a pilot is safe to fly with a functional impairment. Three cases utilizing a MFT for abnormal visual function will be presented. **BACKGROUND:** Flight Standards Order 8900.1, Vol5, Ch8, Sec1 provides guidelines for the administration of a MFT and is updated as necessary. Outcomes include a Special issuance (SI), Statement of Demonstrated Ability (SODA), Letter of Evidence (LOE), or denial by the Office of Aerospace Medicine. A pilot with defective color vision who is unable to pass an FAA approved color vision test has his/her medical certificate limited with "NOT VALID FOR NIGHT FLYING OR BY COLOR SIGNAL CONTROL." To remove the limitation, additional operational color perception tests are necessary and are determined by the class of Medical Certificate requested. If successful, an LOE is granted. Pilots with defective vision in one eye, such as from amblyopia, are also evaluated by an MFT and granted a SI or SODA if successful. Since May 2023, airmen must hold at least second class medical to exercise the privileges of a commercial pilot certificate in a balloon for non-instructional flight. This has expanded the use of MFT to include balloon pilots.

CASE PRESENTATION: Case 1: A 24-year-old pilot with 52 hours and abnormal color vision sought an upgrade from a Class 3 to Class 1 medical certificate and removal of his color vision limitation. He successfully completed an Operational Color Vision Test (OCVT) as well as MFT and was issued an LOE. Case 2: A 54-year-old pilot with 576 hours and right eye amblyopia with best corrected acuity 20/100, sought Class 2 medical certificate. He passed an MFT in a balloon and was issued an SI limited to balloon operations. Case 3: A 27-year-old pilot with 354 hours and right eye amblyopia with best corrected acuity 20/60, passed an MFT and was issued SODA May 2020 for Class 3 and subsequently upgraded to an SI for Class 1. **DISCUSSION:** The MFT process involves coordination between different offices of the FAA Aviation Safety Line of Business. The MFT enables practical functional testing when medical evaluation alone is insufficient. MFTs can be accomplished in airplanes, simulators, helicopters, and balloons, as appropriate. The MFT is performed by FAA Flight

Standards Aviation Inspectors (ASI) or specially authorized Designated Pilot Examiners (DPEs). MFTs are used for multiple conditions including abnormal vision.

Learning Objectives

1. The participant will be able to identify the source document for Special Medical Flight Tests: Flight Standards Order 8900.1, Vol5, Ch8, Sec1.
2. The participant will be able to identify 2 vision abnormalities for which Medical Flight Tests can be performed.
3. The participant will identify 3 medical certification outcomes that can result after a Medical Flight Test.

Wednesday, 05/08/2024 ***8:30 AM***
Grand Hall J

[S-51]: SLIDES: AVIATION MEDICINE- POTPOURI

Chair: Warren Silberman
Co-Chair: Roy Allen Hoffman

[286] ANALYZING TOP GUN & TOP GUN 2: CINEMATIC INSIGHTS INTO AVIATION MEDICINE FOR EDUCATIONAL ENRICHMENT

Paul Dhillon[1], Eric Juneau[2]
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(Education - Tutorial/Review)

Aviation Medicine Pearls Unveiled: Teaching Through Film Analysis in Top Gun and Top Gun: Maverick

Aviation medicine, an intricate field vital for pilot health and safety, can be uniquely conveyed and comprehended through the lens of popular aviation films. This abstract highlights key aviation medicine pearls extracted from the iconic film "Top Gun" and its sequel, "Top Gun: Maverick," exemplifying the educational potential of aviation film analysis.

In "Top Gun," the character of Pete "Maverick" Mitchell, portrayed by Tom Cruise, embodies various aspects of aviation medicine. His enigmatic personality and risk-taking behavior provide a foundation for discussing psychological evaluations and stress management in aviation personnel. Moreover, the film's depiction of aerial combat situations allows for exploration of G-forces, spatial disorientation, and their impact on pilot physiology.

The sequel, "Top Gun: Maverick," delves further into the realm of aviation medicine. With advancements in technology and increased realism, the film provides a platform to discuss modern aerospace medicine. Topics such as cockpit ergonomics, advanced avionics, and their influence on pilot performance are readily evident. Furthermore, the film delves into the challenges of aging pilots, shedding light on medical assessments and fitness standards for senior aviators.

Engaging the audience through aviation film analysis not only fosters an appreciation for aviation medicine but also encourages critical thinking. Viewers are encouraged to question the accuracy of medical portrayals in the movies and explore the real-world implications of the depicted scenarios.

Incorporating these cinematic pearls into aviation medicine education can be achieved through interactive discussions, case studies, and simulation exercises. By dissecting the medical aspects of "Top Gun" and "Top Gun: Maverick," educators can stimulate curiosity, enhance knowledge retention, and instill a deep appreciation for the intricacies of aviation medicine.

In conclusion, the exploration of aviation medicine pearls within the context of "Top Gun" and its sequel, "Top Gun: Maverick," demonstrates the potential for effective teaching through aviation film analysis. These films offer a captivating gateway to understanding the multifaceted field of aviation medicine while engaging and educating future aviation medicine professionals in an accessible and enjoyable manner.

Learning Objectives

1. Analyze aviation medicine concepts in "Top Gun" and its sequel.
2. To promote critical thinking through film-based aviation medicine discussions centered around a singular aviation medicine franchise.

[287] TBI MECHANISMS OF INJURY IN U.S. AIR FORCE PILOTS

Allan Ward, Joseph Connolly, Aven Ford, Joseph Wagner
USAFSAM, Wright-Patterson AFB, OH, United States

(Original Research)

INTRODUCTION: Traumatic brain injury (TBI) is a leading cause of disability worldwide and a disqualifying condition for U.S. Air Force (USAF) personnel on flying status. A query of the Aeromedical Information Management Waiver Tracking System (AIMWTS) database revealed over 3000 USAF Airmen with aeromedical waiver submissions between 2001 and 2023. We sought to better understand demographics such as age at TBI and most common mechanisms of injury (MOI) within a pilot subset of this population. **METHODS:** The aeromedical waiver summaries of 764 USAF pilot and pilot candidates with history of TBI were mined using the AIMWTS database. Age at TBI, TBI severity, MOI, loss of consciousness (LOC) incidence, and CT/MRI imaging results were collected. MOI was categorized as one of the following: combat/blast injury, fall, vehicular/crash, violence, struck by/against, sports related, or other. The study protocol was approved by the 711 HPW IRB. **RESULTS:** Of the 764 flyers studied, 708 (92.7%) were male and 56 (7.3%) were female. Mean age at TBI occurrence was 22.3 years (range: 0.68-56.8 years). 76.7% of TBI events occurred among ranks O-3 and below (including civilian status). Applying severity criteria defined by the USAF Aerospace Medicine Waiver Guide, 67.3% of the TBIs were categorized as aeromedically mild, 18.5% were moderate, and 12.7% severe. Regarding MOI, most TBIs in this population were sports related (34.7%), followed by falls (30.5%) and vehicular/crashes (19.4%). 65.3% of TBIs had associated or suspected loss of consciousness (LOC), and 66.6% had undergone head CT scans, most (74.0%) of which were read as normal. 91.0% of flyers with mild TBI had a normal CT scan (no intracranial injury). 19.5% of flyers with moderate TBIs had some abnormality on CT scan, although typically for reasons other than intracranial injury (e.g., non-displaced skull fracture), while most severe TBIs (87.0%) were associated with some degree of intracranial injury. **DISCUSSION:** Among USAF pilots and pilot candidates, the majority of TBIs for which aeromedical waiver was sought occurred prior to military service and in lower ranks. Most TBIs were mild and sports-related and/or due to falls, although nearly 20% were associated with vehicular mishaps. The majority who underwent evaluation with head CT scan showed no intracranial injury, whereas most moderate and severe TBIs had some imaging evidence of brain contusion (e.g., hemosiderin deposition or diffuse axonal injury).

Learning Objectives

1. The audience will be able to identify the most common TBI mechanisms of injury among USAF pilots with history of TBI.
2. The audience will learn the average age and age range for TBI events in the USAF pilot population.
3. The audience will review the current USAF aeromedical waiver standards for determining degree of head injury and requirements for aeromedical waiver consideration.

[288] DECODING THE DIAGNOSTIC ENIGMA: SUBACUTE THYROIDITIS MASQUERADING AS NEUROLOGICAL SYMPTOMS IN AN AIRLINE PILOT.

Ganesh Anbalagan
CASA, Australia, Canberra, Australia

(Education - Case Study)

INTRODUCTION: This case report illuminates the intricate complexities inherent in the diagnosis, management, and aeromedical disposition of a pilot who experienced a perplexing transient neurological

episode during pre-flight preparations. **Case Description:** The pilot's initial presentation featured a sudden-onset blurred vision, sensory deficits, and an unusual cold sensation in the left arm, leg, and neck. Initial assessments effectively ruled out stroke, transient ischemic attack (TIA), and focal seizures. Subsequent evaluations conducted by multiple specialists ensued. The first neurologist proposed anxiety as a potential cause, likely triggered by excessive caffeine intake and subsequent hyperventilation. A subsequent evaluation by a second neurologist and neuro-otologist posited a sensory migraine aura (without headache) as the primary diagnosis, despite the lack of corroborative evidence and the unconventional nature of the symptoms. While considering hyperventilation, it was regarded as less likely due to its association with symmetrical paraesthesia. **DISCUSSION**: The extensive investigation failed to pinpoint a definitive root cause for the pilot's perplexing symptoms. During this investigative phase, an endocrinologist's assessment was initiated due to an abnormal thyroid function test. Subsequently, the pilot received a diagnosis of subacute thyroiditis, supported by an elevated thyroid-stimulating hormone (TSH) and positive anti-thyroid antibodies. Subsequent thyroid function tests exhibited gradual improvement, further confirming the diagnosis. This case highlights the intricacies of diagnosing and managing unusual medical presentations in aircrew members, underscoring the importance of interdisciplinary collaboration and thorough investigation in ensuring flight safety. The most probable cause, as established by the endocrinologist, appeared to be subacute thyroiditis, known for its idiosyncratic manifestations, including neurological symptoms. The diagnosis was further supported by the clinical course of thyroid function tests and the absence of other neurological pathologies. The pilot's case underwent review by the aviation medicine complex case management panel, which resulted in the issuance of a conditional certificate enabling him to fly in a multicrew environment under surveillance.

Learning Objectives

1. The audience will be able to understand the complexities and intricacies inherent in aeromedical fitness assessment of unusual medical conditions, such as the case presented.
2. The audience will gain insights into the clinical presentation, diagnostic criteria, and management of subacute thyroiditis, a condition known for its atypical manifestations.

[289] TACTICAL USAGE OF NICOTINE FOR COGNITIVE PERFORMANCE IN LONG DURATION MISSIONS

Joseph Tierney
University of Massachusetts - Amherst, Amherst, MA, United States

(Education - Tutorial/Review)

INTRODUCTION: Nicotine use is popular in the Air Force, specifically among aviators to improve their cognitive performance. It's important to understand nicotine delivery methods and its evolution from centuries ago, the effects on the body, and the way that aviators could utilize it in critical phases of flight. **TOPIC**: The usage of nicotine has been around for centuries and until recently was primarily derived from tobacco. Historically, nicotine in the forms of tobacco from cigarettes, dip, and pipes, was seen as a drug with more negative effects than positive, leading to its cultural phase-out. This is true regarding the ingestion of carcinogens and other harmful chemicals that led to mouth, cardiovascular, and respiratory diseases from the tobacco plant. Rarely discussed is the use of nicotine itself to improve cognitive function, specifically working memory and attention. The use of modern nicotine delivery devices like gum, patches, and pouches, allow for a slow release of nicotine into the body and prolonged effects compared to smoking. This comes without tobacco and carcinogenic exposure, as well as deliberate controlled amounts from the delivery system. There are several physiological reactions when administered nicotine such as increased heart rate, increased blood pressure, and dopamine release. Nicotine can improve reaction time, working memory, and attention which directly increases cognitive performance. With advancements in delivery methods, aviators can regulate amount and time of nicotine administration at critical phases of flight. **APPLICATION**: The use of nicotine for critical phases of flight could substitute the use of modafinil and other "GO-Pills" that have prolonged effects and can result in much more severe problems. In flight, aviators can use nicotine devices to counter the effects of withdrawal if having previous dependency, but this could expand to non-traditional users to improve their cognitive function. Additionally, nicotine is a stimulant that increases heart rate and blood pressure, a positive effect for increasing +Gz tolerance. With a slow delivery method of nicotine, the effects can be felt for a specified period with a short half life that would not interfere with an aviators sleep after.

Learning Objectives

1. The participant can recall basic facts of the history of nicotine delivery systems.
2. The participant will understand the effects on nicotine on the human body.
3. The participant can recall the advantages of nicotine for aviators in mission critical situations.

[290] UTILIZING MACHINE LEARNING FOR PREDICTIVE DIAGNOSIS OF METABOLIC SYNDROME IN COLOMBIAN MILITARY AIRMEN

Diego L Malpica H[1], Marian Farfan[2]
[1]*Colombian Aerospace Force, Bogota, Colombia;* [2]*National University of Colombia, Bogota, Colombia*

(Original Research)

INTRODUCTION: Metabolic syndrome (MetS) is a cluster of cardiometabolic abnormalities that predispose individuals to type 2 diabetes and cardiovascular disease. This is particularly relevant to airmen, who may be exposed to occupational stressors that increase their risk of developing MetS. This study aimed to determine the prevalence of MetS among Colombian military airmen from the Aerospace Force and evaluate the utility of the Atherogenic Index of Plasma (AIP) as a diagnostic tool for MetS. **METHODS:** A retrospective cross-sectional review was conducted using clinical records and laboratory measurements from annual aeromedical examinations of 1365 military airmen from 2022 to 2023. MetS was defined according to established criteria, and various hematological and metabolic parameters were compared between individuals with and without MetS. Logistic regression and machine learning techniques were employed to identify the most influential predictors for MetS diagnosis. **RESULTS:** The prevalence of MetS was 10.6%, with significant differences observed in several key indicators between individuals with and without MetS. The AIP demonstrated high utility in identifying subjects with MetS, boasting an area under the curve of 0.92, a sensitivity of 88.4%, and a specificity of 84.4%. The optimized Random Forest model achieved an overall accuracy of 95% and an F1-score of 97% for class '0' and 63% for class '1'. **DISCUSSION:** The study revealed a considerable prevalence of MetS among Colombian military airmen, highlighting the need for risk factor management and preventive measures. The AIP emerged as a valuable diagnostic tool for MetS, with potential applications in aerospace medicine and extreme physiology research. Future studies could explore the impact of interventions targeting MetS risk factors on the health and performance of airmen.

Learning Objectives

1. Understand the prevalence of metabolic syndrome among Colombian military airmen and its implications for their health and performance.
2. Recognize the utility of the Atherogenic Index of Plasma as a diagnostic tool for metabolic syndrome in the context of aeromedical certification and its implications for risk management in public health.

[291] SEVERITY OF HYPOXIA EFFECTS IN RAPID VS. GRADUAL DECOMPRESSION

Jeremy Beer[1], Andrew Mojica[1], Kara Blacker[2], Todd Dart[1], Bria Morse[1], Paul Sherman[3]
[1]*KBR Science & Space, San Antonio, TX, United States;* [2]*Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States;* [3]*U.S. Air Force 59th Medical Wing, Joint Base San Antonio-Lackland, San Antonio, TX, United States*

(Original Research)

INTRODUCTION: Legacy studies have reported that rapid decompression (RD) causes greater cognitive disruption than gradual ascent, but these findings were based on limited samples. Here, a hypobaric chamber study was conducted to identify potential differences in the cognitive and physiological effects imposed by RD vs. gradual decompression, and to determine whether hypobaria would impede performance in the absence of hypoxia. **METHODS**: Twelve altitude-qualified participants (11 male, one female) completed RD and Gradual Ascents from 2743m (9000ft) to 7620m (25000ft) altitude pressures while breathing Air (Hypoxia condition) or 100% O_2 (No Hypoxia condition). Throughout these exposures, cognition was evaluated using the SYNWIN synthetic workstation which combines memory, arithmetic, visual monitoring, and auditory tasks. Physiological indices included S_PO_2, heart rate (HR), respiration metrics, end tidal O_2 and CO_2 partial pressures ($P_{et}O_2$, $P_{et}CO_2$), and EEG. A repeated-measures design was employed, incorporating Epoch (Ground-Level, Pre-Breathe, Ascent, Recovery), Ascent Rate (RD, Gradual) and Breathing Gas (Air, 100% O_2). **RESULTS**: Altitude effects in hypoxic "Air" exposures included significantly elevated HR and Minute Ventilation ($\dot{V}_E$) combined with decreased S_PO_2, $P_{et}O_2$, and $P_{et}CO_2$ (all $p \leq 0.001$); S_PO_2 and HR effects were greater after RD ($p<0.01$). HR and $\dot{V}_E$ remained altered relative to Ground-Level baseline during Recovery from hypoxia ($p<0.01$). SYNWIN performance declined during Ascent on Air ($p<0.001$), with key metrics falling further after RD ($p<0.05$). Broad cognitive impairment was not recorded on 100% O_2, and no lingering impairment was recorded in Recovery. EEG signals showed increased slow-wave activity during hypoxia. **DISCUSSION**: In Air conditions, RD impaired performance more than Gradual Ascent. Notably, cognitive impairment was not observed to linger into Recovery from these brief acute hypoxia exposures. Hypobaria did not impair performance comprehensively in the absence of hypoxia. HR and $\dot{V}_E$ metrics suggested compensatory slowing following altitude stress. Participants appeared to adjust their cognitive strategy during hypoxia, redistributing effort to preserve performance of less demanding tasks at the expense of efficiency and computational throughput.

Learning Objectives

1. The audience will understand the conduct and results of a hypobaric chamber study comparing the effects of rapid vs. gradual decompression—with and without hypoxia—on physiologic metrics and performance in a synthetic workstation.
2. The audience will understand the complexities of testing whether and for how long physiologic effects and cognitive impairment linger after altitude exposure.

Wednesday, 05/08/2024 ***8:30 AM***
Grand Hall K

[S-52]: PANEL: RESIDENT IN AEROSPACE MEDICINE (RAM) GRAND ROUNDS IV

Chair: Sonya Heidt
Co-Chair: Jonathan Elliot

PANEL OVERVIEW: *Resident in Aerospace Medicine (RAM) Grand Rounds consists of 6 clinical case presentations. Each case is presented by current RAMs who will review the clinical case, diagnosis, treatment pathway and current policies from different agencies. The aviator's aeromedical disposition and waiver or special issuance outcome (if applicable) will be discussed. These unique case presentations describe clinical aviation medicine as well as policy updates for common medical and/or mental health conditions encountered in the practice of Aerospace Medicine.*

[292] DECOMPRESSION SICKNESS IN A FLIGHT SURGEON COURSE STUDENT

Cosme Belmonte
U.S. Army Medical Center of Excellence, Fort Novosel, AL, United States

(Education - Case Study)

INTRODUCTION: This case report describes a military flight surgeon course student who was diagnosed with type 2 decompression sickness following exposure to rapid decompression from ground level to 25,000 ft in a hypobaric chamber. **BACKGROUND**: Decompression sickness (DCS) occurs when dissolved gasses exit solution and form bubbles during depressurization. It can occur during diving activities while flying in unpressurized aircraft, or exposure to a hypobaric chamber. Type 1 DCS involves the skin, musculoskeletal, or lymphatic system. Type 2 DCS involves the central nervous system. The incidence of Decompression sickness itself is rare and depends on the length and depth of exposure. Tissue damage occurs from the effects of bubbles which may be direct endothelial damage and activation of inflammatory mediators. Joint pain accounts for most cases. Neurological manifestations are present in 10 to 15% of cases, and most commonly present as headaches or visual disturbances. Pulmonary DCS is uncommon in aviators due to oxygen pre-breathing protocols. **CASE PRESENTATION:** The patient was attending the Army's Flight Surgeon Course and underwent type 4 hypobaric altitude chamber protocol and subsequently developed symptoms the following day that included bilateral wrist pain and anterior elbow paresthesia. After consultation with the Naval Dive Medical Officer in Pensacola Florida, the patient was flown via MEDEVAC and treated with US Navy treatment table 6. He had complete resolution of symptoms. He underwent another round of hyperbaric oxygen treatment the next day with US Navy treatment table 5. **DISCUSSION:** Though DCS is rare, an untreated patient may develop long-term tissue damage. Often, providers must err on the side of caution in someone with symptoms that sound suspicious for DCS after exposure to depth or altitude. In this case, the presence of wrist pain developed the evening of the hypobaric altitude training, but the patient did not present to the Flight Surgeon until the following afternoon. He was appropriately treated and was placed on a downslip until evaluated by a Neurologist according to the Army aeromedical policy letters.

Learning Objectives

1. The audience will learn about the symptoms of Decompression Sickness and its related complications.
2. The audience will learn about the aeromedical implications and flight considerations of patients with Decompression Sickness.

[293] BLOCKING THE WAY TO SPACE: EVALUATION OF A PATIENT WITH RECURRENT SMALL BOWEL OBSTRUCTION FOR SPACEFLIGHT

Isaiah Reeves, Samantha King
UTMB, Galveston, TX, United States

(Education - Case Study)

INTRODUCTION: This case report describes a 40-60 year-old astronaut seeking a waiver after a small bowel obstruction status post-lysis of adhesions. The individual had a past medical history of appendicitis status post open appendectomy as a young child complicated by a small bowel obstruction (SBO) approximately 20 years later treated with laparotomy and adhesion release. They were previously granted a waiver for long duration spaceflight. They developed another SBO and underwent laparoscopic adhesiolysis without complication. After recovery,

they were evaluated for certification for long-duration spaceflight. **BACKGROUND**: SBOs are a common complication of intra-abdominal surgery due to the formation of adhesions. SBOs can be treated conservatively with oral intake restriction, rehydration, and symptom management but may be treated with surgical intervention. Recurrence of an SBO is common but less frequent with operative intervention. Screening for adhesions predisposing an individual to recurrence are not commonly performed. **Case Presentation:** After recovery, this individual underwent evaluation for long-duration spaceflight. Outside of prior abdominal surgeries they had no other complicating medical conditions. Due to the concern for recurrence of SBO, the individual underwent additional screening evaluation for adhesions via abdominal ultrasound evaluation which showed "visceral slide" and did not find evidence of bowel adhesions. The astronaut was presented to the Multilateral Space Medical Board and granted certification for long-duration spaceflight. **DISCUSSION**: This case presentation describes a common complication of intra-abdominal surgery, SBO, and one process for evaluation for qualification for spaceflight. Intra-abdominal surgery is a common operation that an individual may undergo for a variety of conditions, including childhood surgery for appendicitis. Any individual with a history of prior intra-abdominal surgery is at risk for a small bowel obstruction and prior SBO puts an individual at risk for recurrence. An SBO in spaceflight would put the individual at risk of uncontrollable nausea and vomiting, dehydration, and be potentially mission ending. Possible adhesions and SBOs can be diagnosed with ultrasound. Risk reduction and prediction of recurrence is important for safety of the individual and the mission.

Learning Objectives

1. The participant will understand the potential risks of a prior small bowel obstruction during medical evaluation for spaceflight.
2. The participant will understand one possible method of evaluation of a crewmember with a history of a small bowel obstruction for certification for spaceflight.

[294] This abstract was moved to S-28.

[141] I CAN SEE FINE DOC! A CASE OF ENDOTHELIAL CORNEAL DYSTROPHY IN UNMANNED AIRCREW

Greg Rogers
Naval Aerospace Medical Institute, Pensacola, FL, United States

WITHDRAWN

[295] ACUTE CRYPTOGENIC STROKE IN A PILOT STUDENT WITH PATENT FORAMEN OVALE: A CASE REPORT

Jeffrey Brown, Jesse Laverdiere
Department of Aviation Medicine, Fort Novosel, AL, United States

(Education - Case Study)

INTRODUCTION: This case report describes the acute presentation and management of a military flight school student that was found to have an acute cryptogenic stroke in the setting of a patent foramen ovale. **BACKGROUND:** Strokes are considered cryptogenic when no source can be identified. A patent foramen ovale (PFO) is detected in approximately half of patients following cryptogenic stroke. PFOs are present in about 20-25% of the adult population. An Atrial Septal Defect (ASD) is disqualifying for Army Aviation. ASD's are eligible for exception to policy or waiver with surgical correction and appropriate clearance by Cardiology. However, most people with PFOs are asymptomatic and for many patients this defect is identified following a stroke or TIA. **CASE PRESENTATION:** The military flight school student presented to the ER after his wife noticed right-sided facial droop and difficulty speaking. On arrival to the ER, he had an aphasia and a right-sided facial droop. His NIH Stroke score was 9. Non-contrast CT of his head as well as perfusion and angiogram CT studies of his head and neck were normal. The patient was treated for an ischemic stroke with tPA at 3 hours and 24 minutes from onset of symptoms. An MRI obtained post tPA revealed subacute infarct in the left frontal lobe. A subsequent echocardiogram revealed a PFO. Doppler studies were negative for a DVT in bilateral lower extremities. No episodes of atrial fibrillation or arrythmia were observed on EKG or telemetry. The patient was started on double anti-platelet therapy and referred to a PFO/Stroke clinic to determine if he would be a candidate for PFO closure. **DISCUSSION:** Flight school candidates are thoroughly screened prior to admission into flight school. However, there are many conditions that may be asymptomatic and clinically undetected. In this case, the flight student demonstrated no prior signs or symptoms suggestive of a PFO. This case demonstrates the humbling challenges a flight surgeon must accept when conducting medical screening, stressing the importance of managing known risks while appreciating the existence of unrecognized and unknown risks.

Learning Objectives

1. The audience will learn about cryptogenic strokes in the setting of a patent foramen ovale.
2. The audience will learn about the aeromedical implications of patients with atrial septal defects.

[296] FLY IN THE EYE

Shelby Dean
U.S. Army, Fort Novosel, AL, United States

(Education - Case Study)

INTRODUCTION: This case report describes a military pilot who was diagnosed with a delayed hypersensitivity reaction following an insect flying into his eye. **BACKGROUND**: Allergic reactions to insect venom are common, but most people think of bee, wasp, or ant stings, and they also tend to think of type 1 immediate hypersensitivity reactions that cause anaphylaxis. However, it is possible to have reactions to other types of insects, including sanguivorous insects. In fact, many people become sensitized to the saliva of these bugs. Some patients have an immediate wheal that is mediated by IgE, but others have delayed (12-24 hours) T-cell mediated reactions that result in a papule. **CASE PRESENTATION:** The 38-year-old patient noticed an insect flew into his left eye. He noted a brief immediate discomfort. Then, he later developed a white papule followed by erythema and throbbing. On exam, the patient had localized injection and fluorescein uptake on the papule surface. There was also a papillary response on the superior lateral palpebral conjunctiva and some mild serous discharge. No foreign material was noted in the eye. The patient was diagnosed with a delayed hypersensitivity reaction and prescribed a topical steroid. **DISCUSSION:** The saliva of blood-feeding arthropods contains proteins that are different from Hymenoptera venom, and there is not enough data to demonstrate cross-reactivity. Type 4 delayed hypersensitivity reactions are possible. Several sanguivorous insects live in southern Alabama, in addition to other insects, such as eye gnats, that frequently end up in eyes but do not feed on blood. If an aviator is experiencing significant eye pain or decreased visual acuity, they should be grounded.

Learning Objectives

1. The audience will learn about the symptoms of delayed hypersensitivity reactions and its related complications.
2. The audience will learn about the aeromedical implications and flight considerations of patients with ocular irritation.

Wednesday, 05/08/2024 ***8:30 AM***
Grand Hall GH

[S-53]: PANEL: BRINGING A RESEARCH PROJECT TO FRUITION: FROM CONCEPT TO JOURNAL PUBLICATION

Chair: Douglas Boyd
Co-Chair: Frederick Bonato

PANEL OVERVIEW: *INTRODUCTION In an academic setting, published research represents one of the benchmarks commonly used for peer recognition and career advancement. However, bringing a research project to fruition (i.e. a published manuscript) represents a complex multi-step process. While researchers schooled in this sphere receive training in this respect, this is less frequent for aerospace medicine professionals who have transitioned to a research path later in their career. TOPIC Herein, this Panel, sponsored by the Education and Training Committee, will discuss the multiple steps involved in taking a research project from a novel concept through to publication. APPLICATION Research starts with an idea/concept posed by the investigator. The first presentation will address how to determine if the idea is novel via a literature search and designing an appropriate experimental approach, data acquisition and analysis towards answering the question. In the second presentation, the issue of whether the research represents human subjects research and navigating the required approval process will be covered. In the third presentation, the past editor of the "Aerospace Medicine and Human Performance" journal will discuss statistical methods and statistical packages commonly used in aeromedical research projects. The following session, journal selection manuscript preparation, reference managers and the Editorial process for submitted papers will be discussed. In the final presentation, the manuscript review process will be addressed. Since, by far, the majority of manuscripts require at least one round of revision how best to respond to critiques towards getting a manuscript accepted will be addressed.*

[297] BRINGING A RESEARCH PROJECT TO FRUITION: FROM CONCEPT TO JOURNAL PUBLICATION

Douglas Boyd[1], Fred Bonato[2]
[1]*Embry-Riddle Aeronautical University, Daytona Beach, FL, United States;* [2]*St. Peter's University, Jersey City, NJ, United States*

(Education - Program/Process Review)

INTRODUCTION: In an academic setting, published research represents one of the benchmarks commonly used for peer recognition and career advancement. However, bringing a research project to fruition (i.e. a published manuscript) represents a complex multi-step process. While researchers schooled in this sphere receive training in this respect, this is less frequent for aerospace medicine professionals who have transitioned to a research path later in their career. **TOPIC:** Herein, this Panel, sponsored by the Education and Training Committee, will discuss the multiple steps involved in taking a research project from a novel concept through to publication. **APPLICATION:** Research starts with an idea/concept posed by the investigator. The first presentation will address how to determine if the idea is novel via a literature search and designing an appropriate experimental approach, data acquisition and analysis towards answering the question. In the second presentation, the issue of whether the research represents human subjects research and navigating the required approval process will be covered. In the third presentation, the past editor of the "Aerospace Medicine and Human Performance" journal will discuss statistical methods and statistical packages commonly used in aeromedical research projects. The following session, journal selection manuscript preparation, reference managers and the Editorial process for submitted papers will be discussed. In the final presentation, the manuscript review process will be addressed. Since, by far, the majority of manuscripts require at least one round of revision how best to respond to critiques towards getting a manuscript accepted will be addressed.

Learning Objectives

1. generating a novel research question which adds to the current body of scientific knowledge.
2. navigating the human subjects approval process, experimental design, data acquisition and its interpretation.
3. tips for writing a scientific manuscript to improve the chances of acceptance, responding to reviewer critiques.

[298] THE NUTS AND BOLTS OF A RESEARCH PROJECT FROM CONCEPT THROUGH TO DATA ANALYSIS

Douglas Boyd
Embry-Riddle Aeronautical University, Daytona Beach, FL, United States

(Education - Program/Process Review)

INTRODUCTION: In an academic setting, published research represents one of the benchmarks commonly used for peer recognition and career advancement. However, bringing a research project to fruition (i.e. a published manuscript) represents a complex multi-step process. While researchers schooled in this sphere receive training in this respect, this is less frequent for aerospace medicine professionals who have transitioned to a research path later in their career. **TOPIC:** Herein, the author will discuss the steps involved in a research project from the germinating seed of an idea to data acquisition. **APPLICATION:** Research starts with an idea/concept posed by the investigator. One of the first steps is to determine whether this question has been addressed previously-this is important as priority in research is accorded more to novelty than a confirmation of older findings. Towards answering this question, various literature search platforms (e.g. PubMed, Google Scholar) will be discussed and how to bypass the fee required by some journals for non-subscribers. Consequently, selection of research methods which most directly answer the question posed will be addressed as well as data collection and analysis. Will research funding be required? Does the research lend itself to multiple experiment approaches to corroborate each other? What factors affect the population size needed? Importantly, is the allotted experimental time frame (including approvals for human subjects' research, acquisition of research funds) within that achievable by the investigator? This presentation will segue to the next two where human subject research approval and manuscript preparation are addressed.

Learning Objectives

1. coming up with a novel research question which advances scientific knowledge,
2. literature searches: has similar work been done previously or does yours differ in a specific way?
3. what experimental design/methods are appropriate for the research question posed?

[299] NAVIGATING INSTITUTIONAL REVIEW BOARDS AND SURVIVING THE JOURNEY

Michael Wiggins
Embry-Riddle Aeronautical University, Daytona Beach, FL, United States

(Education - Program/Process Review)

INTRODUCTION: Research involving human subjects is required by law to be reviewed and approved by an institutional review board (IRB). Understanding the requirements and insuring your application contains the necessary information are the keys to success. **TOPIC:** Any research involving human subjects is required by law to be reviewed and approved by a qualified IRB to ensure that the rights and welfare of participants who volunteer in research activities. Institutional review boards are federally mandated by the Department of Health and Human Services to regulate this protection by the respective institution. The processes and requirements are clearly defined and are published by the institution. Key components of the regulations found in Title 45 of the Code of Federal Regulations (CFR) Part 46. These key components are based on the "Common Rule" and 45 CFR Part 46. These components set the basis for the review process. Each institution will have unique process flow based on these components. Understanding both the regulatory requirements and the specific process flow established by individual institutions will help ensure an applicant is successful and help research get approved in a timely manner. **APPLICATION:** Researchers who conduct research involving human subjects will need to follow their institution's process for gaining approval prior to conducting the research

and to ensure the research is conducted in a manner that protects the rights, dignity, and safety of participants. **RESOURCES:** Office of Human Research Protections, U.S. Department of Health and Human Services, https://www.hhs.gov/ohrp/regulations-and-policy/regulations/45-cfr-46/index.html

Learning Objectives

1. New researchers will learn about the role of institutional review boards in research involving human subjects.
2. New researchers will learn about the processes needed to successfully gain institutional review board approvals when planning and conducting research involving human subjects.

[300] STATISTICS FOR AEROSPACE MEDICINE

Frederick Bonato
St. Peter's University, Jersey City, NJ, United States

(Education - Tutorial/Review)

INTRODUCTION: Scientific rigor in most research endeavors demands rigorous statistical analysis of the collected data before drawing any conclusions regarding changes in an endpoint. However, in aerospace medical training, the emphasis on statistical comprehension can sometimes fall short. TOPIC: In this presentation, we aim to provide a comprehensive overview of the different categories of data that are frequently generated in aerospace medicine research. We will delve into suitable statistical tests and delve into the nuances of interpreting their results. To enhance understanding, we'll draw upon examples from published studies to illustrate key points. **APPLICATION:** Any research project typically amasses datasets, which necessitate statistical scrutiny to decipher whether an observed alteration is genuinely significant or merely an outlier. The choice of a statistical test is contingent on the research question at hand, and whether the data adheres to a parametric (normal distribution) or non-parametric structure. The ensuing discussions will revolve around common research scenarios:
1) Do differences exist in the mean/median values of a specific parameter across two or multiple groups? Such variations can be assessed using statistical tools like the Student's T-test or ANOVA for parametric data, and Mann-Whitney U tests for non-parametric datasets. 2) Is there a pronounced representation of a specific trait or parameter in a population? Proportion analyses, such as the Chi-Square test or logistic regression (when dealing with multiple variables), are apt for such inquiries. Further, we'll elucidate on the interpretation of statistical outputs, emphasizing the determination of association strength, confidence intervals, and significance thresholds. To conclude, we will highlight the appropriateness of several statistical software options for aerospace medicine professionals, emphasizing user-friendliness and accessibility for those not well-versed in statistics.

Learning Objectives

1. Participants will understand the correlation between the type of data and the selection of statistical tests, distinguishing between parametric and non-parametric data.
2. Insights will be provided on how to interpret statistical results from tests frequently employed in aerospace medicine.
3. The session will introduce attendees to select statistical software, highlighting user-friendliness for those without a statistical background.

[301] DRAFTING AND SUBMITTING A MANUSCRIPT TO AN ACADEMIC JOURNAL

Frederick Bonato
St. Peter's University, Jersey City, NJ, United States

(Education - Tutorial/Review)

INTRODUCTION: Publishing in a scientific journal, such as Aerospace Medicine and Human Performance, not only propels one's professional trajectory but also contributes valuable insights to the broader community within the specific field or specialty. The decision to select an appropriate journal is multifaceted, encompassing factors like the journal's indexing, its impact factor, the relevance of the content ('fit'), the availability of Open Access, and the expected review duration. **TOPIC:** Navigating the world of scientific publication begins with discerning the most fitting journal tailored to your research content. Once this is established, it's crucial to invest time and effort into crafting and structuring a well-prepared manuscript. It's equally paramount to ensure that the necessary ethical clearances, such as those from the Institutional Review Board or Institutional Animal Care and Use Committee, are in place. As you move forward, a grasp of the editorial process, from the peer-review phase to understanding review turnaround durations, becomes essential. Throughout this journey, establishing and maintaining constructive communication with the editorial board and journal management can play a significant role in streamlining the publication process. **APPLICATIONS:** The meticulous approach to manuscript submission, from the preparatory stage to eventual submission, is vital. Ensuring the appropriate selection of a journal and then adhering to outlined steps in manuscript preparation, submission, and revision can substantially increase the chances of manuscript acceptance and eventual publication. These tenets are generally relevant across various scientific journals.

Learning Objectives

1. Atendees will be provided a systematic approach to writing and submitting a manuscript for publication.
2. The audience will be given a "behind-the-scenes" look at the editorial review process.

[302] A BEHIND THE SCENES LOOK AT THE MANUSCRIPT REVIEW PROCESS-HOW BEST TO HANDLE REVISIONS (AND REJECTIONS)

Douglas Boyd
Embry-Riddle Aeronautical University, Daytona Beach, FL, United States

(Education - Program/Process Review)

INTRODUCTION: In academia, peer-reviewed published papers represent one of the benchmarks used for peer recognition/career advancement. After submission, a research manuscript is subjected to at least one round of reviews by subject matter experts/reviewers/referees and rarely accepted "as is." **TOPIC:** In this presentation, the author, (a reviewer for over 30 journals in as many years), will discuss the various elements that reviewers scan for and how best to deal with referee critiques. **APPLICATION:** A manuscript Introduction should be concise, state the gap in knowledge and the research question posed. Too often, Introductions read like a graduate thesis and/or contain irrelevant material (red herrings). In the Results, how consistent are the data with each other? For example, if data from 200 and 230 subjects were presented in two separate tables/graphs, the discrepancy warrants explanation. In the **DISCUSSION**, were the conclusions drawn by the author(s) supported by the data? Did this section represent a regurgitation of the Results - suggesting a poorly read author out of touch with the literature? Also in the **DISCUSSION**, did the author address how the new research fits in with the bigger picture and importantly other work? Were the limitations of the research clearly stated? Commonly, authors are invited to revise/resubmit a manuscript after addressing a reviewer's concerns. Shortcomings highlighted by the referee should be addressed via new data acquisition/analysis/experiments. Finally, responding to the reviewer in a non-confrontational manner will improve one's chances of final acceptance.

Learning Objectives

1. pertinent elements to include in a manuscript Introduction, how to present the Results section in a logical manner,
2. importance of highlighting the "take home" message in the discussion, discussing the findings in context of the bigger picture and practical applications.
3. strategies for revising and resubmitting a manuscript.

Wednesday, 05/08/2024 ***8:30 AM***
Grand Hall I

[S-54]: PANEL: ADVANCES IN AEROSPACE MEDICINE IN IBEROAMERICA

Chair: Pilar Garzon

PANEL OVERVIEW: *For this panel, the aids are presented in English and the speakers' interventions are made in Spanish. Aerospace medicine in Latin America has gradually gained space in areas of research, generation of regulations, and support for air operations. At this meeting, the work of professionals from different countries associated with aspects of education, research and clinical cases will be presented.*

[303] ALTERNATIVE PHARMACOLOGIC MANAGEMENT OF HEART FAILURE SECONDARY TO COVID-19 IN COMMERCIAL AVIATION PILOTS

Jean Duenes
Country Medical Center Cardiocountry, Orlando, FL, United States

(Original Research)

INTRODUCTION: During the Covid-19 pandemic, research revealed that heart failure and acute myocarditis were post-covid -19 complications of concern. Previous studies showed elevations in D-dimer, ferritin, and C-reactive protein, which normalized within two (2) months after medical discharge. Post-Covid-19 heart failure became evident, as reports of hospitalized patients with elevated troponin levels of unknown causes emerged. In this study, most pilots had ongoing symptoms and signs associated with Heart Failure, leading to the initiation of Pharmacological Resynchronization Therapy, already an established treatment for patients with CHF and Ejection Fractions less than or equal to 35%. **MATERIALS AND METHODS:** This retrospective study reviewed the case findings of twenty-three (23) pilot [eighteen (18) men, five (5) women] presenting with dyspnea, tachycardia, cough, moderate to severe systolic dysfunction. All were unsuccessfully treated using standard measures for heart failure, so it was decided to institute a pharmacological alternative with Sacubitril-Valsartan. **DISCUSSION AND ANALYSIS:** The 23 pilots received the standard of care for management of CHF, however, most subjects presented alterations in functional class and tachycardia. Alternative pharmacological resynchronization treatment with Sacubitril-Valsartan improved symptoms and LVEF in less than 6 months in more than 60% of the patients. This is of great importance to our pilot populations because angiotensin receptor antagonists are permissible per the current standards for continued use after reinstatement to work under a management.

Learning Objectives

1. Know the number of commercial pilots who suffered from Covid-19 and were diagnosed with heart failure refractory to treatment.
2. Determine the percentage of the population that started this resynchronization therapy.
3. Identify which users improved post-medication myocardial contractility and ejection fraction Estimate which population returned to aeronautical activity post Heart Failure.

[304] SECONDARY AERO-RESCUE, "THE NEW CONCEPT OF MEDICAL CARE IN THE TRANSFER OF CRITICAL PATIENTS BY AIR"

Wagner Samaniego[1], Vicente Ciancio[2], Marcos Saldivia[3]
[1]*Transportes Aereos San Rafael, Coyhaique, Chile;* [2]*Universidad Nacional de la Plata, La Plata, Argentina;* [3]*Samu, Coyhaique, Chile*

(Education - Program/Process Review)

One of the key points in patient care is pre-hospital medicine, therefore, every aspect of it becomes essential in order to avoid delays and offer better health care. In chile, since 2011, law 83 regulates the air transportation service for sick or injured people. There are two types of medical transportation based on the need and requirement of the patient. 1.- primary, that which is carried out from the place where the sick or injured person is, previously stabilized, to a hospital center. 2.- secondary, that which is carried out from the healthcare center where the patient is located to a healthcare center of greater complexity. However, in the southern part of the country, due to geographical, meteorological and access characteristics of the hospital system, it is challenging to correctly apply this classification since patients frequently have to be transferred without having been completely stabilized. In the chilean region of aysen, according to the last population census data, there are 107,334 inhabitants living in an area 108,494 km2, with a population density of 1.01 inhabitants per km2. The healthcare network is made up of 30 rural health facilities, 4 low-complexity hospitals and a regional hospital. In this environment, aeronautical medical transportation represents an important role. A patient who is in the town of villa o'higgins, 563.4 km south of the regional hospital, and who has a life-threatening condition, should in principle be treated in a rural facility where there is no relevant equipment or personnel, the patient does not meet the criteria for primary transportation, since the stability of the patient not yet been achieved, and must be transferred to a healthcare center to change the prognosis. Patient also does not meet the criteria for secondary transportation. In these circumstances, we propose the concept of secondary air rescue to include this type of patients. This mode of medical transportation enable patients to reach their destination quickly and efficiently, eliminating geographical barriers and more importantly, saving lives.

Learning Objectives

1. The participant will be able to understand the evacuation by air of critical patients.
2. The audience will learn about the our proposal. A new concept of aeromedical evacuation from remote and difficult geographical zones.

[305] COGNITIVE ALTERATIONS OBSERVED IN NORMOBARIC ALTITUDE TRAINING IN CIVIL AVIATION IN LATIN AMERICA: A CASE STUDY FROM ANTIOQUIA, COLOMBIA.

Diana Carolina Gutierrez[1], Juan Carlos Camacho[1], Orlando Gracia[2], Tatiana De la Hoz[3], David Puerta[4], Adriana Zuluaga[1]
[1]*Universidad Nacional de Colombia, Medellín, Colombia;* [2]*Servicios Gran Colombiana, Bogota, Colombia;* [3]*MAISO IPS, Medellín, Colombia;* [4]*Independiente, Medellín, Colombia*

WITHDRAWN

[306] IDIOPATHIC FACIAL PARALYSIS IN AIRCREWS: A CLINICAL AND EPIDEMIOLOGICAL ANALYSIS IN THE COLOMBIAN AEROSPACE FORCE

Alejandra Correa, Laura M. Pineda, Diego Malpica
Colombian Aerospace Force, Bogota D.C., Colombia

WITHDRAWN

[307] FLIGHT-RELATED NECK AND LOWER BACK PAIN AMONG COLOMBIAN ANTI-NARCOTICS POLICE PILOTS: PREVALENCE AND RISK FACTORS

Marian Farfan[1], Martha Marichal[2], Alexandra Mejia[3], Diego Malpica[1]
[1]*National University of Colombia, Bogota, Colombia;* [2]*National Police of Colombia. Anti-narcotics Division, Aviation Medicine, Bogota, Colombia;* [3]*Aerocivil Colombian Civil Aviation Authority, Bogota, Colombia*

(Original Research)

INTRODUCTION: *The Anti-Narcotics Police of Colombia command one of the largest police aviation enforcement divisions in South America. With a surge in flight missions in recent years, there has been a corresponding increase in reported musculoskeletal complaints among its pilots. Research focusing on military pilots has identified various factors like aircraft type, flight hours, and ergonomic conditions as predictors for neck and back pain. However, data focusing explicitly on police aviation sectors remain conspicuously absent in current literature.* **METHODS:** *We conducted a comprehensive cross-sectional study involving 261 pilots, which represents 70.9% of the intended sample population. The sample consisted of 81 fixed-wing pilots (31.0%), 145 rotary-wing pilots (55.5%), and 35 remotely piloted aircraft (RPA) pilots (13.4%). Participants were administered an anonymous online survey segmented into demographics, flight history including aircraft type, musculoskeletal symptoms, and Night Vision Device usage. Anthropometric measurements were also acquired. Statistical analyses employed included univariate assessments and binary logistic regression models for identifying factors significantly associated with neck and back pain. The research protocol was approved by the National Police's institutional ethics review board.* **RESULTS:** *The reported 12-month prevalence for low back pain was 31.42%. Significantly, rotary-wing aircraft operations were associated with an elevated risk (OR: 2.18; 95% CI: 1.26 - 3.77). Neck pain had a 12-month prevalence of 26.67%, with RPA operators marking the highest incidence at 37.14%. Engaging in physical activity for durations exceeding 20 minutes, a minimum of thrice weekly, was identified as a protective factor against cervical pain (OR: 0.47; 95% CI: 0.34 - 0.66).* **DISCUSSION:** *The study's outcomes largely align with existing data on 12-month prevalence rates for low back and neck pain in the military aviation domain. However, we identify RPA operators as a unique cohort deserving targeted ergonomic and safety research. The evidence collected here necessitates further longitudinal investigations, along with research into preventive methodologies and the efficacy of treatment modalities to strengthen the scientific basis of these initial findings.*

Learning Objectives

1. The audience will recognize remotely piloted aircraft (RPA) pilots as a new target population for research on ergonomics, morbidity, and operational safety impact.
2. The participant will be able to identify potential risk factors for neck and lower back pain among anti-narcotic police pilots.

Wednesday, 05/08/2024 ***8:30 AM***
Grand Suites 2 & 3

[S-55]: POSTERS: NEUROPHYSIOLOGY

Chair: Ryan Mayes
Co-Chair: Samir Alvi

[308] THE EXAMINATION OF INDIVIDUAL FACTORS AND AFTE TRAINING OUTCOMES

Tayton Hess[1], Patricia Cowings[2], William Toscano[2], Gary Ellis[3], Mary Nimmer[1], Allison Ludwig[3], Mariateresa Sestito[1], Fernando Espinosa[4], Kevin Novak[5]
[1]*Naval Medical Research Unit - Dayton/ORISE, Dayton, OH, United States;* [2]*NASA Ames Research Center, Mountain View, CA, United States;* [3]*Naval Medical Research Unit - Dayton/Leidos, Dayton, OH, United States;* [4]*NASA Ames Research Center/SJSUF, Mountain View, CA, United States;* [5]*Naval Medical Research Unit - Dayton, Dayton, OH, United States*

(Original Research)

INTRODUCTION: Motion sickness is common among military aviators. It describes a specific group of symptoms that include epigastric awareness, nausea, pallor, sweating, salivation, and fatigue. Occurrences of these symptoms can pose a significant risk to safety and adversely impact mission success. Accordingly, researchers have developed specific interventions to act as countermeasures. For example, Autogenic Feedback Training Exercise has been empirically validated as a training method that mitigates the impact of motion sickness. However, it remains unclear the extent to which individual factors moderate (or mediate) the effects of this intervention. The examination of individual factors such as interoceptive accuracy (IA) and specific personality traits might provide insight into whom may benefit most from AFTE. **METHODS:** Participants were administered the Big Five Inventory (BFI) and State Trait Anxiety Inventory (STAI). In addition, they were given an interoceptive accuracy task (i.e., heartbeat counting task). The participants' reported value was then compared to the actual number of heart beats obtained via ECG. Completion of the IA task was followed by pre- AFTE and Post-AFTE rotating chair tests to evaluate motion sickness and the effects of AFTE training. **RESULTS:** Participants (n=16) were evaluated on IA, personality factors (i.e., BFI & STAI) and performance on the rotating chair. IA was unrelated to personality traits ($p > .05$), but inversely related to state anxiety post training ($p < .05$). Finally, IA did not predict performance on rotating chair $F(1, 14) = 1.18$, $p > .05$). **DISCUSSION:** 1. IA is unrelated to personality traits as measured by BFI and STAI. 2. Individual factors are unrelated to AFTE training outcome. 3. AFTE training can be beneficial for all.

Learning Objectives

1. The audience will learn about evaluating whether IA is associated with individual personality factors.
2. The audience will learn about examining whether individual personality factors are predictive of AFTE training outcomes.

[309] COLOR VISION DEFICIENCIES, HYPOXIA AND THE HOLMES WRIGHT LANTERN

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(Original Research)

INTRODUCTION: Pilots in the United States are allowed to fly without supplemental oxygen up to 12,500 ft (3800 m). Previous research has shown that the color vision of individuals with normal color vision (NCV) can be mildly affected near this altitude, but little information exists regarding the ability of individuals with congenital red-green color vision defects (DCV) to identify signal light colors in this environment. **METHODS:** Thirteen NCV and 17 DCV individuals participated as part of a larger study at the Civil Aerospace Medical Institute. CAMI's hypobaric chamber simulated ground and 12,400 ft (3780 m) pressure equivalents. The Holmes-Wright Type A Lantern (HWA) was used to assess a subject's ability to identify red, green and white navigation lights. The point brilliance corresponds to viewing lights from 1 nautical mile at a low photopic adaptation state. Nine pairs of lights were presented in each of 3 trials at the two altitudes. A failure was any red light called green or vice versa, or more than two other types of errors on the 3 trials. **RESULTS:** The pass rate for NCV subjects at ground was 92.3% and 100% at 12,400 ft. The DCV pass rate was 11.8% at both altitudes. Only one NCV subject had errors on the lantern at either altitude. In contrast, only 2 DCV subjects had perfect scores at both altitudes. The percentage of errors made by the DCV subjects was the highest for the white light, followed by green and red. The DCV error rates for the different colored lights were significantly different (RMANOVA; $p<0.001$), but the main effect of altitude ($p=0.900$) and the interaction term were not significant ($p=0.432$). **CONCLUSIONS:** The negative findings for the NCV performance are similar to previous studies, which reported no change or subtle changes in color vision at 12,400 ft/3780 m for photopic vision. The lack of an altitude effect on DCV performance is likely due to a ceiling effect. The HWA is challenging for most DCVs, so that the numerous errors might have masked any slight change in color discrimination in our study.

Learning Objectives
1. Understand how mild hypoxia can influence color identification of red, green and white aviation signal lights.
2. Understand how challenging identifying red, green and white signal lights is for individuals with color vision deficiencies.

[310] PILOT ADAPTATION TO MODERN HELMET MOUNTED DISPLAYS (HMD) IN 5TH GENERATION FIGHTER JETS.

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(Original Research)

INTRODUCTION: The development of Head-Up Displays (HUDs) in modern fighter jets has seen significant advancements, ensuring pilots have immediate access to critical flight data without looking away from their viewpoint. HUD technology has evolved, with color coding being used to display key information efficiently. Furthermore, modern fighter jets like the F-35 and Eurofighter have transitioned to Helmet-mounted Displays (HMDs), which project essential flight data onto the pilot's visor, providing a more integrated and immersive information display. The ergonomic design and evaluation of visual coding for aircraft HUDs are crucial to mitigate potential visual stress, which may be exacerbated in complex flight environments with varying weather, terrain, and other environmental conditions. Furthermore, the pilots individual visual parameters may influence how well the pilot adapt to using HMDs. This study investigates the adaptation to new HMD in 5th generation fighter jets. **METHODS:** 25 Danish pilots received a questionnaire 3 times during their transition training to the f-35 aircraft. The questionnaire had questions related to quantification a certain potential discomfort on a scale from 1-10. Questions included information about how tired the pilots felt in their eyes feel after flying, how clear their vision were after flying and symptoms like headache/mental tiredness and fatigue. The pilots answers were crosslinked with previous measurements of visual parameters such as visual acuity, color vision, phoria and stereopsis. **RESULTS:** 25 pilots returned a total of 70 filled questionnaires. In general they were all relatively satisfied with the HMD system. The average score on questions relating to visual discomfort was 2,2 and regarding fatigue the score was an average of 3,2. There were not found any correlation between previous individual measured eye parameters and discomfort score in the questionnaires. **DISCUSSION:** This study found that pilots adapts well to the HMD systems in newer fighter jets. This suggests keeping the high visual standards for initial pilot applicants in the Danish Airforce. A limiting factor to our study is that it only represents discomfort scores after relatively short flying sorties (1-2 hours). An exposure to the HMD system over prolonged hours might produce a different result.

Learning Objectives
1. The audience will learn about adaptation to modern helmet mounted displays.
2. The audience will learn about visual standards for fighter pilots.

[311] EVALUATION OF A BONE-CONDUCTED VIBRATION (BCV) DEVICE FOR AIRSICKNESS MITIGATION

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(Original Research)

INTRODUCTION: Airsickness (AS) continues to impact pilot training and combat readiness. Recent experiments suggest bone-conducted vibration (BCV) technology may have the potential to mitigate AS in military flight environments. The experimental BCV device is a non-invasive, flight helmet worn device designed to apply vibrations directly and unilaterally to the vestibular system. The aim of this study is to evaluate the effectiveness of a BCV device in mitigating airsickness in a provocative motion environment. **METHODS:** Participants (n = 12) passively experienced two, 30-minute pre-recorded, simulated flights using NAMRU-D's motion-based platform, the Disorientation Research Device, while wearing either the experimental BCV device or a placebo. The device presentation order was counterbalanced between participants with a minimum of one day between flights. During each flight, participants completed a target tracking task and verbally reported subjective motion sickness ratings every two minutes using the Baxter Animated Retching Faces (BARF) scale. Time to nausea (BARF ≥ 1) and time to failure (BARF ≥ 4) were also assessed. The Motion Sickness Assessment Questionnaire (MSAQ) was administered post-flight. **RESULTS:** No significant differences were observed for MSAQ, BARF, tracking task, time to nausea, or time to failure across BCV conditions. Significant differences were observed for MSAQ, BARF, time to nausea, and time to failure across study visits. On average, MSAQ and BARF scores were lower and time to nausea and time to failure were longer for visit two compared to visit one. **DISCUSSION:** The BCV device failed to mitigate AS in a provocative motion environment compared to a placebo. Previous research has shown that repeated exposure to a nauseating stimulus mitigates motion sickness. This could explain the differences in motion sickness scores across visits regardless of BCV condition. Another limitation of this study was the session termination procedures. To avoid emesis, sessions were terminated once the participant reached a BARF of ≥ 5. Time between visits and study termination cutoffs should be increased in future studies. Future research should also examine whether vestibular stimulation could contribute to undesirable outcomes such as spatial disorientation and headaches, as these outcomes were reported by several participants.

Learning Objectives
1. The audience will learn about the scientific theory behind the Bone Conductive Vibration (BCV) device and how it may interact with the vestibular system to aid in the mitigation of motion sickness symptoms.
2. The audience will learn about common measures used to determine motion sickness severity during experimental studies.

[312] COMPARISON OF ACTIVE AND PASSIVE HEAD IMPULSE TESTING OF THE HORIZONTAL VESTIBULO-OCULAR REFLEX: EXPLORING DIFFERENT APPROACHES FOR SPACEFLIGHT

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(Original Research)

Astronauts experience sensorimotor disturbances primarily due to microgravity-induced vestibular changes in spaceflight. Head Impulse Testing (HIT) examines changes in horizontal vestibulo-ocular reflex due to rapid head movements to detect changes in vestibular function. Interpretation requires consideration of artifacts and constraints across different mission phases. Therefore, the aims of our study were to (1) examine reliability across test operators and (2) compare results of active (aHIT) vs passive (pHIT) methods for self-administered vs operator-assisted approaches. Comparison of normal vs occluded vision evaluated other oculomotor influences across conditions, and comparison with machine-generated rotation (rHIT) examined full-body movement effects on ocular responses.

Seventeen non-astronaut volunteers completed HIT using video-oculography goggles and a rotator system with these conditions: (1) default passive head-on-torso (pHIT) using two operators (Op1, Op2), (2) active head-on-torso (aHIT, subject initiated), and (3) passive head and torso using a rotary chair (rHIT). Eye and head movement data processing generated gains in each direction. The primary outcome measures were average gain, asymmetry, and the percentage of acceptable trials with sufficient head amplitude and limited artifact.

While pHIT gains were similar with vision (1.032±0.043) and occluded (1.029±0.038), acceptable trials were greater with vision (Op1=93.0%, Op2=93.2%) vs occluded (Op1=70.7%, Op2=67.6%). The reliability between operators was greater for pHIT gain (ICC=0.66, p=0.001) than for pHIT asymmetry (ICC=0.57, p=0.01). Acceptable trials decreased by ~20% during aHIT for both visual conditions. While aHIT gains were not significantly different from pHIT, measures were poorly correlated. aHIT and pHIT gains were significantly greater than rHIT gains, presumably due to the reduced peak rotator velocity. Asymmetry measures were poorly correlated across conditions, although no subjects had asymmetries greater than 16%.

The findings support the feasibility of pHIT for spaceflight. Similarities between visual conditions reflect that these responses were mediated by the peripheral horizontal canals rather than other oculomotor mechanisms. The inter-tester reliability was acceptable despite training differences. In addition to non-vestibular interference during aHIT, pHIT resulted in more acceptable trials and should be more efficient and reliable measures for spaceflight.

Learning Objectives

1. The presenter will demonstrate the necessity for reliable, replicable vestibular function assessments during spaceflight, where as previous assessments have been predominantly limited to testing only before and after missions.
2. The audience will learn about the feasibility of standard clinical vestibular testing to evaluate changes in vestibulo-ocular reflexes during spaceflight.

[313] MODIFIED AUTOGENIC FEEDBACK TRAINING PRODUCES EFFECT ON MOTION SICKNESS

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(Original Research)

INTRODUCTION: Motion sickness is a common physiological reaction to provocative motion and is characterized by a constellation of symptoms, including stomach awareness, nausea, emesis, pallor, sweating, hypersalivation, and fatigue. The emergence of these symptoms can pose a significant threat to safety, particularly in the context of aviation. Given its prevalence among aviators and its detrimental impact on performance, researchers have endeavored to identify effective countermeasures for motion sickness. Currently, many of the existing interventions are pharmacological in nature and while effective, they present a problem due to their associated adverse side effects. A modified two-hour version of Autogenic Feedback Training Exercise (AFTE) could be an effective countermeasure to motion sickness without adverse side effects. AFTE combines principles of autogenic therapy, biofeedback, and learning to teach individuals to control their own internal physiological reactions through a series of relaxation and arousal exercises. **METHODS:** AFTE was administered over 6 days. On the first day, participants were exposed to provocative motion via a rotating chair test to collect baseline physiological data. AFTE sessions were conducted on four consecutive days and lasted approximately 30 minutes each session. Participants were exposed to the rotating chair again on the 6th day. **RESULTS:** Participants (n = 16) were evaluated on the number of rotations experienced and cumulative minutes spun in the chair. Participants tended to ride longer (M = 21.0 min, SD = 16.56) and tolerated more rotations (M = 244.8 rotations, SD = 310.62) on their second rotating chair test compared to baseline (M = 14.0 min, SD = 9.35; M = 125.8 rotations, SD = 124.08; t(15) = 2.21, p = .02). A moderate effect size was recorded (Hedges's g = 0.44). **DISCUSSION:** A modified two-hour version of the AFTE is effective at increasing tolerance of symptoms associated with motion sickness.

Learning Objectives

1. To demonstrate that brief autogenic feedback training allows greater tolerance to nauseogenic environments.
2. To show that Autogenic feedback training can effectively mitigate the adverse effects of motion sickness without side effects.

[314] ONE SMALL STEP: A LOOK AT THE IMPACT OF OPENING UP CREW POSITIONS TO BELOW THE KNEE PROSTHETIC USERS ON ANALOG ASTRONAUT MISSIONS

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(Original Research)

INTRODUCTION: Recent shifts in human spaceflight have shown interest in including astronauts who fall outside the historical standards for selection. Most recently this trend has included persons with disabilities, however no data on the impact of this inclusion exists within the literature. **METHODS:** This observational study was conducted in the setting of at the LunAres ICAres-2 analog mission in Poland. The crew consisted of six people, 4 women, 2 men ranging in age from 23-42yrs, including one person with a disability (lower-limb amputee). The crew members were assigned anonymized numbers, which they used to fill out questionnaires after events where performance was to be measured. This included a perceived-effort rating scale (Borg RPE), perceived time taken, and any changes or modifications needed to complete a task. Additionally, objective time performance and error-rate data was obtained through video data with those tasks where these metrics pertained. **RESULTS:** In all activities that were measured the crewmember using the prosthetic scored in the middle range of values for perceived effort, time performance, and error rate. Additionally, there were only a few occasional modifications undertaken to complete a task, but it was not always the prosthetic-user needing to make the modifications. **DISCUSSION:** Acknowledging the paucity of data including persons with disabilities in this setting, and the small n involved in this study, the data interpretation must be undertaken with caution to its wider applicability at this time. However, the notable lack of performance delta in our crewmember using a prosthetic lower limb as compared with the able-bodied crew during normal operations opens up an interesting discussion on crew selection and performance measures in the analog environment. It also sets the stage for follow-up studies that might inform mission planners about where failure points could be when considering a prosthetic user for crew. Based on the findings in this study, this would require more examples of prosthetic users, different prosthetic systems, and likely more extreme testing environments to identify salient deltas in performance.

Learning Objectives

1. To understand what mission impacts, planning considerations, or equipment adaptations might facilitate this inclusion, there needs to be a deliberate study of these ideas in a relevant setting. Because so few analog missions have included people with disabilities, this lack of data acts as a further barrier to their inclusion.
2. Impact of inclusion of persons with disability in spaceflight endeavors are, in many cases, not as onerous as it might first seem. The actual impact may be negligible, but there might also be a few small, but important details needed to facilitate inclusion, which must be studied to be understood.
3. Normal operations in this analog study did not produce a delta in performance between crew members. in highlight potential relevant deltas, additional studies which more aggressively focus on aspects of the crew member's disability, will be needed.

[315] ANTHROPOMETRIC SURVEY OF JAPAN AIR SELF-DEFENSE FORCE AIRCREWS

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(Original Research)

INTRODUCTION: Since the Japan Air Self-Defense Force (JASDF) conducted initial anthropometric survey in 1961, anthropometric datasets had been replaced every ten years until the survey in 1998. Twenty years after that, females have begun to be recruited as fighter pilots. In addition to the percentile values conventionally used as design criteria of equipment, multivariate analysis are required to properly determine accommodation. In light of the above, the latest anthropometric survey was conducted to update the data including female pilots and to do multivariate analysis. In this presentation, we will present the basic statistics of the body dimension data obtained in this survey. **METHODS:** Sixty two items (61 for males) were selected for the JASDF anthropometric surveys to be applied as ergonomic data for the design of equipment and other products. The measurement method was the same as in the previous study, using a Martin-type anthropometer. A total of 429 subjects were measured: 303 males (pilots, navigators, and candidates) and 126 females (pilots, navigators, candidates, and others). Measurement and recording errors were excluded. **RESULTS:** The data for the analysis included 401 subjects: 279 males and 122 females, excluding 28. Percentile values were calculated as basic statistics to obtain the dimensions needed for equipment development. **DISCUSSION:** The latest body measurements obtained in this study can be utilized in the equipment and clothing design process. Because the JASDF aircrews tend to be small in stature and long in body length, careful consideration must be given to their suitability in the design of equipment.

Learning Objectives

1. The participant will understand the body dimensions required for designing equipment.
2. The participant will understand the characteristics of the Japanese body type.

[316] PULMONARY FUNCTION TEST VALUES IN US AIR FORCE INSTRUCTOR PILOTS ACROSS TIME

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(Original Research)

INTRODUCTION: High performance aviators require optimal lung function to counter the environmental stressors of tactical aviation. Pulmonary function tests (PFTs) are key measurements of respiratory health. We sought to characterize PFT values in US Air Force instructor pilots following successive sorties across a work week. The purpose of this study was to use pulmonary function testing to characterize respiratory performance over a two-week period of time. **METHODS:** This study was approved by both the Air Force Research Laboratory Institutional Review Board and Case Western Reserve University. Portable spirometry was used to assess pulmonary function at 6 time points across two weeks in T6 and T38 instructor pilots at two Air Force training bases. Frequencies and descriptive statistics (Mean ± Standard Deviation) were calculated for percent predicted PFT metrics of forced vital capacity (FVC), forced expiratory volume in one second (FEV-1), FEV-1/FVC ratio, and forced expiratory flow at 25%-75% of vital capacity (FEF 25-75%). Paired t-tests were used to determine if values changed from baseline (Sunday) to final (Thursday) across each week of the study. **RESULTS:** Instructor pilots (N=35; 31 male + 4 female) ranged in age from 25-48 years (M=34.7 ± 5.6) with 10.9 ± 5.2 years military pilot experience. Approximately 10% of instructor pilots had suboptimal percent predicted FEV-1 values (≤ 80%) for Week 1 and Week 2. Four pilots had 3 suboptimal FEV-1 measurements and three pilots had suboptimal FEV-1 levels at each assessment. FVC increased across the work week from the Sunday baseline (94.63 ± 9.1) to the Thursday measurement (96.37 ± 10.1) in Week 1 (p=0.47). **DISCUSSION:** Limitations of the cross-sectional study design and small sample size preclude the ability to determine if the suboptimal FEV-1 results in a small subset of instructor pilots represent an acute pulmonary response or unrecognized chronic condition. This suggests a need for future longitudinal research studies of pulmonary function in high performance aviators.

Learning Objectives

1. The participant will describe the range of pulmonary function test values of US Air Force instructor pilots across the work week following successive training flights.
2. The participant will learn that suboptimal percent predicted FEV-1 values may exist in a subset of instructor pilots experiencing successive sorties.

[317] PRELIMINARY FINDINGS: ONLINE COGNITIVE TRAINING (CTR) ENHANCES IN-COCKPIT EXPERIENCES IN STUDENT PILOTS

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(Original Research)

INTRODUCTION: This cornerstone project at The Ohio State University explored the use of a structured online brain exercise program to potentially reduce hours of flight training, and thereby costs, through strengthening underlying neurocognitive abilities known to be associated with flight performance and safety ("Aviator Cognition"). **METHODS:** Qualitative and quantitative data were collected to determine Part 141 flight student experiences related to the effects of completing brain exercises on the ground with actual skill development in the sky. Seven student volunteers were asked to complete a 5 week, coached, online cognitive training program (CTr) designed for pilots, as well baseline and post-training questionnaires that examined personal in-cockpit experiences; instructor impressions were also collected. Cost-effectiveness analysis estimated changes in throughput at an institutional level. **RESULTS:** No student completed the full CTr program, while the 71% who had sufficient CTr data showed significant cognitive gains of 21.8 percentile points. Qualitative data indicated students perceived CTr as a means by which they overcame personal obstacles to flight training in 80% of those who sufficiently engaged with the online CTr platform. Reported benefits ranged from "auditory-related memory skills improved, which correlated to conversing with ATC and remembering their instructions" to "maneuvers and landings seemed to get better due to better awareness." Instructors also perceived improvements, especially as related to focus and attention in the cockpit. Flight students estimated CTr would lead to over a 10% reduction in in-cockpit training time and associated costs, which would also have the effect of allowing this particular flight school to enroll up to 10 more students per year based on throughput analyses. **DISCUSSION:** These findings indicated direct training of Aviator Cognition led to perceived improvements in memory and multi-tasking capacities, which in turn allowed some flight students to overcome personal obstacles to their progress. Such improvements in flight training efficiency have a network effect that benefits both pilots and organizations alike. To enhance numbers of participants, flight students suggested future studies use CTr during summer months, when more time is available, while providing additional educational materials.

Learning Objectives

1. Participants should understand underlying elements of Aviator Cognition (AC) and known effects of AC on flying.

2. Participants should understand the "network effect" of enhancing a pilot's brain functioning to peak performance levels on improving performance, safety, and organizational functioning in the aviation environment.

[318] MAXIMAL AEROBIC TESTING LOGISTICS AND ITS APPLICATION AS A PRE-FLIGHT COUNTERMEASURE FOR MICROGRAVITY-RELATED VASCULAR DEGRADATION: A REVIEW

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(Education - Tutorial/Review)

INTRODUCTION: If VO2max can be optimized closer to launch, health and performance during long-duration missions are less compromised as vascular health is preserved. TOPIC: Of fourteen ISS crew members during a long duration mission, eight began with a VO2max of 40 mL/kg/min or above. Out of those eight, four maintained their VO2max. These findings suggest that not all crew members maintain their aerobic capacity in microgravity. Just over half began this mission with an above average VO2max. Of the crewmembers that were tested during the Gemini Program, all but one experienced a decrease in aerobic capacity. EVA's require an aerobic capacity of ~32.9 mL/kg/min. If crew members are starting a mission with a VO2max of 40 mL/kg/min and are not maintaining it, EVA ability could be compromised. Aerobic testing in relation to launch date is also significant. During the Skylab program VO2max was assessed about twelve and six months prior to missions. Typically testing takes place six months before flight, and submaximal testing thirty days prior. Estimates of VO2max from submaximal data are widely used in clinical populations however in healthy individuals a standard error of estimate of 4.234 mL/kg/min was found. Aerobic capacity can be lost rapidly; thirty days of bed rest elicited a decline of almost 1% per day. The importance of optimizing aerobic capacity pre-flight extends beyond the ability to perform mission tasks. Healthy mice were exposed to galactic cosmic ray illumination to simulate the microgravity environment. These mice exhibited increased elastin dissolution; After sixteen weeks of exercise training, there was a significant increase in elastin volume in the aorta of young rats. In a systematic review over 94% of the literature showed that exercise training promoted protective effects on a cellular level in the context of radiation exposure. These findings have implications for aerospace and terrestrial based medicine. APPLICATION: ISS crew members have expressed that added volume for preflight exercise training is needed. Optimizing aerobic capacity closer to launch date may help maximize vascular integrity as a pre-flight countermeasure for the inevitable decline.

Learning Objectives

1. The audience will be able to understand the current/past aerobic testing protocols for long duration missions.
2. The audience will be able to understand the effect of the microgravity environment on aerobic capacity and vascular health.
3. The audience will be able to understand the effects of exercise training and optimizing aerobic capacity on vascular health.

[319] INTEGRATION OF A MOBILE PHYSIOLOGICAL MONITORING SYSTEM INTO AIRCREW EQUIPMENT

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(Original Research)

INTRODUCTION: A flying weapon system is equipped with a variety of sensors to gather information about the current situation, but up to now, there is no systematic monitoring system for physiological data of jet pilots in flight. In particular, the excessive demand on the pilot in the human-machine interface can lead to excessive mental workload. This excessive demand can be recognized using physiological parameters. In order to be able to assess the workload in a fighter aircraft more precisely the German Air Force Centre of Aerospace Medicine (GAFCAM) is working on recording physiological parameters during flight. For this purpose, the data acquisition system must be integrated into the aircrew equipment, must be robust enough to withstand the loads during a flight under high G-loads and must not restrict the airworthiness of the aircraft. **METHODS**: In order to provide the relevant evidence, a test was accomplished in the long-arm centrifuge at the GAFCAM in Königsbrück. A male test pilot who had several hundred hours of flight experience in a Panavia PA-200 Tornado jet aircraft as a weapon system officer (WSO) was equipped with a mobile physiological laboratory (mobPhysioLab). This device records ECG, respiration rate, oxygen saturation, skin conductance, body temperature, and environmental conditions such as G-load, ambient pressure, temperature and relative humidity. The subject completed a run in the centrifuge with (1) a ramp profile and (2) a rapid on set profile. The centrifuge internal measurement system PowerLab is used as a reference. **RESULTS**: Our results show that the data recorded by the mobPhysioLab during the centrifuge runs are evaluable and plausible, as shown by a comparison with the established system. We were able to proof that this mobile system is robust enough to be used at high G-loads while maintaining data accuracy. **DISCUSSION**: The setting we tested can be stowed in the pilot's flight suit, takes up as little space as possible and does not impair the pilot's comfort during the flight. The physiological monitoring system fulfills the requirements for in flight test, which will be our next step.

Learning Objectives

1. The participant will able to understand the result of the test in the centrifuge and the possibilty to use the mobile physiological monitoring system to record data under G-loads.
2. The participant will understand how the physiological monitoring system will be used in the next step for in flight measurement by the German Air Force Centre of Aerospace Medicine.

[320] THE EFFECT OF SPATIAL DISORIENTATION TRAINING ON GROUND FOR DUTY FIGHTER PILOTS IN JAPAN AIR SELF-DEFENSE FORCE

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(Original Research)

Spatial disorientation (SD) is one of the important causes of critical aircraft mishaps. In these five years (2019-2023), Japan Air Self-Defense Force (JASDF) has lost three fighter pilots due to mishaps. The Accident Investigation Board concluded that one of the causes of these mishaps was unrecognized SDs. Since then, JASDF decided to start SD training for duty fighter pilot using the SD Trainer (GL-4000, ETC, USA.). But, there is no clear evidence whether the SD training would be effective for pilots to recognize SDs during flight. To evaluate the effectiveness of SD training, we asked the trainees of SD training to participate in the questionnaire survey. The SD training consists of the 1-hour lecture and SDs experience by SD Trainer. The questionnaire was answered while the trainees had been engaged in the ordinary flight duties approximately 3 months after SD training. Among 234 research participants, we received 32 answers and analyzed them (as of October 31, 2023). 13 pilots (40.6%) experienced the actual SDs after SD training and most of them (11; 34.3%) felt it is easy to recognize SDs compared to before. Especially, some of them answered their SDs would induce the severe mishap unless they could recognize them. However, some pilots (2; 6.25%) could not realize the effectiveness of SD training. SD training was seemed to be potentially effective to easily recognize SDs during flight, but effectiveness of single-time training might be limited. To prevent the severe mishaps related to SDs, it would be important to establish the system to undertake SD training repeatedly.

Learning Objectives
1. The audience will learn about the Spatial Disorientation Training On ground how effect to recognize the SD in flight.
2. The audience will learn about the SDs' episode in JASDF in flight.

[321] BARRIERS TO MENTAL HEALTH SEEKING AMONG ARMY AVIATION PERSONNEL: PRELIMINARY FINDINGS

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(Original Research)

INTRODUCTION: Aviation operations require constant vigilance where personnel must perform their duties under significant physical and psychological stress. Prolonged or intense stress events can lead to mental health issues, even among those with formal resilience training. Barriers to mental health seeking prevent military aviation personnel from receiving the assistance they need, yet little is known about these barriers. **METHODS:** Quantitative survey responses were collected from current and former U.S. Army Aviation personnel recruited via social media and snowball sampling between October and December 2023. Information regarding barriers to mental health seeking were determined using the Barriers to Access to Care Evaluation - Version 3 (BACE V3). The BACE V3 provides 30 statements covering attitudinal, instrumental, and stigma barriers, asking participants to select the extent to which the provided questions stopped, delayed, or discouraged them from seeking mental health care. Selections range from "Not at All" (1) to "A Lot" (4). **RESULTS:** Fifty responses have been received at this point, 49 of which had sufficient data to determine barriers to mental health seeking. The average values for attitudinal-related questions were 2.29, stigma questions averaged 2.22, and the average responses for instrumental were 1.54. **DISCUSSION:** The preliminary results indicate that attitudinal and stigma barriers play the largest role in inhibiting mental healthcare seeking among U.S. Army Aviation personnel, while instrumental issues played a lesser role. Examples of attitudinal barriers include perceived treatment ineffectiveness, belief that the problem will pass on its own, and a self-reliant problem-solving mindset. Sigma barriers include concerns about social, practitioner, and organizational biases. These findings indicate that approaches to overcoming mental health hesitance should focus on overcoming aviation personnel's perception of stigma by their friends, employees, and regulators, along with dispelling the internal mindsets on mental health among Army aviation community members. As this research progresses, the intent is to determine the effects of age, gender, and aviation career field on barriers to mental health seeking.

LEARNING OBJECTIVE 1. This research provides additional insight into the effects of attitudinal, instrumental, and stigma barriers to mental healthcare seeking among U.S. Army Aviation Personnel.

Learning Objectives
1. The audience will gain insight into the effects of attitudinal, instrumental, and stigma barriers to mental healthcare seeking among U.S. Army Aviation Personnel.
2. Participants will learn about the impact of pilot mindset and perceived biases on Army Aviation members' propensity to seek assistance for mental health symptoms

[322] CHARACTERIZING FATIGUE DURING CIRCADIAN DISRUPTED SHORT-HAUL AVIATION OPERATIONS: STUDY METHODOLOGY

Erin Flynn-Evans[1], Nicholas Bathurst[1], Lucia Arsintescu[2], Kevin Gregory[1], Laura Barger[3], Amanda Lamp[4], Hannah Baumgartner[5], Thomas Nesthus[5], Cassie Hilditch[2]
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(Original Research)

INTRODUCTION: Fatigue is a challenge in short-haul aviation flight operations due to irregular schedules that often involve circadian disruption. Specifically, schedules that encroach on the window of circadian low, including redeye flights, and those that switch between early starts and late finishes can cause circadian disruptions. These schedules reduce sleep opportunity and may require additional fatigue mitigation. Such sleep loss and circadian disruption, together with high workload factors common to short-haul operations (e.g., fast turnarounds, multiple takeoffs and landings) may impact cognitive performance and safety. The FAA NextGen Human Factors Division has funded this research, conducted by the Civil Aerospace Medical Institute in support of the FAA Aviation Safety Organization. Therefore, we are characterizing the impact of these circadian disrupted schedules on pilot fatigue and performance during short-haul operations using validated objective and subjective methods. **METHODS:** Participants include commercial passenger pilots from four US airlines (target n = 144). Volunteers collect data for 1-3 days before, during, and 1-3 days after two trip types, one involving circadian disruption (i.e., a trip with a redeye or a trip that switches between early and late duties) and one without circadian disruption (i.e., all duties scheduled between 0700 and 2359). Participants are recruited in a counterbalanced order, with an equal number of pilots completing each trip type first. Data collection includes continuous actigraphy and daily sleep, meal, and exercise logs. Participants also complete the five-minute psychomotor vigilance test (PVT), Karolinska Sleepiness Scale, and Samn-Perelli fatigue scale three times per day on days off, and after waking, pre-duty, at top-of-descent for each flight, post-duty, and before bed on duty days. Pilots report hassle-factors and complete a NASA Task Load Index after each flight to characterize workload. Data are collected using the NASA PVT+ application on an iPod that is provided to the pilots. **RESULTS:** To date, 116 participants have consented to participate. Participants have contributed 4,613 PVTs over ~1,075 days of data collection, suggesting the study methodology do not involve excessive burden to the pilots while on duty. **DISCUSSION:** This study is ongoing, but preliminary findings suggest that the pilots are compliant with study procedures.

Learning Objectives
1. Understand what types of short-haul operations are being targeted for study.
2. Understand how data collection is being approached to characterize short-haul operations.

[323] TACTILE GUIDED SLOW AND DEEP BREATHING TO COUNTERACT HYPOXIA IN HELICOPTER PILOTS

Yuval Steinman[1], Monique Frings-Dresen[2], Eric Groen[3]
[1]*Centre for Man in Aviation, Soesterberg, Netherlands;* [2]*University of Amsterdam, Amsterdam, Netherlands;* [3]*TNO, Soesterberg, Netherlands*

(Original Research)

INTRODUCTION: It has previously been shown that slow and deep breathing (3–6 breaths/min) significantly increases oxygen saturation (SpO_2), which makes it an interesting technique to cope with the effects of altitude-induced hypoxia. A tactile signal could be useful to prompt aircrew to initiate slow and deep breathing as it is less effected by hypoxia compared to vision and hearing. We investigated the effect of tactile guided slow and deep breathing compared with that of spontaneous breathing on SpO_2, alertness, and hypoxia symptoms during acute hypobaric hypoxia. We also evaluated the usability of this tactile breathing guidance. **METHOD:** Twelve male military pilots were exposed to a simulated altitude of 15,000 ft in a repeated measures study during spontaneous breathing and during tactile guided slow and deep

breathing. We measured the following physiological parameters: SpO_2, heart rate (HR), respiratory frequency (RF), minute ventilation (V_E), tidal volume (V_T), end-tidal oxygen partial pressure ($PetO_2$), and end-tidal carbon dioxide partial pressure ($PetCO_2$). We also investigated the effect of workload on the pilot's adherence to the tactile guidance by engaging them with a cognitive task. Alertness was measured with the Stanford Sleepiness Scale. Hypoxia symptoms were reported using a list of general hypoxia symptoms. Usability of the tactile guidance was evaluated in a questionnaire. **RESULTS:** Compared to spontaneous breathing slow and deep breathing significantly increased SpO2, HR, VT and $PetO_2$, and significantly decreased $PetCO_2$. We found no effect of slow and deep breathing on alertness or the number of hypoxia symptoms. The usability questionnaire showed that pilots were positive about the intensity and sensation of the vibration signal, but had difficulty following the vibration pattern during the cognitive task. **DISCUSSION:** The increase in SpO_2 during guided slow and deep breathing did not alter alertness and hypoxia symptoms. This indicates that $PetCO_2$ may play a role in the development of these symptoms. Pre-training may improve the ability of pilots to follow the vibration pattern while being occupied with a cognitive task. Future studies may examine the effect of tactile guided slow and deep breathing on these variables under dynamic conditions that represent real operational flight.

Learning Objectives

1. The audience will learn about the physiological response to slow and deep breathing under hypoxia.
2. The audience will learn about the role that PetCO2 may play in the development of hypoxia symptoms.

Wednesday, 05/08/2024 ***10:30 AM***
Grand Ballroom CD South, EF

[S-56]: PANEL: MEDICAL CAPABILITIES AND TECHNOLOGIES TO ENABLE SPACE EXPLORATION BEYOND LOW-EARTH ORBIT

Chair: Rahul Suresh
Co-Chairs: Moriah Thompson, Kris Lehnhardt, Ben Easter, Courtney Schkurko

PANEL OVERVIEW: *Building upon the success of the last two decades of human spaceflight medical operations onboard the International Space Stations (ISS), NASA now must start to evolve to a deep space medical operations model. This new paradigm will include numerous challenges such as communication delays and blackouts, infrequent or nonexistent resupply opportunities, significant vehicle resource constraints, and delayed or nonexistent evacuation options. To overcome these challenges, the Exploration Medical Integrated Product Team (XMIPT) of NASA's Mars Campaign Office has defined a strategic roadmap that identifies required medical capabilities for exploration and outlines an approach for maturing technology development and integrating new medical capabilities across disciplines. During this panel, the XMIPT will present an overview on how medical capability gaps are defined and addressed and provide details on current XMIPT projects including a ground study to assess the effects of vacuum on pharmaceuticals, technology demonstrations of highly integrated multi-functional medical devices, development of an integrated data architecture, and development of an onboard automated medical inventory system.*

[324] EXPLORATION MEDICAL INTEGRATED PRODUCT TEAM (XMIPT) OVERVIEW AND STRATEGIC ROADMAP UPDATES

Moriah Thompson[1], Rahul Suresh[1], Justin Yang[2], Phyllis Friello[3]
[1]*NASA JSC, Houston, TX, United States;* [2]*Aegis Aerospace, Houston, TX, United States;* [3]*Leidos, Houston, TX, United States*

(Education - Program/Process Review)

BACKGROUND: The Exploration Medical Integrated Product Team (XMIPT) is focused on formulating a medical system for exploration missions to Mars. Such a medical system must overcome expected mass, volume, resupply, and communication delay constraints and address current gaps in medical capability. The XMIPT's portfolio consists of activities to close 10 medical gaps that were derived based on inputs from NASA flight surgeons, clinical providers, and other NASA subject matter experts. These activities and gaps reside on the XMIPT's exploration medical integrated roadmap and are used to communicate progress, areas of need, collaboration, and programmatic infusion to stakeholders internal and external to NASA. **OVERVIEW:** This presentation will provide an overview of the required planned gap-closing activities and current efforts within the exploratio medical domain. The XMIPT's approach to prioritizing development is based on factors such as operational need, the maturity of the technology, and activities being performed by other NASA organizations. Current XMIPT activities to meet exploration mission needs include development of an in situ intravenous fluid generation device, development of an Exploration Electronic Health Record, evaluation of medications after exposure to vacuum, as well as performing market surveys and down select of Clinical Decision Support, Mini X-ray, Compact Laboratory Analysis, and Behavioral Health and Performance tools. The importance and status of these specific activities will be discussed here and in subsequent panel presentations. **DISCUSSION:** The XMIPT integrated medical roadmap is reviewed and revised annually providing a status of activities by groups across NASA to close exploration medical capability gaps. XMIPT projects are focused on advancing technology readiness level and conducting ground and inflight demonstrations to enable programmatic infusion. The XMIPT partners with external organization such as the DoD and commercial partners to leverage shared resources to achieve gap closure priorities. Collectively, the XMIPT's curated, integrated medical roadmap and development activities seek to mitigate medical risk for crews on Mars missions.

Learning Objectives

1. The participant will be able to describe the XMIPT's current activities and how they contribute to exploration medical gap closure.
2. The participant will be able to understand the process by which exploration medical capability gaps and resulting roadmap activities were identified and prioritized.

[325] PILOT STUDY OF MEDICATIONS EXPOSED TO VACUUM

Phyllis Friello[1], Justin Yang[2], Moriah Thompson[3], Rahul Suresh[3], Tina Bayuse[4], Sincy Mathew[4], Craig Nowadly[5]
[1]*Leidos, Houston, TX, United States;* [2]*Aegis, Houston, TX, United States;* [3]*NASA, Houston, TX, United States;* [4]*KBR, Houston, TX, United States;* [5]*DoD, San Antonio, TX, United States*

(Education - Program/Process Review)

BACKGROUND: Few studies have been conducted regarding the effects of vacuum on medications and their packaging. While relevant on the International Space Station, understanding these effects becomes even more critical as future NASA missions venture farther away from Earth. Vehicles supporting the Artemis missions will have dedicated, vehicle-specific medical kits as well as crew medical accessory kits. Although most of the kits will be stored in a pressurized, climate-controlled volume, there are specific scenarios in which they may become exposed to vacuum. These include the vehicle being brought to vacuum to enable clearance of atmospheric contaminants, and on Human Landing System (HLS), in the airlock (in which kits may be stored) during extravehicular activities. **OVERVIEW:** The Exploration Medical Integrated Product Team (XMIPT) in collaboration with the Department of Defense is conducting a pilot study to assess the effects of vacuum on the medications and their packaging to be used in exploration missions. Phase A of this study will focus on manufacturer's package integrity and

Phase B on identifying chemical changes through active pharmaceutical ingredient (API) testing of the medications at 0, 4.5 and 9 months post exposure. Two exposure durations, 1 hour and 8 hours were selected to represent the expected time at vacuum for an Orion contaminated atmosphere vent/repress and the time at vacuum for a lunar surface EVA. The medications for this study were identified based on those currently being considered for future Artemis missions and represent the types of pharmaceuticals and formulations that are likely to comprise an exploration formulary. **DISCUSSION:** The results from this pilot study will aid in decision making related to the development of medical kits, medication packaging and stowage for long duration lunar and Mars missions, and inform the direction of future medication in vacuum studies.

Learning Objectives

1. The audience will gain an understanding of the potential vacuum exposure scenarios of exploration medications.
2. The audience will learn about the planned testing for medications in vacuum exposures.

[326] CREW HEALTH AND PERFORMANCE INTEGRATED DATA ARCHITECTURE PROJECT

Amanda Smith[1], Brandon Schmitt[2], Dennis Beaugrand[2], Philip Augustine[3], Melissa Lyons[2], Michele Beaugrand[2], Luis Montalvo[1]
[1]*KBR, Houston, TX, United States;* [2]*Alidyne, Houston, TX, United States;* [3]*NASA JSC, Houston, TX, United States*

(Education - Program/Process Review)

BACKGROUND: Future Human Exploration missions introduce a new paradigm as crews move further from the resupply and near real-time ground support typical of Low Earth Orbit missions today. Without immediate support from ground-based personnel, exploration crews will be more reliant on inflight data and technology to respond to emergencies and anomalies. A data architecture to support a new generation of technologies, employing advanced analytical and predictive modeling techniques, is needed to enable crew autonomy. **OVERVIEW:** The Crew Health and Performance Integrated Data Architecture (CHP-IDA) project funded by NASA's Exploration Medical Integrated Product Team (XMIPT) is laying a foundation for future in-flight informatics by providing a back-end architecture for collecting, storing, and integrating multiple sources of data generated by and around the crew. CHP-IDA provides a platform for common data models and Application Programming Interfaces to access, integrate, process, and display CHP data (e.g., environmental, exercise, medical, sleep, performance, etc.). This will facilitate the increased situation awareness and decision support required by the crew and remote support of exploration missions. This presentation will describe the currently ongoing effort to develop and evaluate a path-to-flight concept of the CHP-IDA software and its core capabilities. Current integrations will be discussed, including analytics for Extravehicular Activity metabolic rate and data ingestion from a multi-functional integrated medical device. The presentation will also provide examples of scenarios used to demonstrate the CHP-IDA through human-in-the-loop test bed activities as well as examples of appropriate system performance metrics. **DISCUSSION:** Today, in-flight data is often siloed, unsynchronized, and largely inaccessible in real time. Many data sets require manual entry and/or data transfer between vehicles and the ground. These issues contribute to risks in supporting exploration medical capabilities. The CHP-IDA is a back-end data system providing core capabilities needed for timely and meaningful data insights across CHP domains to crew and remote personnel to enable increased crew autonomy. Future work includes collaboration with additional CHP domains, new technology integrations, and further demonstrations of the IDA within different vehicle and communication latency contexts.

Learning Objectives

1. The audience will understand that the CHP-IDA is a back-end system, providing a platform to facilitate access, promote decision tools, and provide meaningful insights to crew and to remote stakeholders during exploration missions.
2. The audience will gain insight into human-centered research and activities used to discover CHP domain data needs and pain points and how this information is used to guide development of the IDA.

[327] AN AUTOMATED MEDICAL INVENTORY SYSTEM (AMIS) TO ENABLE EARTH-INDEPENDENT MEDICAL OPERATIONS

Courtney Schkurko[1], Justin Yang[2], Moriah Thompson[3], Rahul Suresh[3], Kimesha Calaway[4]
[1]*NASA Glenn Research Center, Cleveland, OH, United States;* [2]*Aegis Aerospace, Houston, TX, United States;* [3]*NASA JSC, Houston, TX, United States;* [4]*ZIN Technologies, Cleveland, OH, United States*

(Education - Program/Process Review)

BACKGROUND: Inventory of medical consumables and durables (medications, treatment aids, diagnostic equipment, etc.) aboard the International Space Station is a manual process whereby crewmembers reach out to their flight surgeon to relay when items are used. Performing a full medical system inventory is time intensive. However, as exploration progresses to long duration missions with little to no resupply or evacuation capabilities, maintaining an accurate account of inventory and location for medical systems across the mission will become increasingly critical. A new system must be developed for future exploration missions to meet the need for a crew-facing, real time method of managing medical inventory. **OVERVIEW:** NASA's Exploration Medical Integrated Product Team (XMIPT) is funding the AMIS project to mature the technology readiness level and to conduct a flight demonstration of a medical inventory capability. AMIS will leverage lessons learned from a Medical Consumables Tracking project previously demonstrated aboard the ISS in 2016 and 2017. Key components of AMIS include a database, supporting hardware and software, and interfaces to power, communications, or other vehicle or medical systems. Some medical inventory capability may be provided by the vehicle inventory management system which relies upon RFID-based technology and can track larger items such as medical kits or medical hardware. AMIS will augment these capabilities to enable tracking of individual medical kit contents. Efforts are underway to characterize the optimal solution trade space by comparing system specifications (e.g. mass and volume, etc.) across maintenance and operational use cases (e.g. crew time saved, total inventory automated, etc). **DISCUSSION:** The contents of a Mars Medical System have not been fully defined which poses challenges to defining an inventory system and requires assumptions regarding medical kit contents and medical system design. Other important considerations include minimizing crew time required, avoiding access restrictions to medical inventory in the event of an emergency, and ensuring that data is accessible to other medical system elements to enable crew autonomy in provision of medical care.

Learning Objectives

1. The audience will gain an understanding of the benefit of including a medical inventory tracking system for exploration spaceflight missions.
2. The audience will gain insight into the challenges of designing a medical inventory system suitable for spaceflight.

Wednesday, 05/08/2024 ***10:30 AM***
Grand Ballroom A

[S-57]: PANEL: MAKING SENSE OF SPECIAL SENSES III; IMPAIRED SENSORY FUNCTION AND AVIATION MISHAPS

Sponsored by AsHFA, Aerospace Medicine Human Factors Association

Chair: Harriet Lester
Co-Chair: Benisse Lester

PANEL OVERVIEW: *It's still the basics, when it comes to special senses and flight. Our limitations can be lethal. Intact visual, vestibular and auditory perception, and the accurate interpretation of sensory input, determine aviation performance and survival. Aeromedical standards help regulators identify defects in order to reduce the risk of accidents. Training and technology help offset shortcomings. The visual, vestibular and auditory systems will be discussed in terms of how failure of fundamental components including misperception can lead to mishaps, injury and death. Hearing in relationship to accidents, and abnormal visual fields and faulty stereopsis in USAF pilots will be discussed. Case report presentations will include: A mishap attributed to acute degradation of stereopsis due to monovision contact lenses; two fatal accidents involving spatial disorientation and vestibular illusions in instrument rated commercial pilots; and a fatal accident involving a monocular Flight Instructor with 22,000 hours. Failure and deficiencies of the auditory, vestibular, or visual systems, can be lethal. Aeromedical standards help mitigate risk but are not absolute. Pilots with intact sensory apparatus can have misperceptions, and pilots with abnormal sensory apparatus can under certain circumstances be well adapted. Safe flight depends upon intact special sensory systems, correct interpretation of sensory information, training and experience, and compliance with regulatory requirements designed to mitigate safety risk.*

[328] ANALYSIS OF A COMMERCIAL AIRLINE MONOVISION-RELATED MISHAP: CAN AN ACUTE DEGRADATION IN STEREOPSIS THREATEN YOUR LOVED ONES?

Douglas Ivan
ADI Consultants, San Antonio, TX, United States

(Education - Case Study)

INTRODUCTION: In 1996, a Delta Airlines McDonnell Douglas MD-88 commercial aircraft sheared off its main landing gear while attempting to land visually at LaGuardia Airport in New York City. **BACKGROUND**: After making physical contact with the approach lights and runway seawall, the aircraft impacted the ground, rotated 180 degrees, and slid nearly 3,000 feet down the active runway before stopping perilously short of Flushing Bay. Miraculously, all passengers safely evacuated the aircraft with only a handful of minor injuries. Although there were several environmental and technical factors that potentially impacted this event, the National Transportation Safety Board (NTSB) concluded that the probable cause of the mishap was the pilot's unapproved use of monovision contact lenses (CLs) that prevented him from overcoming the visual illusions and correctly interpreting the normal references associated with the landing. **DISCUSSION**: This paper will analyze the post-mishap ophthalmological findings of the mishap pilot and discuss the perceptual visual factors involved in this accident, particularly the likely role that an acute degradation of stereopsis from monovision CLs played in this event.

Learning Objectives

1. Attendees will learn about the visual factors and illusions associated with this particular commercial airline mishap.
2. Attendees will learn about the impact of monovision on stereopsis.

[329] VISION REQUIREMENTS REMAIN DESPITE TECHNOLOGICAL ADVANCES

Jonathan Ellis
USAFSAM, Wright -Patterson AFB, OH, United States

(Education - Case Study)

The ACS Ophthalmology Branch has advanced vision standards as new data, medical/surgical treatments, and aircraft/display technology has also advanced. However, despite all of this, there remain some vision standards that remain and will continue to do so despite any future gains. Cases will be discussed regarding visual field defects and defective stereopsis to highlight unique findings in these cases as well as the continued need for full binocular vision to ensure safety of flight and mission success. How these impairments in sensory function can contribute to aviation mishaps will be presented. Lastly, the likelihood and severity of the impact of these conditions on safety of flight will be used to quantify and highlight the level of risk using the Aeromedical Consultation Service Medical Risk Analysis and Assessment Matrix (AMRAAM).

Learning Objectives

1. The audience will learn about past and present stereopsis standards in USAF aircrew.
2. The audience will learn about past and present standards regarding visual field defects and conditions that can lead to visual field defects in USAF aircrew.
3. The participant will hear case reports of specific examples of aircrew who did not meet standards and learn how those conditions can adversely impact aviation duties despite technological advances.

[330] MAKING SENSE OF SPECIAL SENSES: MONOCULARITY CASE REPORT

Harriet Lester[1], Heather Hunn[2], Scott Nicholson[3], Benisse Lester[4]
[1]*FAA, Jamaica, NY, United States;* [2]*Federal Aviation Institute, Oklahoma City, OK, United States;* [3]*FAA, Oklahoma City, OK, United States;* [4]*Self-employed, Washington, DC, United States*

(Education - Case Study)

INTRODUCTION: A fatal accident involving a monocular Flight Instructor is presented. **BACKGROUND:** Vision is a critical and vulnerable special sense for the aviator. The loss of vision in one eye results in loss of binocular depth perception, and loss of visual field in areas not replicated by the eye with normal visual function. Monocular pilots seeking medical certification must demonstrate competency by successfully performing a Special Medical Flight Test (MFT) according to Flight Standards Order 8900.1, Vol5, Ch8, Sec1. The MFT can be performed after 6 months of visual function stability, and successful performance results either in a Statement of Demonstrated Ability (SODA) or a Special Issuance (SI), depending upon variables including ophthalmic diagnoses and Class of Medical Certification. **CASE PRESENTATION:** NTSB Report ERA13FA295 involved a 69 yo Flight Instructor with 22,0000 hours and a Class 1 Special Issuance for controlled Type 2 Diabetes Mellitis. He had a prosthetic left eye since age 16, and was 20/20 in his right eye with a mild nuclear sclerotic cataract, and no diabetic retinopathy.The accident resulted in 2 fatalities, on 6/20/2013 about 1648 EST in McClellanville, South Carolina. Visual meteorological conditions prevailed and an IFR flight plan was filed. A Rockwell International 690B went into an aerodynamic stall/spin. NTSB determined probable cause to be pilot loss of airplane control during high-altitude maneuvering and his subsequent failure to recover airplane control. Contributing to the accident was the flight instructor's inadequate supervision of the pilot and his failure to perform remedial action. They had not flown together previously. The purpose of the flight was for the pilot to accomplish a CFR Part 61.56 flight review. The flight instructor's resume listed more than 5800 hours in turboprop airplanes and more than 4100 hours as a flight instructor. CAMI toxicology reported diphenhydramine in the liver and urine, and slightly elevated glucose in the urine, consistent with hisType 2 diabetes. **DISCUSSION:** This fatal accident was not attributed by NTSB to monocularity, yet illustrates how multiple factors can contribute to an accident. Incidence of monocular vision (ICD10 code blindness) among deceased individuals within the AAM-612 Autopsy Program Team's aviation accident database (MANTRA) was reviewed from October 1, 2008 to September 2023, resulting in 15 cases. This data query will be discussed.

Learning Objectives

1. Participants will learn about medical certification requirements for monocular pilots.
2. Participants will learn about visual functions affected by monocularity as well as adaptations.

[331] VESTIBULAR SENSORY ILLUSIONS: FIXED-WING AIRCRAFT PILOT SPATIAL DISORIENTATION CASE STUDY

Jason Sigmon
FAA, Oklahoma City, OK, United States

(Education - Case Study)

INTRODUCTION: This case report describes two instrument-rated commercial pilots' loss of aircraft control and subsequent accident with 7 resulting fatalities due to spatial disorientation. **BACKGROUND:** Vestibular illusions during flight operations lacking adequate visual horizon are a sensory response from a *normal* functioning vestibular system. Accident(s) due to spatial disorientation and resulting loss of aircraft control still account for 5-10% of aviation accidents and are associated with a 90% or higher fatality rate. Despite artificial cockpit horizon reference and instrument training pilots still succumb to spatial disorientation in both general and commercial aviation. **CASE PRESENTATION:** On May 29th 2021, at 1053:06 CST a Cessna Citation departed Smyrna, Tennessee destined for Palm Beach International Airport on an IFR flight plan with two pilots and 5 passengers. The aircraft entered instrument meteorological conditions shortly after take-off and during maneuvering flight executed a series of abnormal flight control inputs resulting in controlled flight into terrain at 1055:05. A review of radar track data revealed the aircraft executed a series of heading changes along with several climbs and descents before it entered a steep descending turn and impacted the ground with a vertical descent speed in excess 30,000 feet-per-minute. Both pilots' were instrument and type-rated in the Cessna CE-501 and held commercial pilot certificates. Weather reporting at the time of the accident included winds out of the North at 10 knots and a cloud ceiling of 1,300 ft AGL. The final NTSB determined the probable cause of the accident to be loss of aircraft control due to spatial disorientation during aircraft climb. **DISCUSSION:** While non-instrument rated pilots operating VFR into IMC is a well described and recurrent cause for spatial disorientation accidents, instrument rated experienced pilots are not immune to loss of aircraft control due to spatial disorientation. Piloting an aircraft is dependent upon the combination of valid sensory information combined with motor inputs for a complete kinesthetic response for the safe operation of the aircraft in all phases of flight. The loss of visual horizon reference introduces illusory sensations in a pilot resulting in the potential for spatial disorientation. This case illustrates the importance of pilot awareness, recurrent training, and education to help mitigate the risks for spatial disorientation.

Learning Objectives

1. The audience will learn of the unresolved problem of spatial disorientation and aircraft accidents within the US national airspace system.
2. The audience will leave with a better understanding of the challenges in mitigating spatial disorientation due to the human sensory inner ear systems functional biases.

[332] IS HEARING A FACTOR IN FLIGHT SAFETY? YES, IN MORE WAYS THAN ONE

John Allen
Star Harbor, Denver, CO, United States

(Education - Program/Process Review)

BACKGROUND: There is dearth of literature on hearing loss resulting in aviation or space activities. This may be due to the establishment of hearing standards (e.g. AFI 48-127/48-123; OCHMO STD 100.1A) for both aviation and spaceflight participation. It may also be due to hearing conservation programs (NASA NPR 1800.1) and procedures that prevent significant hearing loss. However, many things affect the ability to communicate in individuals with hearing loss. This presentation will discuss communication challenges for all levels of aerospace participation, how hearing loss may or may not present operational safety risks, and what mitigation measures are or should be applied to both reduce the risk of hearing loss or communication challenges which might result in aerospace accidents. **OVERVIEW:** Hearing loss has been noted for decades to be caused by exposure to excessive noise. Data collected through routine medical examinations and hearing conservation programs has demonstrated the persistent degradation in hearing acuity accompanying years of noise exposure (Allen, et al, 2016). And yet military and commercial aviation and NASA space medical standards allow for progressively greater amounts of hearing loss, to a point. Standards also assume a certain level of communication ability, to a point. Program managers and engineers must understand hearing demands in all aspects of design and operations. including face to face, communications systems, and warnings and alerts. The designed acoustical environment of the air/space craft, the availability of personal hearing protection, and the noise levels of payloads that are manifested on space craft can all impact hearing and/or communications, potentially creating an unsafe environment. In addition to the above topics, this presentation will discuss the rationale for current hearing and noise standards as they relate to hearing abilities and demands on aviation and astronaut operations. **DISCUSSION:** The importance of good operational communication for the safety of any aviation or aerospace activity cannot be overstated. Accidents, whether minor or major, can be the direct result of inability to hear and understand critical messages and alerts (Casto and Casali, 2013). Vigilance in hearing protection and acoustical engineering design needs to be implemented to maintain participant health and safety.

Learning Objectives

1. The audience will learn about the importance and the insufficiency of current hearing standards.
2. The audience will learn about the need for a systems approach to preserving hearing and enhancing communication.
3. The audience will learn about the difference between "hearing" and "communication" and the importance of both.

Wednesday, 05/08/2024 ***10:30 AM***
Grand Ballroom B

[S-58]: PANEL: PSYCHONAUTICS: EMERGING THERAPIES IN MENTAL HEALTH AND HUMAN PERFORMANCE

Chair: Cheryl Lowry
Co-Chair: Brian Pinkston

PANEL OVERVIEW: *INTRODUCTION: Over the past decades, traditional mental health therapies for behavioral health diagnoses have been effective but not optimal. Psychedelic medications, glutamatergic drugs and immersive technologies using light and sound are emerging in clinical research trials as viable alternatives to traditional behavioral health therapies. New psychoactive drug development efforts are occurring on a global scale at unprecedented pace. Military forces, veterans and pilots may receive these emerging therapies via clinical trials or FDA-approved treatment protocols. Therefore, aviation medicine professionals must begin to understand these agents. This presentation is based on a review of literature regarding the clinical use of nontraditional behavioral health treatments and performance enhancements. Methodologies reviewed include psychedelic medications, glutaminergic drugs, immersive technodelic experiences, vagus nerve stimulation, and naturally-induced holotropic states of consciousness. Diagnoses considered for treatment include PTSD, depression, anxiety and substance use disorder. TOPIC: Nontraditional methods of treatment for common behavioral health conditions have shown beneficial results in numerous clinical trials. Treatment-specific indications and results will be discussed in separate panel sections. APPLICATION: Despite appropriate psychotherapy and pharmaceutical development, traditional psycho therapeutic treatment modalities remain inadequate in addressing the mental health crisis worldwide. The Veterans Administration, Department of Defense and healthcare systems have prioritized mental health disease morbidity and mortality reduction; therefore, pilots and personnel in safety-sensitive occupations may receive these novel treatments and performance enhancements. Aerospace medicine professionals must be familiar with*

the psychoactive properties of these modalities, as well as their clinical indications and associated risk profiles. The development of therapeutic modalities that to reduce the burden of behavioral health disorders among aircrew must be balanced with meticulously-performed research in order to maintain aviation safety.

[333] INTRODUCTION TO PSYCHEDELIC-ASSISTED THERAPY (PAT)

Brian Pinkston
Kinetic Medical Consultants, St. Petersburg, FL, United States

(Education - Tutorial/Review)

INTRODUCTION: The clinical use of psychedelic medications in western medicine began with Albert Hofmann's synthesis of lysergic acid diethylamide (LSD) in 1939. Early research with LSD showed remarkable results as psychotherapeutic agents, as well as psychomimetic and psycholytic agents. The abuse of psychedelic medications by the counterculture in the 1960s led to the prohibition of their legal use and the cessation of sanctioned research efforts. LSD and other psychedelic medications were listed as Schedule one drugs by the Controlled Substances Act of 1970, further constraining their legal use. This presentation will review medications commonly used in PAT, potential clinical indications for PAT, and the typical architecture of PAT sessions. This presentation is based on a literature review regarding the history and clinical use of psychedelic-assisted therapy and the introduction of holotropic states of consciousness in the therapeutic environment. **TOPIC:** The utility of these medications recently re-emerged through the research efforts of Roland Griffiths at the Johns Hopkins Center for Psychedelic and Consciousness Research. The Hopkins team showed significant reduction in death-related anxiety in patients with terminal illnesses, warranting further research in their use for treatment of other behavioral health conditions. Research efforts legitimized continued research over the last two decades, ultimately resulting the rapid worldwide emergence of PAT clinical trials. **APPLICATION:** This section provides an overview of current medications used in PAT and indications for their use. Naturally-induced holotropic states of consciousness will be discussed. The current status of clinical trials and FDA approval efforts will be explored. Finally, a case presentation will illustrate key objectives.

Learning Objectives

1. Name five substances that have been used in psychedelic-assisted therapy.
2. Describe the phases of psychedelic-assisted therapy. Discuss clinical trial findings for the uses of each substance currently used in psychedelic- assisted therapy.
3. Discuss clinical trial findings for the uses of each substance currently used in psychedelic- assisted therapy.

[334] GLUTAMATERGIC DRUGS, WITH A FOCUS ON KETAMINE AND ESKETAMINE, FOR TREATMENT-RESISTANT DEPRESSION IN PILOTS AND VETERAN

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(Education - Program/Process Review)

INTRODUCTION: Medication selection and management is a major component of psychiatric treatment. Medication options increased dramatically over the last 50 years and will expand further during the next 10-25 years. One in three of the 21 million Americans who receives care for depression each year is not responsive to treatment and meets criteria for treatment-refractory depression (TRD). Intravenous ketamine and intranasal esketamine (ESK) have been used clinically for patients with TRD. Preliminary clinical trial results show significant symptom improvement. Pilots and veterans with depression and TRD may pursue these treatment modalities; therefore, an understanding of their development, safety profile and therapeutic benefit is essential. **METHODS:** This presentation is based on a literature review regarding the clinical use of ketamine and esketamine for treatment-refractory depression. We also review and discuss the development and use of novel drugs affecting the central nervous system. **RESULTS:** Esketamine nasal spray, a noncompetitive *N*-methyl-d-aspartate (NMDA) receptor antagonist classified as a rapid-acting agent, is the first novel mechanism of action antidepressant to be approved in over 60 years. ESK is indicated for use in conjunction with an oral antidepressant for the treatment of adults with TRD as well as suicidality associated with depression. Despite ESK being FDA approved in 2019, its use in clinical practice has not been widespread, particularly considering the prevalence of treatment resistant depression TRD. Changes in psychiatric treatments occur as understanding of the pathophysiology of psychiatric illnesses advances, discoveries in genetic research and brain imaging occur, and new physiological, biochemical, and pharmacologic tools are developed. **DISCUSSION:** It is imperative that aerospace medicine practitioners and policy makers understand the risks and benefits of treating depressed or suicidal veterans and pilots with ESK. Clinicians must understand how knowledge of the pathophysiology underlying psychiatric illness led to currently-available medications and informed the discovery of the mechanisms by which they work. Understanding the process of new drug development is critical for clinicians to evaluate the literature and judge whether and how to introduce new medications for the treatment of pilots and veterans with treatment-refractory psychiatric illness.

Learning Objectives

1. Understand the drug discovery and development process as it pertains to novel mechanism of action CNS drugs.
2. Review the literature on intravenous ketamine and intranasal esketamine for treatment-refractory depression (TRD).
3. Understand how the development program and FDA approval of esketamine for TRD as well as suicidality associated with major depression can be a road map for studying other novel mechanism of action drugs for psychiatric illness.

[335] PSILOCYBIN AND PSYCHEDELICS IN AVIATION MEDICINE

Cheryl Lowry[1], William Tyler[2]
[1]*Kinetic Medical Consultants, St. Petersburg, FL, United States;* [2]*Diamond Therapeutics, Inc., Birmingham, AL, United States*

(Education - Tutorial/Review)

INTRODUCTION: Recent clinical trials have demonstrated the potential of psilocybin and related tryptamine psychedelics in addressing mental health and substance abuse disorders, as well as enhancing human performance. The Department of Veterans Affairs has recently begun clinical trials for the use of psychedelic medications for treatment of PTSD and other behavioral health diagnoses. Therefore, it is possible that pilots with a military background will have received these experimental treatments. It is important for physicians involved in both clinical aerospace medicine, as well as aeromedical policy and safety, to understand the clinical indications and implications of psychedelic medications. **This presentation is based on a review of recent literature involving the use of psychedelic medications for for treatment of** behavioral health diagnoses including PTSD and addiction. **TOPIC:** When treating depression, anxiety, PTSD, and addiction among aircrew, psilocybin therapy appears to bolster introspection and perceptions of wellbeing, potentially diminishing aviation safety risks attributed to mental health. Separately, there is emerging evidence indicating non-medical advantages of psilocybin microdosing, such as heightened focus, creativity, and sensorimotor performance. These effects have potential to refine the cognitive and physical prowess of pilots and astronauts, offering augmented training outcomes, expedited reactions, and superior aircraft handling. **APPLICATION:** If psychedelic medicines receive

regulatory approval, stringent protocols and guidelines must be crafted to safeguard against any detrimental impacts on aviation operations and safety. Determining the effects of psychedelic treatments on aviation-specific cognitive and sensorimotor skills necessitates rigorous exploration. Judicious microdosing may benefit aerospace and military performance. Psychedelic treatments may refine cognitive and physical prowess of pilots and astronauts, offering augmented training outcomes, expedited reactions, and superior piloting. The rapid re-emergence of psychedelic treatments warrants the attention and involvement of the aerospace medicine community. Additional safety and efficacy research is imperative to navigate the complexities of integrating psychedelics within aviation, and the applicability to pilots and military personnel.

Learning Objectives

1. Identify the clinical research indications for the use of psychedelic medications.
2. Discuss the potential performance enhancement properties of psychedelic medications and their application in aviation medicine.
3. Discuss the risks of psychedelic medication use in pilots.

[336] EMERGING NONPHARMACOLOGIC BEHAVIORAL HEALTH AND COGNITIVE TREATMENT MODALITIES

Brian Schiefer[1], Cheryl Lowry[2]
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(Education - Tutorial/Review)

INTRODUCTION: Depression, PTSD, addiction, and traumatic brain injury (TBI) continue to represent significant treatment challenges for pilots, as well as the general population. Traditional therapies have shown varying degrees of effectiveness, and there is growing interest in innovative interventions. "Technodelics" is a term that blends technology such as virtual reality, light, sound and immersive digital experiences. These are used alone or in combination with breathwork or psychedelic substances to induce states of consciousness. Technodelics provide users with a novel and often immersive sensory experience that can alter perception, enhance creativity, or lead to a heightened sense of connectedness. Some proponents argue technodelics can have therapeutic or consciousness-expanding effects similar to traditional psychedelics, without ingesting any substances. These new therapeutic modalities may represent viable treatment adjuncts or alternatives for pilots and other safety-sensitive occupations. **This presentation is based on a review of recent studies involving the use of technodelics for treatment of** behavioral health diagnoses.**TOPIC:** Recent scientific literature suggests that technodelics, when administered in controlled settings, have shown promising results in the treatment of behavioral health diagnoses, addiction and TBI. Research has shown statistically significant improvements in mood and cognitive function, as well as overall well-being. Technodelics appear to modulate neural activity and facilitate introspection, potentially aiding in the resolution of trauma and addiction-related issues. Light and sound therapy may influence circadian rhythms and neuroplasticity, which can positively impact mood disorders and therapy, and sound therapy presents a novel approach to addressing depression, PTSD, addiction, and TBI. Pilots seeking treatment for behavioral health conditions and TBI may benefit from these emerging non-pharmacological treatments. The effectiveness of these treatments can vary among individuals. While preliminary results are promising, more extensive and controlled research is required to establish the safety and efficacy of these treatments and to determine their long-term impact on patients. Additional studies are needed to determine the safety and efficacy of these treatments in pilots and personnel in safety-sensitive occupations.

Learning Objectives

1. Define and describe the term "technodelic" clinical treatment modalities and their indications.
2. Understand various types of immersive "technodelic" methodologies including light, sound and virtual reality.

[337] VAGUS NERVE STIMULATION FOR ENHANCEMENT OF HUMAN PERFORMANCE IN AVIATION

William Tyler
IST, LLC, Birmingham, AL, United States

(Education - Tutorial/Review)

INTRODUCTION: The potential of auricular vagus nerve stimulation (aVNS) to improve health and performance in aviation and military professionals is gaining attention. This non-invasive neuromodulation technique uses electrical impulses delivered to the outer ear to stimulate auricular branches of the vagus nerve. AVNS has been shown to reduce fatigue, anxiety and depression through neuromodulation. This presentation is based on a literature review regarding the use of aVNS for fatigue mitigation, stress reduction and performance enhancement. **TOPIC:** Recent research has demonstrated aVNS may offer solutions to some of the pressing challenges faced by pilots and other personnel in aviation and military occupations. Irregular sleep schedules and circadian disruption can severely impact performance through fatigue and impaired alertness. By modulating key neurotransmitters and brain activity starting in the ascending reticular activating system, aVNS can improve sleep quality and restore natural circadian rhythms. Utilizing aVNS in this capacity can lead to more rested and vigilant pilots and crew, enhancing aviation safety. Additionally, high levels of occupational stress in aviation can contribute to mental health disorders, including anxiety and depression. It has been shown that aVNS can provide therapeutic effects for those suffering from depression and anxiety leading to an improved quality of life. Chronic stress also raises systemic inflammation, increasing future health risks. It has been shown that aVNS can reduce inflammation by reducing cytokines through modulation of the cholinergic anti-inflammatory pathway. **APPLICATION:** AVNS could be a useful non-pharmacological intervention in the aviation industry and special duty personnel, given the high-pressure environment. Inflammation reduction by aVNS could not only improve quality of life, but also boost operational readiness by reducing stress and illness-related absences. In summary, through its versatile effects on sleep, mental health, and inflammation, aVNS is an appealing new avenue for optimizing the performance and safety of aviation and special duty professionals. Further research on this non-pharmacological neuromodulation technique may uncover approaches to enhance aerospace medicine through both treatment and prevention.

Learning Objectives

1. Describe the potential indications for the use of auricular vagus nerve stimulation.
2. Understand the mechanism of action for vagus nerve stimulation treatments.

Wednesday, 05/08/2024 ***10:30 AM***
Grand Hall J

[S-59]: SLIDES: HEALTH AND WELLNESS EVALUATIONS

Chair: Paul Young
Co-Chair: Sandy Salzman

[338] MOVED TO [S-65]: AEROSPACE MEDICINE IN GERMANY AND SWITZERLAND

[339] CURRENT RESEARCH AND FUTURE DIRECTIONS IN FEDERAL AVIATION ADMINISTRATION COGNITIVE SCREENING TESTS FOR PILOT MEDICAL CERTIFICATION

Kelene Fercho
FAA, Oklahoma City, OK, United States

(Original Research)

INTRODUCTION: Pilots work in a cognitively demanding environment, making decisions under conditions of operational stress not experienced by most workers. The outcome of a pilot's decisions has the potential to impact hundreds of lives; thus, it is critical that only those who are medically fit to fly do so. As part of the medical certification process, the Federal Aviation Administration (FAA) may require cognitive screening if a pilot has a medical history associated with a potential aeromedically significant cognitive impairment (e.g., stoke, head injury). In these cases, a computer-based neuropsychological test provides an objective measure of cognitive status. Computer-based neuropsychological testing has evolved over the past decades, and now many computerized screening tests and comprehensive test batteries are widely available for both clinical and research use. This current FAA research seeks to: 1) determine reliable and valid, commercially available computer-based tests that could be used for cognitive screening as part of the FAA's medical certification process; and 2) develop pilot normative data for these tests. **METHOD:** Candidate computer-based neuropsychological test batteries were identified through literature searches, market surveys, and in consultation with subject matter experts. Test inclusion and exclusion criteria were applied, and a scoring rubric was used to select the tests for data collection. Normative datasets are being developed for two pilot reference groups: 1) pilots with a FAA first-class or second-class medical certificate; and 2) pilots with a FAA third-class medical certificate. **RESULTS:** Sixty-two computer-based neuropsychological test batteries were identified. Test inclusion and exclusion criteria reduced the number of candidate tests to eight. Subject matter experts used an objective scoring rubric to select the three tests used in normative data collection. Normative data collection is in progress with a target total sample size of 960 pilot participants across two reference groups (i.e., FAA medical class) and six age bands. **DISCUSSION:** This research will ensure that FAA aeromedical guidelines for cognitive screening in the FAA medical certification process are consistent with the best current scientific knowledge, and will increase cognitive screening test options with pilot normative data for use by aeromedical health care providers.

Learning Objectives

1. Understand the FAA's research effort to identify computer-based cognitive screening tests in the FAA medical certification process, including the FAA's test selection criteria and methods.
2. Describe the FAA's ongoing normative data collection effort with a large pilot sample following an Institutional Review Board (IRB)-approved protocol.

[340] LONG TERM OUTCOMES OF REFRACTIVE SURGERY IN AVIATORS

Oded Ben-Ari[1], Liora Levian Moadim[1], Aya Ekshtein[1], Maya Avni[1], Dana Berger[1], Yuval Kozlov[2]

[1]*Aeromedical Center, Israeli Air Force, Ramat-Gan, Israel;* [2]*Hebrew University of Jerusalem, Jerusalem, Israel*

(Original Research)

INTRODUCTION: Photorefractive Keratectomy (PRK) and Laser-Assisted in Situ Keratomileusis (LASIK) are widely applied procedures designed to correct refractive errors in adults. Despite the evidence on the safety and effectiveness of these surgeries, long-term visual and refractive outcomes in combat pilots are not thoroughly investigated. This study aimed to investigate long-term effects of PRK and LASIK on Israeli Air Force (IAF) aviators. **METHODS:** Medical records of aviators who underwent refractive surgery during their service were extracted. Preoperative and annual- postoperative data were analyzed. Key metrics included visual acuity (VA) and spherical equivalent (SE). This study was approved by the Institutional Review Board. **RESULTS:** 87 records were analyzed. Mean age at the time of surgery was 31.8±9.8 years, 95.4% male. Pre surgery myopia severity (SE) was -2.060±1.158. LASIK and PRK procedures were performed in 62.1% and 33.3% of the surgeries, respectively. Both PRK and LASIK demonstrated significant, sustained improvements in VA for 11 years ($p=0.035$) and SE for 12 years ($p<0.001$). Myopia severity pre-surgery was identified as a crucial determinant for postoperative outcomes for VA ($p=0.029$) and SE ($p=0.008$). Age, astigmatism, and procedure type did not significantly influence long-term outcomes. **DISCUSSION:** This retrospective study of IAF aviators provides vital understanding into the enduring effectiveness of PRK and LASIK procedures. Notably, the study demonstrated substantial and sustained enhancements in different visual parameters for up to 12 years post-surgery. Both PRK and LASIK yielded substantial improvements, with no procedure showing superior results, allaying some prior concerns regarding potential corneal instability from LASIK's corneal flap.

Learning Objectives

1. This study shows that LASIK's corneal flap stability is preserved even under extreme altitudes, hypoxia, and high acceleration over a long period of time.
2. This study demonstrated that PRK and LASIK both led to significant enhancements, and neither procedure demonstrated superior outcomes over the other.

[341] MENTAL HEALTH AND WELLNESS FRAMEWORK FOR PILOTS AND AIR TRAFFIC CONTROLLERS: A SINGAPORE APPROACH

Benjamin Tan, Chun Hon Chong

Civil Aviation Authority Singapore, Singapore, Republic of Singapore

(Education - Program/Process Review)

BACKGROUND: There has been a rapidly growing global burden of mental health disorders, and the COVID-19 pandemic has acutely highlighted its importance not only at workplaces but also across societies and varied populations. Aviation professionals around the world are not spared and may have occupation related stressors including high workload, inconsistent work schedule, time zone shifts, fatigue and sleep disturbances. The impact of aviation professionals' mental health on aviation safety is wide-ranging; from lapses and errors to intentional pilot actions. There is a need to address mental health related risks toward aviation safety. **OVERVIEW:** To effectively mitigate the associated aviation safety risks, a salutogenic approach and comprehensive framework for mental health were assessed to be critical. In Singapore, a unique tripartite framework on mental health and wellness for pilots and air traffic controllers was jointly developed by the Civil Aviation Authority Singapore, the airlines and unions. Also known as the EPIC framework, several initiatives along the four pillars of Education, Peer Support, Intervention and Collaborative Programs were pursued collaboratively to strengthen mental health and wellness for our aviation professionals. **DISCUSSION:** In this presentation, the philosophy and conceptualization of the EPIC framework will be expounded. The various efforts to strengthen the mental health support structures and networks, in alignment to the EPIC framework, will also be shared. Upcoming initiatives to anchor sustainable and long term outcomes will be briefly covered.

Learning Objectives

1. Understand the complex nature of mental health and wellness issues and the importance of safeguarding it for Pilots and Air Traffic Controllers, to better manage aeromedical risks and aviation safety.
2. Learn about a novel tripartite approach for mental health and wellness under the EPIC Framework that has been designed to change culture, reduce stigma and grow peer support networks in encouraging aviation professionals to actively seek help and support.

[342] PEER SUPPORT SERVICE UTILISATION AND USER SATISFACTION OVER A FIVE-YEAR PERIOD: CHALLENGES AND OPPORTUNITIES FOR AN EMERGING FIELD.

Aedrian Bekker, Rob Bor
Centre for Aviation Psychology, London, United Kingdom

(Education - Program/Process Review)

BACKGROUND: Peer Support within the aviation sector is gaining increasing prominence and has become a popular mental health intervention for those who work within it. For those employing commercial pilots, it is a mandated requirement across Europe and the UK and is rapidly becoming best practice in North America and other parts of the world. **OVERVIEW:** At its heart, Peer Support is primarily a user-led service supported mostly by trained, volunteer colleagues (i.e. peers). It is designed to (a) lower the barriers to help-seeking behaviour within largely reticent professions, such as pilots, (b) de-pathologise stressful and debilitating experiences and feelings of users through the unique support and validation of their peers, (c) where appropriate, encourage and direct users towards more specialist services, and (d) prevent common life stressors and mental health challenges from escalating to potentially career-limiting and costly outcomes for both the user and their employer. While Peer Support programmes and their methodologies vary, most operate within specific terms of reference, including oversight or access to a specialist mental health professional. While frequently referenced in the industry press, at conferences and workshops, there are few published studies looking at the utilisation patterns, satisfaction levels and user demographics of those who use of Peer Support services. **DISCUSSION:** Our primary purpose of this study has been to answer the following questions: 1) Who uses Peer Support? 2) Why do they use it? 3) How debilitating are their current circumstances that led them to this service? 4) Has it made a significant improvement to their situation having used it? Over the past 5 years, we have aggregated utilisation, categorisation and distress-intensity patterns, along with feedback and (limited) outcome data from across a range of AOCs across the commercial aviation sector. This presentation will explore these findings and consider them within the context of existing challenges and opportunities for this burgeoning field of practice and study. 'Lessons learned" will also be shared with those considering this intervention for other safety-critical professions.

Learning Objectives

1. Considering the usage, causes, and user demographics of pilots utilising peer support services.
2. Contextualising these findings within the challenges and opportunities for those operating (and studying) these services as primary mental health interventions.
3. Understanding the similarities and differences when applying peer support services to other safety-critical, aviation professions.

[343] A REGULATORY SAFE HAVEN

Tim Sprott, Claude Preitner, Sarita Dara
Civil Aviation Authority New Zealand, Wellington, New Zealand

(Education - Program/Process Review)

AUSTRALASIA AND A REGULATORY SAFE HAVEN

BACKGROUND: Estimates for healthcare avoidance for fear of aeromedical certificate loss vary between 46% to 56% with up to 72% of pilots feeling concerned about the possible impacts of seeking medical care on their career or recreation. Rates of withholding or misrepresenting information on a written questionnaire, such as routine medical examinations, may be in the order of 26-27%. There are also tensions faced by aviation and other health professionals working with pilots, even where defined practical pathways for disclosure exist. Healthcare avoidance in combination with the absence of recognised pathways for disclosure to regulators can lead to major risks to safety of the aviation system. The most publicised example is the Germanwings accident but this is far from an isolated example. **OVERVIEW:** Confidential safe zones external to formal regulatory processes are integral to peer support programmes such as HIMS and PAN. This project expands this concept further for a system that applies to all health conditions that may affect the safety and well being of pilots. **DISCUSSION:** This presentation outlines the concept of a confidential reporting system incorporating a safe zone to encourage pilot disclosure of medical conditions outside the formal regulatory framework, but with some oversight. The management of reported conditions and the potential liability, safety risks and "safety drift" are discussed.

Learning Objectives

1. The current magnitude of healthcare avoidance and non-disclosure of medical conditions by pilots concerned about potential consequences on their aeromedical certification status and careers.
2. The potential aviation system risks associated with pilot healthcare avoidance and non-disclosure of medical conditions.
3. A potential confidential system incorporating a safe zone to encourage pilot disclosure of medical conditions outside the formal regulatory framework, but with some oversight. The management of reported conditions and the potential liability, safety risks and "safety drift" are discussed.

Wednesday, 05/08/2024 ***10:30 AM***
Grand Hall K

[S-60]: PANEL: USAFSAM AAMIMO 2024 CLINICAL CASE PRESENTATIONS: A MULTI-NATIONAL MILIEU OF MALADIES

Chair: Jeffrey Harris

PANEL OVERVIEW: *The Advanced Aerospace Medicine for International Medical Officers (AAMIMO) program is a 6-month workshop hosted by the US Air Force School of Aerospace Medicine (USAFSAM). Experienced Aerospace Medicine physicians from militaries around the world complete educational rotations with each US Dept of Defense Agency, as well as with the FAA and NASA. The workshop is meant to increase understanding and interoperability between Aerospace Medicine practitioners from all over the world. Each participant will prepare and present an educational clinical case, either from their country or from their experiences at USAFSAM, that will highlight similarities and differences in international medical standards and how we care for our patient populations. The panel will be a grand rounds style collection of clinical cases in aviation medicine.*

[344] FLIGHT OF THE GIRAFFE: MUSCLE TENSION DYSPHONIA IN A FEMALE OFFICER CADET PILOT

Sampath Hewawasam[1]; Liu Yutong[2]
[1]*Sri Lankan Air Force, Trimcomalee, Sri Lanka;* [2]*Flight Training Command, Gangshan AFB, Kaohsiung, Taiwan*

(Education - Case Study)

INTRODUCTION: This case report describes a female officer cadet pilot with poor quality of communication with the Air Traffic Control (ATC) tower, causing significant problems for safety of flight. **BACKGROUND:** Radio communications are a critical link in the ATC system. If this communication is not established properly, misunderstandings can arise leading to the potential for fatal accidents or violation of flight safety rules. Hence, the clarity of communication between pilots and ATC is a critical factor in the field of aviation. **CASE PRESENTATION:** The subject pilot was a 22-year-old in the Sri Lankan Air Force. The ATC tower crew recognized that the communications from the pilot while in the air were not clear enough during her solo flight. She had no problems with communication, including no hoarseness of voice in normal day-to-day life. She was grounded from flying due to unclear communication with ATC crew. She underwent an extensive physical and psychological workup to determine the cause of her speech difficulties. She was found to be suffering from a fear of flying and training stress. A video stroboscope also found that

she had abnormal function of her left vocal cord. She was diagnosed as secondary muscle tension dysphonia by an ENT surgeon. Her vocal cord was surgically repaired. Her fear of flying was successfully treated with cognitive behavioral therapy and a short course of Fluoxetine. She completed speech therapy with good results and was ultimately allowed to return to flying. At present, she is performing her duties as a clever pilot in SLAF. **DISCUSSION:** Training pilots requires a significant investment of resources, and flight surgeons should be capable of managing this type of complex case to meet the operational needs of the military and to assist a young pilot achieve their professional aspirations. We will discuss the differential diagnosis for speech difficulties as well as the treatment for MTD. We will also compare aviation medical standards both military and civilian in Sri Lanka, Taiwan, and the United States.

Learning Objectives

1. The audience will learn about the presentation, diagnosis, and/or treatment of an interesting Aerospace Medicine case.
2. The audience will learn about the similarities and differences in medical standards and pilot medical clearances for civilian, US and foreign military aviation professionals.

[345] WPW SYNDROME IN A JAPAN SMALL JET PILOT

Shotaro Yamamoto[1]; Liwaa Alaa Al-Hamami[2]
[1]*Air Staff Office, Tokyo, Japan;* [2]*Iraqi Air Force Aeromedical Facility, Tikreet, Iraq*

(Education - Case Study)

INTRODUCTION: In this case report we will describe a Japanese military U-125 Pilot who was found to have WPW syndrome during his annual aviation medical examination and returned to flight duties through catheter ablation. **BACKGROUND:** Wolff-Parkinson-White syndrome, or WPW syndrome, is a cardiac arrhythmia characterized by an abnormal electrical pathway in the heart. Normally, the heart's contractions are regulated by a specific pathway, but in WPW syndrome, an abnormal pathway known as an "accessory pathway" exists. This can lead to rapid and irregular heartbeats. One specific arrhythmia associated with WPW syndrome is called "pseudo ventricular tachycardia." In this condition, the abnormal pathway allows the ventricles to be excited prematurely, resulting in a faster heartbeat than usual. This pseudo ventricular tachycardia is distinct from regular ventricular tachycardia. When pseudo ventricular tachycardia occurs, the heart rate becomes very fast, and the rhythm becomes irregular. Symptoms may include dizziness, shortness of breath, and chest discomfort. In severe cases, loss of consciousness can occur. **CASE PRESENTATION:** The pilot was 46 years old when an electrocardiogram during an aviation medical examination showed ventricular tachycardia-like waveforms, and he was suspended from flight duties. He underwent cardiac electrophysiology testing, was diagnosed with WPW syndrome, and underwent catheter ablation. One month after the ablation, he underwent echocardiography, Holter ECG, and exercise stress ECG, none of which showed arrhythmia. Aeromedical Evaluation Board allowed him to return to flight duties on conditions. No further problematic arrhythmias were found. Another Aeromedical Evaluation Board was conducted, with arrythmia mitigated, he was returned to fly. **DISCUSSION:** At JASDF, the Aeromedical Evaluation Board determines whether a pilot who fails an aviation medical examination is allowed to return to flight duties. Ablation for WPW syndrome generally has a high success rate. However, in some patients with multiple abnormal conduction pathways, other conduction pathways may cause recurrence, so it is necessary to define appropriate evaluation criteria for each patient with WPW syndrome. This presentation will discuss the flight conditions imposed on pilots and the measures used by Japan, Iraq, and the US military for various arrhythmias.

Learning Objectives

1. The audience will learn about the presentation, diagnosis, and/or treatment of an interesting Aerospace Medicine case.
2. The audience will learn about the similarities and differences in medical standards and pilot medical clearances for civilian, US and foreign military aviation professionals.

[346] MISPLACED MALARIA: VIVAX ON ICE

Sneha Dinakar
Department of Acceleration Physiology, Institute of Aerospace Medicine, Indian Air Force, Bengaluru, Karnataka, India

(Education - Case Study)

INTRODUCTION: Malaria continues to pose a problem in endemic countries, due to emergence and spread of drug resistant Plasmodium parasites. Plasmodium (p) falciparum and p. vivax are responsible for the bulk of global morbidity and mortality statistics. India accounts for ~ 80% of cases and ~ 83% of deaths reported in South East Asian (SEA) regions as of 2021. **BACKGROUND:** Malaria is not so much of a diagnostic issue if it occurs in an endemic region. However, with fewer than 2000 cases annually in the US, only a high degree of suspicion can nail the diagnosis. The reported cases of malaria in the US are always imported by people returning from endemic regions or troops returning from deployment. Amongst the four common species of malaria parasite (falciparum, vivax, ovale and malariae), vivax has the longest dormant phase in the liver going from weeks to months. **CASE PRESENTATION:** A 54 yo Indian Air Force (IAF) airman, with no known co-morbidities and not on any medication, was deployed to Alaska for a 4-week flying exercise. He travelled via civil air and was asymptomatic for the first two weeks after arrival. He presented with fever and myalgia in the third week, that was managed with anti-pyrectics for 48 hours. After 48 hours of continued symptoms, his bloodwork showed significant thrombocytopenia. He was hospitalised and managed as a case of malaria. **DISCUSSION:** A high degree of suspicion must be exercised in a patient presenting with unexplained fever and thrombocytopenia. History of travel from such areas should raise caution. In aeromedical concerns, once the acute phase is treated, the patient/aircrew will also be treated with pharmacotherapy to eliminate all phases of the parasite. It is imperative to treat a case like a mixed infection (vivax+falciparum) to prevent recurrence after a dormant phase. The duration of extended care and recuperation may take up to 4 weeks, during which time the adverse drug reaction will be looked for and treated. The aircrew can resume flying duties thereafter.

Learning Objectives

1. The audience will learn about the presentation, diagnosis, and/or treatment of an interesting Aerospace Medicine case.
2. The audience will learn about the similarities and differences in medical standards and pilot medical clearances for civilian, US and foreign military aviation professionals.

[347] THE EFFECT OF FLIGHT MANEUVERS ON G-TOLERANCE IN A FIGHTER PILOT

Saja Ameer Hanoon
Iraq Air Force Medical Command, Baghdad, Iraq

(Education - Case Study)

INTRODUCTION: This is a case of a fatal F-16 mishap due to G-induced loss of consciousness (GLOC), that highlights physiologic factors which may decrease a pilot's tolerance of G forces. **BACKGROUND:** G forces continue to be a significant threat in fighter aviation. Safety data shows that 157 G-related mishaps occurred between FY01 and FY11 with five Class As and three fatalities costing $86.2M. Almost all military pilots, as part of their flight training, will undergo some exposure to the high +G environment. Fast jet operations, however, are where the vast majority of high +G exposure occurs. Fighter pilots are given extensive tools and training to overcome the effects of +G, including centrifuge training, advanced technology anti-G suits (ATAGS), positive pressure breathing for +G, physical conditioning, and refresher training on the anti-G straining maneuver (AGSM) continuously throughout their careers. **CASE PRESENTATION:** The mishap pilot was a physically fit 34-yr-old man. He had over 600 total flying hours. He was a pilot instructor on T-6A and completed training the T-38 prior to entering training in the F-16. On a regular training sortie, the pilot executed a maneuver that caused him to experience negative G followed immediately

by + 9G at which point he experienced GLOC. The pilot regained some level of consciousness prior to crashing and tried to eject, however, it was unsuccessful. The aircraft was destroyed and the pilot dead. He was current on all Aerospace Physiology training. Prior to the mishap sortie. After the crash, a postmortem tissue examination detected the consumption of a nutritional supplements. No carbon monoxide, ethanol, or illegal substances. The mishap aircraft was an F-16CM built in1991. **DISCUSSION:** This tragic accident is one of many that have occurred in military fighter pilots. As flight surgeons, we should be award of all factors that may negatively contribute to a pilots abilities in the jet, and be ready to educate air crew about how to stay healthy. In this presentation we will discuss some specific factors that affect G tolerance, including the push-pull effect, the effect of lifestyle on physiologic compensation and decision making under stress, as well as potential effects of common nutritional supplements.

Learning Objectives

1. The audience will learn about the presentation, diagnosis, and/or treatment of an interesting Aerospace Medicine case.
2. The audience will learn about the similarities and differences in medical standards and pilot medical clearances for civilian, US and foreign military aviation professionals.

[348] PERSISTENT TUBERCULOSIS IN A MILITARY TRANSPORT PILOT: A CASE REPORT

Nurunnabi Ibn Hossain[1]; Haseena Syazwani Hassan[2]
[1]*Banabandhu AFB, Bangladesh;* [2]*Institute of Aviation Medicine, Malaysia*

(Education - Case Study)

INTRODUCTION: This case report describes a Royal Malaysian Air Force (RMAF) transport pilot with recurrence of pulmonary tuberculosis (PTB) despite completion of 2 courses of anti-TB treatment. The recurrent PTB was found incidentally during workup for a positive home COVID-19 test. **BACKGROUND:** Tuberculosis is a public health concern in many countries including Malaysia and Bangladesh. It is usually a subacute respiratory infection with prominent constitutional symptoms. The most frequent symptoms are cough, fever, weight loss, night sweats, malaise, and hemoptysis. PTB is a significant aeromedical concern as the symptoms affect aircrew's ability to perform effectively and the treatments may adversely affect concentration and coordination. Additionally, airborne transmission results in significant hazards for flight safety in transport operations. **CASE PRESENTATION:** The pilot was a 33-yr old RMAF C-130 pilot with 210 flying hours. He experienced a 4 kg weight loss and episodic hemoptysis over 4 weeks. PTB workup including sputum AFB smears were positive. He was treated with for 8 months. His sputum AFB smears were negative after the first month. Although asymptomatic at the end of the treatment, a HRCT showed pulmonary fibrosis and tree-in-bud pattern, and his bronchioalveolar lavage contained TB DNA. He was diagnosed with smear negative PTB and started a second round of antibiotics. He was not permitted to fly for a year following treatment completion. His return was delayed by another positive AFB smear discovered during workup for a mild COVID-19 infection. He required a third course of antibiotics. His return to fly assessment included two spirometry tests (3-month interval) and hypobaric chamber training which he completed without difficulty. He was allowed to fly with limitations to fly as, or with, co-pilot and with yearly spirometry. **DISCUSSION:** PTB represents a danger to flying environment during due to its effects on the infected pilot, the potentially incapacitating side effects of treatment, and the risk of spread in a confined aircraft. Aviators with active disease and undergoing long term treatment must be grounded. Careful, thorough follow up evaluation must be completed prior to resuming flying duties.

Learning Objectives

1. The audience will learn about the presentation, diagnosis, and/or treatment of an interesting Aerospace Medicine case.
2. The audience will learn about the similarities and differences in medical standards and pilot medical clearances for civilian, US and foreign military aviation professionals.

[349] IN-FLIGHT EMERGENCY DUE TO UNRECOGNIZED THALASSEMIA TRAIT CAUSING HYPOXIA: A FIGHTER PILOT CASE STUDY

Shiran Rajakaruna[1]; Mariyam Bano Khan[2]
[1]*Sri Lankan Air Force, Colombo, Sri Lanka;* [2]*Logistics 5 Corps, Pakistan Army, Karachi, Pakistan*

(Education - Case Study)

INTRODUCTION: This case study explores the impact of unrecognized thalassemia trait on a fighter pilot, emphasizing the importance of early detection. **BACKGROUND:** Beta thalassemia minor, an autosomal recessive disorder, is characterized by less severe anemia than thalassemia major. Approximately 1.5% of the global population are carriers, with a prevalence of 1 in 2,600 births in Southeast Asians. Mildly anemic patients may be asymptomatic on the ground but will have problems when exposed to the stressors of flight. **CASE PRESENTATION:** A 30-year-old Pakistani JF-17 Thunder Fighter Pilot, previously healthy, experienced signs of hypoxia during a routine mission. Blurring of vision began at 14,000–15,000 ft, escalating to complete blackout at 18,000 ft. The pilot descended to 10,000 ft with assistance, regained normal vision at 9,000 ft, and landed safely. Medical evaluation revealed low hemoglobin (Hb) levels (10.3mg/dl), prompting further investigation. Diagnosed with anemia, subsequent tests revealed mild hypochromic and microcytic features. Hb electrophoresis confirmed beta thalassemia trait. The pilot was referred for comprehensive evaluation and fitness determination. The pilot remained grounded from flying for over a year. Inspired by similar instances in the Turkish and German Air Forces, together with a sudden increase in operational requirements for the Pakistan military, the pilot was granted a waiver for continued single cockpit fighter flying, contingent upon strict compliance and surveillance. Following this case all aircrew were screened for thalassemia, and two new cases were discovered. They underwent the same waiver process. **DISCUSSION:** Aviators in unique environments face inherent hypoxia risks. Thalassemia trait individuals may remain asymptomatic until hypoxia symptoms emerge. Hemoglobin electrophoresis, not standard in induction processes, is vital for early identification. Regular monitoring, counseling, and adherence to flight safety protocols are crucial for managing thalassemia trait cases among aircrew. This case underscores the need for proactive monitoring of hemoglobin levels, especially in asymptomatic individuals, to ensure early identification, appropriate counseling, and sustained flight safety.

Learning Objectives

1. The audience will learn about the presentation, diagnosis, and/or treatment of an interesting Aerospace Medicine case.
2. The audience will learn about the similarities and differences in medical standards and pilot medical clearances for civilian, US and foreign military aviation professionals.

Wednesday, 05/08/2024 ***10:30 AM***
Grand Hall GH

[S-61]: PANEL: AEROSPACE FOR ALL. DISABILITY IN AVIATION AND SPACE EXPLORATION

Chair: Irene Di Giulio
Co-Chairs: Ryan Anderston, Sheyna Gifford

PANEL OVERVIEW: *BACKGROUND. This panel explores the topic of accessibility in aerospace, examining different perspectives spanning professional and recreational aviation, parabolic flights, and long-term space travel. The focus is on medical requirements, physiological considerations, solutions and adjustments to ensure inclusivity in the aerospace sector, accommodating all individuals with disabilities. OVERVIEW. The first presentation, from R Anderton (Civil Aviation Authority, UK), describes the medical requirements in the aerospace field and the considerations for people with disabilities. The second presentation, from S Gifford (St. Louis University in St Louis, USA and UPenn in Philadelphia, USA), focuses on the*

experience of AstroAccess and the lessons learned from a series of parabolic flights with people with disabilities as test subjects. The third presentation, from C Ramsburg (NASA, USA), provides the perspective of the team working on astronauts with physical disabilities, illustrating the needs of people with sensorimotor impairments. The fourth presentation, from I Di Giulio (King's College London, UK), describes the physiological considerations underpinning the European Space Agency accessibility project, and the lesson learned from aviation and people with disabilities. DISCUSSION. The presentations in this proposed panel will stimulate a productive discussion about the necessary changes in the aerospace industry to foster inclusivity for all participants. Moreover, the panel discussions will challenge the assumption that physical impairments invariably hinder performance, encouraging the audience to contemplate situations where these impairments do not hinder success in aerospace. Quoting astronauts Samantha Cristoforetti and Tim Peake 'We did not evolve to go to space. So, when it comes to space travel, we are all disabled' and 'Actually, it's about ability. It's not about disability'.

[350] REGULATORY MEDICAL CONSIDERATIONS FOR PILOTS WITH A DISABILITY

Ryan Anderton
Civil Aviation Authority UK, London, United Kingdom

(Education - Program/Process Review)

BACKGROUND: The UK Civil Aviation Authority (CAA) regulates and implements medical requirements for professional flight crew and private pilots. One in 5 people globally, and 24% of the UK population, report having a disability. This presentation will discuss the importance of encouraging access to aviation for all through the development of medical policy and guidance material for pilots with a disability, whilst considering the potential implications for safety critical roles. In particular, the aeromedical assessment of applicants for a medical certificate with a prosthetic limb will be discussed. **OVERVIEW:** The aeromedical assessment of pilots considers both the functional ability (e.g., musculoskeletal, hearing, vision) and the risk of incapacitation. The most common types of disability which prospective pilots present with are spinal cord injuries and amputations. In the aviation environment, impairment of the musculoskeletal system may cause difficulty in ingress/egress of an aircraft and the safe operation of controls. Restricted mobility may adversely affect the ability to read instruments or keep a satisfactory lookout. Applicants for medical certification with musculoskeletal disabilities require assessment to ensure they have the strength and range of movement necessary to operate an aircraft safely, with aids or modifications to controls as appropriate. Recently updated UK CAA guidance for the aeromedical assessment of pilots with a prosthetic limb demonstrates the regulatory approach to consideration of certification and the various means by which this may be achieved. This includes the use of Medical Flight Tests and a specialised limb prosthesis assessment form, incorporating an engineering and integration assessment alongside medical considerations. **DISCUSSION**: The development and update of medical policy to provide a clear and transparent assessment process for pilots with a physical disability is an important part of aviation regulatory work. We must also consider that as both aircraft and medical/engineering capabilities evolve, the risk assessment for a particular disability may also need to evolve. This is reflected in current endeavours to support spaceflight for astronauts with a physical disability. As we begin to define regulations for suborbital spaceflight participation, the application of collective experience and knowledge of disability in aviation will be important.

Learning Objectives

1. The audience will learn about the aeromedical considerations for the certification of pilots with a disability.
2. The audience will learn about the UK CAA's regulatory approach to the assessment of pilots with a prosthetic limb.

[351] HUMAN SYSTEMS INTEGRATION (HSI) CONSIDERATIONS FOR PARASTRONAUTS WITH SENSORIMOTOR IMPAIRMENT

Constance Ramsburg[1], Karina Marshall-Goebel[2], Scott Wood[2]
[1]*U.S. Navy/NASA JSC, Houston, TX, United States;* [2]*NASA JSC, Houston, TX, United States*

(Education - Program/Process Review)

BACKGROUND: As the era of the parastronaut begins, there must be a paradigm shift in how the space community approaches its criteria for future parastronaut mission considerations. This analysis reviews the existing body of knowledge on parastronaut considerations and provides a baseline of Human Systems Integration (HSI) considerations that the space industry and HSI experts can apply to enable safe and effective spaceflight missions with parastronauts. **DESCRIPTION:** To date, parastronaut feasibility studies have focused solely on lower limb and stature deficiencies, leaving room for additional impairments to be assessed such as sensorimotor. Notably, parastronauts with sensorimotor impairment may bring potential benefits in enhanced safety through design redundancy and hyperabilities like reduced likelihood of motion-sickness and adaptability during contingency scenarios. In addition, many physiological knowledge gaps on the risk of sensorimotor dysfunction during spaceflight could be researched in flying unique individuals with existing sensorimotor impairment. However, additional assessment and design modifications may also be required in areas such as the space vehicles, space suits, the space station, as well as future considerations for surface and/or microgravity extravehicular activity. Analysis shows all seven HSI Domains (Personnel, Manpower, Training, Safety and Occupational Health, Human Factors Engineering, Habitability, and Survivability) should be considered when selecting, designing for, and assigning parastronauts with sensorimotor impairment to human spaceflight missions. **DISCUSSION:** Recommendations for future research include the use of higher fidelity parastronaut analogs, in-flight exercise hardware assessment, and defining parastronaut selection criteria and feasibility based on the HSI Domains. We recommend strategically optimizing the research benefits of flying unique populations by including both parastronauts and HSI experts in the design and analysis processes. These findings will support the 'Aerospace for All. Disability in Aviation and Space Exploration' panel by stimulating constructive discussion on the inclusion of sensorimotor impairment in human space flight research and missions.

Learning Objectives

1. The audience will be able to understand the considerations for flying parastronauts with sensorimotor impairment in space, using seven Human Systems Integration Domains.
2. The audience will learn about the potential benefits, knowledge gaps, design modifications, and recommendations for flying parastronauts with sensorimotor impairment.

[352] ELEVATING PERFORMANCE ABILITY: OBSERVATIONS FROM ACCESSIBLE PARABOLIC FLIGHT OPERATIONS

Sheyna Gifford[1], Lucas Brane[2], Carlos Archilla-Cady[3]
[1]*St. Louis University Hosptial, St. Louis, MO, United States;* [2]*Mission AstroAccess, Houston, TX, United States;* [3]*Florida State University, Orlando, FL, United States*

(Education - Program/Process Review)

BACKGROUND: Since 2021, AstroAccess (AA) Medical Operations has treated operational capacity, not standard physiology, as the key consideration in crew selection. This elevation of ability over all over metrics, save for safety, has taken place in the context of an aerospace community committed to re-examining and redefining acceptable risk profiles; at a time when commercial aerospace has opened seats on suborbital flights to a wide range of human morphologies; when the word "parastronaut" has entered the vernacular of government aerospace and

the larger industry; and when civilian aerospace agencies are reshaping standards to emphasize performance metrics over age-based cutoffs. **OVERVIEW:** In support of parabolic flights for crew of varied disabilities, AA Medical Operations adapted risk assessment and management standards and procedures used by past and current civilian, military and private spaceflight, expanding them to allow for the inclusion of flyers with physical limitations who are psychologically, cognitively, technically, and professionally qualified. The results have been overwhelmingly positive, with 76 potential flyers with disabilities screened and 23 supported to become parabolic flight crew aka "ambassadors." This ambassador cohort includes 5 individuals who are deaf or hard of hearing, 7 individuals who are blind or have low vision, and 11 individuals with mobility disabilities. Each flight or mission entailed 15-18 lunar, martian, or microgravity parabolas of between 20-30 seconds duration. Over the course of 33 parabolas, the only ambassador injury reported was a minor abrasion on the anterior thigh of one flyer, which went unnoticed until the flight suit was removed. In terms of illness, after parabola 10 on each flight, a few cases of nausea were reported and effectively managed with medication. No ambassador experienced vomiting. **DISCUSSION:** The lessons learned from these flights are many. They apply to space medicine operations more broadly and include shifting the onus of "right stuff" from the solitary domain flyers to the shared purview flight surgeons, who must now have the courage and creativity to lead aerospace into an era of judicious experimentation, open collaboration, and evolving consensus about prioritizing function over form in spaceflight while achieving the highest level of safety.

Learning Objectives

1. The participant will be able to discuss current barriers for integration of disabled SFP including hardware modifications, lack of standardized medical screening, risk stratification, risk mitigation and address industry culture.
2. The audience will learn about disabled flyers' experience with parabolic flights and simulated microgravity. Their publicly-known demographics and medical team's implementation of COE CST recommendations and observed learnings.

[353] LESSONS LEARNED FROM AVIATION TO INFORM ACCESSIBILITY IN SPACE EXPLORATION

Irene Di Giulio[1], Mike Miller-Smith[2], Neil Tucker[2], Ryan Anderton[3], Nicol Caplin[4], Stephen Harridge[1], Peter Hodkinson[1], Marco Narici[5], Ross Pollock[1], Carmen Possnig[6], Joern Rittweger[7]
[1]*King's College London, London, United Kingdom;* [2]*Aerobility, Camberley, United Kingdom;* [3]*Civil Aviation Authority UK, Crawley, United Kingdom;* [4]*ESA, Noordwijk, Netherlands;* [5]*University of Padova, Padova, Italy;* [6]*University of Innsbruck, Innsbruck, Austria;* [7]*German Aerospace Center (DLR), Cologne, Germany*

(Education - Program/Process Review)

BACKGROUND: One in 5 people worldwide lives with a disability, frequently facing challenges in aviation. This makes accessible space flight seem like a distant dream. Recently, ESA selected the first astronaut with a physical disability. Our ESA Topical Team supports this opportunity by reviewing the existing literature and lived experience in the field, to investigate the physical and physiological challenges and also the potential advantages of astronauts with disabilities. **OVERVIEW:** Given the overlap between the medical standards required for pilot medical certification and those for astronaut selection, we started by examining the experience of a disabled flying charity, Aerobility. Three key lessons were learned from this review which will support the collaboration between stakeholders when working with astronauts with physical impairments.The first lesson was to recognise that not everyone will meet the standards for aeromedical certification. Astronauts face similar requirements and a transparent approach to assessment is required. However, these criteria can evolve over time, as advancements in both medical and technological fields may mitigate the impact of physical impairments on an individual's ability to participate in space missions. The second lesson was that people with disabilities can meet the requirements for flying with adapted training and technical modifications. In this context, flexibility and open discussions are needed to understand individual needs and find optimal solutions. Likewise, considering astronauts, dedicated efforts are required to adapt systems and procedures, ensuring accessibility. The third lesson highlighted the significance of involving different stakeholders when reviewing recruitment, training, adaptations, and operations. Unconscious bias remains a challenge in the field. Without scientific evidence demonstrating the suitability of candidates with physical disabilities, space accessibility would remain partial. **DISCUSSION:** We reviewed the experience of a leading flying charity to define key lessons from aviation that could be translated and adapted for space flight. Our overarching goal is to evaluate the physiological considerations for people with physical disabilities in order to support ESA's team and space missions. This work will become even more relevant with the emergence of space tourism, and the need for accommodating a diverse array of candidates for both short-term and extended space flights.

Learning Objectives

1. To discuss the requirements and adjustments for people with disabilities in aviation and how they can inform space missions.
2. To identify the needs and adjustments for astronauts with a physical disability.

Wednesday, 05/08/2024 ***10:30 AM***
Grand Hall I

[S-62]: SLIDES: DIAGNOSIS AND TREATMENT IN SPACE

Chair: David Kim
Co-Chair: Craig Kutz

[354] NEBULIZED INTRANASAL SCOPOLAMINE MAY PROVIDE RAPID RELIEF FOR SPACE MOTION SICKNESS.

Mimi Lan[1], Darin Knaus[2], Shireen Geimer[3], Samantha Leigh[3], Lionel Lewis[3], Jay Buckey[3]
[1]*Thayer School of Engineering at Dartmouth, Hanover, NH, United States;* [2]*Creare LLC, Hanover, NH, United States;* [3]*Geisel School of Medicine at Dartmouth, Lebanon, NH, United States*

(Original Research)

Motion sickness is common with approximately two-thirds of all crew members on Space Shuttle flights having reported motion sickness. About half of the cases are classified as moderate or severe. To avoid sedative effects of motion sickness medications there is an incentive to minimize the dose administered or avoid using motion sickness medication all together. This is especially important during demanding high-performance situations such as take-off, landing, and EVA. Rapid-onset motion sickness remedies are important in the space program when crew members need immediate relief and injections are not an option (i.e., when suited in a capsule or when motion sickness symptoms have begun and oral options are ineffective). A fast-acting formulation can be used as a rescue treatment to provide rapid relief when symptoms begin to occur. Scopolamine is an effective motion sickness treatment which is amenable to alternate (such as intranasal) routes of administration. Intranasal gel formulations of scopolamine have been investigated as a potential fast acting motion sickness treatment option. In studies, however, it has been shown to have a slow T_{max} (time to reach maximum concentration) of approximately 1 hour.

To explore a different formulation with a more rapid onset, a pilot study was conducted at Dartmouth Hitchcock Medical Center using nebulized intranasal administration of an aqueous scopolamine formulation. A nebulizer produces fine particles that can penetrate deeper

into the nasal airway and access the upper nasal mucosa. A nebulizer can be packaged in a low-volume, low-mass, and low-power form factor that can be hand-held and pocket stowable. It has the potential to offer an easy, accessible, non-invasive method that can be self-administered even while suited. A pilot test using the nebulized approach has been promising, with rapid onset in both subjects tested (T_{max} = 5 min), and with one person having plasma concentration levels comparable to IV administration. This pilot study has now been expanded to enroll 14 people to further study the pharmacokinetics of this approach. This study is currently underway.

Learning Objectives

1. The audience will learn about the therapeutic potential of intranasally administered nebulized scopolamine to provide rapid relief for motion sickness.
2. The audience will learn about current challenges in providing motion sickness relief in spaceflight activities.

[355] SPACEFLIGHT CRITICAL CARE: CEREBRAL PERFUSION IN HYPOTENSIVE PATIENTS DURING REENTRY

Michael Boyle
Self-employed, San Francisco, CA, United States

(Original Research)

INTRODUCTION: The advent of non-governmental crewed commercial spaceflight and efforts to send astronauts beyond low earth orbit introduce new medical risks that must be considered in the design of future vehicles. Shock is a significant risk which is more likely to develop in commercial crew with more comorbidities, and in any astronaut on a longer-duration mission further from definitive care. Atmospheric reentry is a particularly hazardous phase of flight for a patient in shock due to the deleterious effects of reentry acceleration on cerebral perfusion. G-induced loss of consciousness (GLOC) occurs when arterial pressure at the brain becomes so low that cerebral perfusion ceases, which, when prolonged, could cause permanent neurologic injury. For this reason it is important to understand the implications of crew positioning during high-G maneuvers. This work establishes limitations on G tolerance and seatback angles for crew members in shock. **METHODS:** Using validated models, max G tolerances were determined for hypotensive patients with varying heart-level mean arterial pressures (MAPs) and seatback angles. Seatback angles from 0 to 75 degrees from vertical were assessed for the 1st percentile to 99th percentile of the US male and female population. **RESULTS:** For patients with a MAP of 65 at the heart, maximum tolerable Gz at 75 degrees seatback angle was 10.6 and 7.8 for the 1st percentile female and the 99th percentile male respectively, which decreased to 2.8 and 2.0 at 0 degrees (vertical). For a MAP of 50, maximum tolerable Gz at 75 degrees seatback angle was 8.2 and 6 for the 1st percentile female and the 99th percentile male, which decreased to 2.1 and 1.6 at 0 degrees. **DISCUSSION:** These results demonstrate that hypotensive patients are particularly vulnerable to neurological injury during reentry. The degree of mitigation depends both on the acceleration vector relative to the vehicle, as well as crew member orientation within the vehicle. This has significant implications for future vehicle design, as return trajectories from the Moon and Mars will experience significant acceleration forces on reentry. For SpaceX's Starship design, reentry accelerations are near-perpendicular to launch accelerations, potentially precluding a single optimized seat orientation. As commercial and exploration-class spaceflight expands, the increased probability of adverse medical events means that engineers must consider these limitations in vehicle design.

Learning Objectives

1. The audience will learn about the physiology of G-LOC and the influence of spaceflight on crew susceptibility to GLOC.
2. The audience will learn about the physical modeling methods used to determine G-LOC.
3. The audience will learn about the implications of hypotension and reentry G-forces for commercial spaceflight.

[356] AN OPHTHALMOLOGY PROCESS FOR AN EARTH-INDEPENDENT, REAL-TIME DIAGNOSIS OF SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME (SANS) FOR DEEP SPACE MISSIONS

Scott Ritter[1], Claudia Stern[1], Juergen Drescher[1], Franco Terranova[4], Oriol Milian[2], Eleonora Zanus[1], Gauravam Majmudar[1], Aidan Cowley[2], Robert Siggel[3], Ommar Ahmad[3], Raphael Sznitman[4]
[1]*German Aerospace Center (DLR), Cologne, Germany;* [2]*European Astronaut Center (EAC), Cologne, Germany;* [3]*Helios University Clinic Wuppertal, Wuppertal, Germany;* [4]*University of Bern, Bern, Switzerland*

(Education - Program/Process Review)

BACKGROUND: Aerospace medical professionals may be familiar with the process of performing fundoscopy examinations for astronauts, and the level training and experience required to correctly diagnose retinal abnormalities. The same procedures can be used by astronauts themselves during spaceflight missions, but with mobile devices and artificial intelligence support, to aid in real-time diagnosis. This presentation will prepare space medicine practitioners, astronaut trainers, and astronauts to use mobile devices and artificial intelligence applications for detection of Spaceflight Associated Neuro-ocular Syndrome (SANS) for potential use during upcoming Artemis missions to deep space. **OVERVIEW:** Operational space medicine practitioners perform regular eye examinations of crew members during their missions to assess symptoms of SANS. These eye examinations may benefit from an Earth-independent, real-time process for SANS diagnosis in-flight with fewer ground support dependencies. To assess the feasibility of using mobile devices for this purpose, a technology demonstration was conducted aboard the International Space Station (ISS). Results from this technology demonstration were evaluated and used to develop an artificial intelligence process for SANS detection with no Internet connection or ground communication required. This process and its development will be presented with special reference to deep space applications, SANS countermeasure support, and where this process could be improved in the future. **DISCUSSION:** Mobile diagnostics and artificial intelligence applications have significance for their potential to save crew time and reduce schedule constraints during operational space medicine examinations. This process serves to support next steps for space medicine during LEO commercialization and the planned Artemis deep space missions. This work also has applications for remote medicine on Earth for professionals in emergency, military, or remote medicine without access to ophthalmology or neurology clinical specialists.

Learning Objectives

1. The participant will be able to understand the process for AI-enabled fundoscopy for potential use during deep space missions.
2. The audience will learn about the capability gaps that may be filled with further development and integration of this technology for deep space missions.

[357] QUANTIFYING THE IMPACT OF SUSTAINED ACCELERATION ON CRITICAL CARE TRANSPORT MEDICAL EQUIPMENT

Craig Nowadly[1], David Freeman[2], Zachary Kerns[2], Romana Valladares[2], Joseph Hegedus[3], Jeremy Beer[2]
[1]*59th Medical Wing/Brooke Army Medical Center, San Antonio, TX, United States;* [2]*KBR Aerospace Environment Protection Laboratory, Inc., San Antonio, TX, United States;* [3]*Brooke Army Medical Center, San Antonio, TX, United States*

(Original Research)

INTRODUCTION: Military and commercial stakeholders are investing to explore the use of hypersonic aircraft and orbital spacecraft

to transport cargo, medical supplies, passengers, and casualties. These vehicle platforms require periods of sustained acceleration and deceleration, but to date, these dynamic forces have not been comprehensively considered in the environment of critical care patient movement because injured patients and advanced aeromedical equipment (AE) are rarely subjected to sustained acceleration. While military AE does undergo Crash Hazard Acceleration Testing, this does not test equipment function during or after sustained acceleration. This study was performed to fill that knowledge gap. **METHODS:** AE currently used by the US Air Force AE and Critical Care Air Transport Teams (ZOLL EMV+® 731 ventilator, ZOLL Propaq® MD cardiac monitor, B Braun Infusomat® Intravenous Pump) was subjected to low (2.5g), moderate (4.5g), and variable acceleration for 3-minute periods at the KBR Brooks Centrifuge. AE was tested for function in three different orientations (gX, gY, gZ). Pre-determined variations were made in equipment input settings to ensure each equipment item would function across mission relevant conditions (differing ventilator tidal volumes, differing cardiac monitor arterial pressure inputs, etc.). AE was evaluated for accuracy compared to controlled inputs, alarm conditions, and equipment failure. **RESULTS:** The EMV+® 731 ventilator and Propaq® MD cardiac monitor had no equipment failures during testing. The ventilator had clinically negligible variations in tidal volume, peak pressure, and fraction of inspired oxygen during acceleration. At the highest tidal volume (480 mL) tested, the ventilator had peak pressure alarms at both 2.5g and 4.5g. However, this was due to limitations in test-lung resistance and was not related to a ventilator fault. Mild effects of sensor orientation were recorded in the Propaq® MD blood pressure results; for example, average differences of +4.9 ±0.3 mmHg (75 mmHg input) were recorded in 4.5gX, compared to -0.9 ±2.6 mmHg (75 mmHg input) recorded in 4.5gZ. **DISCUSSION:** US Air Force AE critical care equipment had detectable impacts from sustained acceleration. This knowledge will facilitate immediate follow-on experimentation with advanced models of combat injury during simulated medical evacuation in sustained acceleration environments.

Learning Objectives

1. Understand the impacts of sustained acceleration on a US Air Force Critical Care Air transport team ventilator's function.
2. Understand the impacts of sustained acceleration on a US Air Force Critical Care Air transport team cardiac monitor's function.
3. Understand the impacts of sustained acceleration on a US Air Force Critical Care Air transport team intravenous pump's function.

[358] CONSIDERATIONS IN THE EMERGENCY TREATMENT OF ASTRONAUTS: A PRIMER FOR EMERGENCY PHYSICIANS

Christina Mackaill[1], James D. Polk[2]
[1]*NHS, Glasgow, United Kingdom;* [2]*NASA, Washington, DC, United States*

(Education - Tutorial/Review)

INTRODUCTION: The steep rise of private and commercial human spaceflight as well as the simultaneous development of the multinational Artemis lunar program has increased the potential need to educate physicians around the world on the potential emergency care of an astronaut, should a contingency occur. Human-rated spacecraft may abort on launch, de-orbit due to spacecraft emergencies, or have anomalies that cause them to land or splashdown down range from the launch site, or outside their intended areas. **TOPIC:** The operational, physical, and environmental elements of a human-rated spacecraft contain potential threats to astronauts and rescuers, such as volatile chemicals, radiation, heat, and pyrotechnics. The potential for decompression sickness in an emergency, excessive impact loads on landing, high G loads from ballistic re-entry as well as untoward sea states, winds, and other hazards may cause potential harm to astronauts. The physiologic changes of spaceflight, especially long duration spaceflight, may have a significant impact on resuscitation and trauma treatment protocols that could impart harm to an astronaut if not correctly recognized. For example, the papilledema of SANS may be mistaken for head trauma, or conversely may make the astronaut more susceptible to ischemic changes in more minor head trauma as they already have mild elevations in intracranial pressure. Preload deficits in long duration astronauts may place them at a higher class of shock if they incur trauma due to their inability to compensate. **APPLICATION:** The astute receiving physician must know the phase of spaceflight in which the anomaly occurred (launch, orbital flight, re-entry, landing), the type of vehicle (capsule versus winged, G loads, water versus land landing) and the duration of astronaut exposure to microgravity in order to correctly anticipate the physiologic changes and potential hazards imparted, and thus the appropriate care. This is especially true if a contingency has placed the responding rescue crews and flight surgeons (who are well versed in aerospace/space medicine) at a geographical disadvantage far from the response or landing site. **RESOURCES:** Provided at presentation.

Learning Objectives

1. Understand the potential emergencies an astronaut may face during different phases of spaceflight (e.g. launch, de-orbit due to spacecraft emergencies, landing).
2. Understand the potential emergencies an astronaut may face during spaceflight due to the operational, physical and environmental elements of spaceflight (eg. volatile chemicals, radiation, heat, pyrotechnics).
3. Understand the salient differences that changes in astronaut physiology or exposures may impact or change resuscitation protocols.

[359] A PROGRAM FOR DIAGNOSIS, PREVENTION AND TREATMENT OF PERIODONTITIS FOR ASTRONAUTS DURING LONG-TERM SPACE TRAVEL

Andreas Pfützner[1], Victoria Sampson[2], Dirk Neefs[3]
[1]*University for Digital Technologies in Medicine & Dentistry, Luxembourg, Luxembourg;* [2]*Dentistry, London, United Kingdom;* [3]*Universita degli Studii de Milano, Milano, Italy*

(Original Research)

INTRODUCTION: Long-term space travel exposes participating astronauts to development of periodontal problems, such as gingivitis or periodontitis. **METHOD:** The aim of this prevention, monitoring and treatment program is to maintain oral health and prevent loss of teeth during long-term space travel. The program is based on a diagnostic technology, which can be conducted under non-gravity conditions: a diagnostic device for assessment of active matrix-metalloproteinase 8 (aMMP-8). It shall be used in combination with effective anti-bacterial treatment methods. aMMP8 is a collagenolytic enzyme involved in the pathophysiology of periodontitis. It cleaves the tight junctions in the periodontal tissues enabling bacteria and viruses to penetrate and destroy the periodontal connective tissue. **RESULTS:** Elevated aMMP-8 assessed in saliva is an indicator for the destructive processes leading to periodontitis. This biomarker and risk factor can easily be measured by means of a lateral-flow-based home use test. Preventive and treatment measures should target to lower the aMM8-concentrations in saliva to normal levels. Prevention includes normal measures of oral health, such as regular cleaning of the teeth and use of disinfecting liquids. Treatment of stable chronic periodontitis can be conducted by several methods, including but not limited to antibacterial treatments, regular application of chlorohexidine, photodynamic therapies, and combinations thereof, e.g. a combination of antibacterial photodynamic therapy (aPDT) and antibacterial blue light (aBL), which has already shown substantial efficacy in home use trials. The suggested diagnostic method, measurement of aMMP-8 in saliva, has been selected as it is fully representative for the ongoing destructive collagenolytic process and can be used to monitor treatment success, only requires minor and small sized equipment, and does not involve gravity for successful operation. The most suitable treatment options need to be identified based on similar criteria. **CONCLUSION**s: Results from clinical trials suggest that measurement of aMMP8 may significantly help to maintain oral health even during planned long-term space trips to Mars or other planets of our solar system.

Learning Objectives
1. To understand the active role of aMMP-8 in the pathophysiology of periodontitis and the functionality of measurement of elevated aMMP-8 in saliva to serve as diagnostic (risk indicater and treatment monitoring biomarker).
2. To understand the predictive value of aMMP-8 for periodontitis development.
3. To understand the importance of implementing assessment measures of oral health during long-term space trips.

Wednesday, 05/08/2024 ***10:30 AM***
Grand Suites 2 & 3

[S-63]: POSTERS: HUMAN FACTORS AND AEROMEDICAL CONSIDERATIONS

Chair: Karen Ong
Co-Chairs: Joanna Nelms, Jonathan Elliot

[360] AEROMEDICAL CONSIDERATIONS FOR WINGSUIT HIGH ALTITUDE WORLD RECORD ATTEMPTS

Veronika Puisa[1], Matt Wilkes[2], Peter D Hodkinson[1]
[1]*King's College London, London, United Kingdom;* [2]*University of Portsmouth, Portsmouth, United Kingdom*

(Education - Tutorial/Review)

INTRODUCTION: July 2023 saw a new wingsuit altitude world record of 13,184 m (43,253 ft). With technological developments, altitudes, flight duration and speeds will continue to increase. While environmental challenges posed in such attempts are not new, they need to be considered in new ways in this context. **TOPIC:** Major physiological concerns include hypoxia, decompression sickness (DCS), cold injury, and physical or cognitive limitation leading to pilot error. The altitudes reached are close to the performance limits of traditional aircrew oxygen delivery systems. It is uncertain how much higher a wingsuit pilot could fly, while avoiding significant hypoxia and DCS, without a full pressure suit. The thermal challenges are significant due to the combination of speed, temperature, and duration of exposure, with limited insulation. Oxygen must be reliably delivered in temperatures of -56°C with additional windchill. Cold injury has been reported during wingsuit descents without adequate protection. Wingsuiting requires physical effort, particularly shoulder abduction, extension and external rotation, to hold the optimum body position for stable, efficient flight. This physical exertion may exacerbate hypoxia, even with pressure breathing and 100% oxygen at these extreme altitudes. In developing mitigation measures, we must be mindful of total weight, weight distribution, aerodynamics, impact on vision and spatial awareness, human factors, and musculoskeletal injury risk. There must be no impediment to key activities including aircraft exit, navigation and communication, canopy deployment, cutaway, steering, or flaring. Operational considerations include flight planning, oxygen pre-breathing protocol and minimization of altitude exposure, which may vary significantly between different platforms (fixed wing aircraft, helicopters, and balloons are most common). Appropriate pilot training is fundamental to record attempts. The rapid evolution and development of equipment, such as aerodynamic helmet designs, pose challenges for systems integration and testing, which can be facilitated by the new generation of wingsuit wind tunnels. **APPLICATION:** We have identified multiple areas for potential further research to support future wingsuit record attempts from the literature. Many require technological development. Our work offers a framework for medical teams supporting pilots pushing wingsuit (and aeromedical) boundaries higher and faster than ever before.

Learning Objectives
1. The audience will learn about differences involved in wingsuiting compared with other air sports and the associated aeromedical considerations.
2. The audience will learn about some of the human system integration and test challenges associated with these bounadry pushing wingsuit altitude world record attempts.

[361] PROFESSIONAL PILOTS REPORT SIGNIFICANTLY HIGHER FATIGUE LEVELS THAN THE WORKING POPULATION

Marion Venus
Venus-Aviation Research, Training & Pilot Support, Zurich, Switzerland

WITHDRAWN

[362] ROYAL NORWEGIAN AIR FORCE (RNOAF) CREW RESOURCE MANAGEMENT (CRM) PROGRAM: DEVELOPMENT AND LEARNINGS

Bobbie Ray-Sannerud[1], Frode Wegger[2]
[1]*Royal Norwegian Air Force, Oslo, Norway;* [2]*Royal Norwegian Air Force, Rygge, Norway*

WITHDRAWN

[363] THE EFFECT OF A DAYTIME NAP ON LEARNING A NOVEL AVIATION TASK

Nicole Beasley[1], Kara Blacker[1], Sara Alger[2], Lynn Caldwell[1]
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(Original Research)

INTRODUCTION: Research has shown the positive effects of sleep on learning and memory. While most work focuses on the effects of a full night of sleep, evidence suggests that a daytime nap has similar effects on improving learning. This notion could be capitalized on when training aircrew. Here we examined the effects of a nap on 3 learning tasks. **METHOD:** Participants (N=75) were randomly assigned to a nap or rest group. The study protocol was approved by the NAMRU-D IRB. Both groups completed: a) a paired associates task (PAT), used to measure declarative memory, b) a finger tapping task (FTT), used to assess procedural memory, and c) an aerial flight maneuvering (AFM) task, used to measure participants' ability to learn to fly a simulated aircraft through a series of targets (e.g., hoops). All tasks were performed in the morning (i.e., test), followed by a 2 hr nap or rest opportunity and then tasks were performed again 30 min after the nap/rest (i.e., retest). EEG was recorded throughout, including polysomnography during the nap. Outcome variables were analyzed using a 2 (time) x 2 (group) repeated-measures ANOVA. **RESULTS:** For the AFM task, we found a significant time x group interaction for both mean distance from the target, p=.01, and percentage of targets hit, p=.002. The nap group demonstrated improved performance at retest compared to the rest group. Within the nap group, we also found that amount of stage 2 sleep was significantly associated with better learning, p=.025. The EEG data during the AFM task demonstrated an opposite effect in beta power changes, whereby the rest group saw a significant increase at retest compared to test, p=.012, and the nap group saw a significant decrease, p=.008. The PAT and FTT tasks did not elicit any significant behavioral or EEG results. **DISCUSSION:** We found

that a daytime nap significantly improved learning performance on a novel aviation task compared to an equivalent rest period. This improvement was evident in both behavioral performance and EEG results. These results suggest that daytime napping could be incorporated into work/rest guidance as a strategy to improve new aircrew training.

Learning Objectives

1. Understand the effects of sleep on different forms of learning and memory.
2. This study showed that a daytime nap can help individuals learn a novel task faster than rest alone.

[364] DEVELOPMENT OF A QUICK SUITABLE SCREENING TEST TO ASSESS POST-COVID-19 COGNITIVE DYSFUNCTION IN THE SETTING OF ROUTINE PILOT AEROMEDICAL EXAMINATIONS.

Solomon Gurmu Beka, Rob Griffiths, Julie Myers, Paul Skirrow
University of Otago, Wellington, Wellington, New Zealand

(Original Research)

INTRODUCTION: Post-COVID-19 impairments can occur following acute infections that are mild or asymptomatic. While flight deck personnel are generally young, fit, healthy, well educated, and largely vaccinated, (and therefore at lower risk of being severely ill in the acute phase or developing Post COVID-19 Condition), nonetheless, there will be pilots who develop prolonged impairment. A sufficiently sensitive and valid screen of cognitive function is likely to be highly beneficial to identify individuals who may require more extensive neuropsychological evaluation. Hence, this study aims to develop quick suitable screening tests for post-COVID-19 cognitive dysfunction with validation via a modified Delphi survey. **METHODS:** Preliminary to this study was a systematic literature search and narrative review of neurocognitive impairments in post-COVID-19 conditions and its screening tests likely relevant to pilot performance. After a thorough review, screening tests that were revealed to be effective in screening difficulties with very demanding skills for airline pilots' performance were identified and sent to panellists for evaluation and validation with a modified Delphi method. The panel was multidisciplinary and mainly contained aerospace medicine specialists and aviation psychologists. **RESULTS:** A total of 18 experts were involved with a response rate of 88.88%. Initially, we identified thirteen screening tools based on their ability to detect COVID-19-related impairment. From this group, we have shortlisted the Trail Making Test parts A/B, Symbol Digit Modalities Test, and Stroop Colour-Word Test as potentially effective tools for assessing skills, such as attention and executive functioning, that are both affected by COVID-19 and predictive of pilot performance. We also included The Paced Auditory Serial Addition Test and Psychomotor Vigilance Test in the development process due to their wide utilisation and suitability of applications in the aerospace sectors. **CONCLUSION:** The Trail Making Test parts A & B and Symbol Digit Modalities Test were selected as suitable screening tools to detect post-COVID-19 cognitive dysfunction for airline pilots in routine aeromedical examinations. These tests were selected due to their sensitivity, effectiveness, utility, availability in multiple versions, and economical tests for Aviation Medical Examiners. Moreover, they were utilized to assess cognitive impairment in Long COVID and demonstrated good predictive values.

Learning Objectives

1. The participants will learn about the importance of identifying individuals with post-COVID-19 neurocognitive dysfunction for further investigation.
2. The audience will be able to understand quick and suitable clinical neurocognitive screening tests for post-COVID-19 conditions.
3. The participants will discuss the appropriateness of screening tests for neurocognitive impairment in post-COVID-19 conditions focusing on attention and executive functioning, particularly for airline pilots.

[365] DYNAMIC CARDIAC PERFORMANCE APPLIED TO ESTIMATE THE G TOLERANCE: A PRELIMINARY STUDY

Chung-Yu Lai[1], Wun-Wei Huang[2], Min-Yu Tu[3], Kwo-Tsao Chiang[4], Kuo-Kuang Jen[5], Shang-Ju Wu[5], Nian-Shen Chen[5], Ching-Chun Chang[6], Fang-Ling Li[7]
[1]*National Defense Medical Center, Taipei City, Taiwan, Greater China;* [2]*Kaohsiung Armed Forces General Hospital Gangshan Branch, Kaohsiung City, Taiwan, Greater China;* [3]*Medical Affairs Bureau, Ministry of National Defense, Taipei City, Taiwan, Greater China;* [4]*Taipei Veterans General Hospital Fonglin Branch, Hualien County, Taiwan, Greater China;* [5]*National Chung-Shan Institute of Science and Technology, Taoyuan City, Taiwan, Greater China;* [6]*Kaohsiung Armed Forces General Hospital Gangshan Branch, Taipei City, Taiwan, Greater China;* [7]*Tri-Service General Hospital Beitou Branch, National Defense Medical Center, Taipei City, Taiwan, Greater China*

(Original Research)

INTRODUCTION: High G training is a part of strenuous and high-intensity sports. Recently, a novel parameter, being the cardiac force index (CFI), was introduced to investigate the relationship with the G tolerance during the centrifuge. Walking CFI on the ground could be applied to predict the level of G tolerance under the gradual onset rate among military flight cadets. The aim of this study was set to reconfirm the potential model between the walking CFI and G tolerance. **METHODS:** We organized this cross-sectional study in August 2023; 24 subjects were recruited from the aeromedical personnel training program in Taiwan. Before the centrifuge training, they wore the non-invasive BioHarness 3.0 devices (Zephyr Technology Corporation, Annapolis, MD, USA) to collect the heart rate (HR) and activity data during the 200-meter walk. Walking CFI was generated from the formula: CFI = weight × activity/HR. Relaxed G tolerance (RGT) and straining G tolerance (SGT) were examined during the gradual onset run of initial high G training (Onset rate: 0.1G/sec). A regression model between the walking CFI and G tolerance was established by the SPSS 24.0 software. **RESULTS:** Of these subjects, the average data of age, height, and weight were 31.25 years, 170.75 cm, and 72.75 kg. The mean of the RGT and SGT were 5.42G and 8.27G. There were between four and 13 subjects at the RGT ≥6.0G and SGT ≥8.0G, respectively. Subjects with the RGT more than 6.0G, and the SGT more than 8.0G, had a significantly higher walking CFI than the others. We also found that each increment of the 10 walking-CFI unit increased the RGT by 1.65G and the SGT by 0.70G. **DISCUSSION:** In this small study, it appeared that walking CFI could assist in the estimation of the G tolerance before the training began again. However, some reports revealed that the G tolerance became various and different every day. It is necessary to collect more data to assess the validity and stability of this algorithm used to predict the G tolerance. We also hope that this finding will further be used to monitor the G performance before the flight mission.

Learning Objectives

1. To understand the physiological challenges and responses during the G load.
2. To develop the model of G tolerance estimation before the training by using the new cardiac parameter.

[366] CHANGES IN FATIGUE RISK MANAGEMENT PHYSIOLOGICAL PARAMETERS DURING A SEMESTER IN A UNIVERSITY PILOT TRAINING PROGRAM

Botond Szűcs
Pharmaflight, Vál, Hungary

WITHDRAWN

[367] BIOETHICAL CONSIDERATIONS FOR FUTURE MICROGRAVITY-BASED HUMAN RESEARCH

Karl Mueller[1], Wiaam Elkhatib,[2], Teo Dagi[1], Michael Harrison[1], Leigh Speicher[1], Dana Herrigel[1]
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(Education - Tutorial/Review)

INTRODUCTION: The rapid growth of the commercial space sector has promoted expansion of biomedical research focused on improving longevity on Earth. When would ethical considerations eclipse the deployment of such innovations aimed to benefit human health? The 4 fundamental principles of bioethics: beneficence, non-maleficence, autonomy, and justice, along with their potential conflicts, are important concepts to consider as aerospace medicine researchers explore medical therapies in microgravity. **TOPIC:** We will describe a hypothetical dilemma to illustrate the principles of bioethics in microgravity research. It is not out of the realm of possibility that we will witness development of microgravity-based medical therapeutics in the not-too-distant future. We will discuss the implications of this hypothetical scenario to explore the topic and to provide education regarding medical bioethical principles, citing historical precedents in human research, such as pioneer Col. John Paul Stapp. The apparent beneficence of offering such unique therapeutics to individuals and humankind is apparent, but other ethical principles must be considered, and guidelines should be developed accordingly. Historically, human research in the United States has been governed by institution-specific IRBs. What research-focused regulatory body will oversee such investigations? Just as any terrestrial procedure, the patient's current state of health and ability to undergo the procedure must be considered. In this hypothetical case, the rigors of space travel must be thoroughly assessed, and the risks and benefits of space travel must be carefully considered for each patient. To respect patient autonomy, risks and benefits must be provided to an individual with capacity to consent. How will these risks and benefits be determined if they are truly unknown? Microgravity-based therapeutics would provide unique justice concerns. Travel to LEO is prohibitively expensive. This poses an ethical dilemma: will patients with greater medical fitness for space travel (minimizing non-maleficence) be overlooked in favor of patients with enhanced financial ability to cover costs? This brings us to another justice concern –availability, posing potential for health rationing. **APPLICATION:** Creating guidelines on how to conduct human research in microgravity is a complex field that will require advanced discussion and application of bioethics.

Learning Objectives

1. To learn the 4 principles of bioethics and how to apply the to aerospace medicine cases.
2. To define an ethical framework to develop guidelines for on how to conduct human research in microgravity.

[368] CAN WE PREDICT WHICH AIRCREW WILL DEVELOP NECK PAIN DURING MILITARY FLYING TRAINING?

Ellen Slungaard[1], Cliona McRobert[2]
[1]*RAF/DMRC Stanford Hall, Loughborough, United Kingdom;* [2]*University of Liverpool, Liverpool, United Kingdom*

(Original Research)

INTRODUCTION: Neck pain within military pilots is recognised as a challenging problem in modern air forces with an estimated one-year prevalence approaching 50%. The Aircrew Conditioning Programme (ACP) is a preventative strategy and has been shown to enhance physiological performance under conditions of high +Gz, however its effect on reducing flight-related neck pain has not been fully investigated. This study aimed to investigate the incidence of neck pain during the first 5 years of UK military flying training in aircrew who had undertaken ACP during this period and have physiological performance metrics recorded as part of a previous PhD project investigating the impact of ACP on +Gz tolerance. **METHODS**: All 36 aircrew enrolled in the previous research project were invited to participate. Data was collected through the Aircrew Neck Pain and Lifestyle Questionnaire and analysis of physiological measures recorded during initial study recruitment at the start of military flying training. **RESULTS**: At the 5 year follow-up, 19 aircrew responded (52.7% response rate), mean age 28 years old. Fourteen aircrew were currently flying in high +Gz capable aircraft, with 443 mean total flying hours and 7.8 mean total Night Vision Goggle hours. A total of 36.8% aircrew (n=7) reported neck pain during flight in the last 12 months, with high +Gz (+4-5.9Gz) reported by 55.5% (n=5) of those aircrew as the cause of neck pain. When asked what preventative activities were used, 47.4% (n=9) reported using ACP. Physiological measures recorded at the start of flying training were reviewed against incidence of flight-related neck pain in responders, there was a tendency for aircrew with a smaller neck circumference, lower isometric neck strength and lower +Gz tolerance to report neck pain at the 5-year time point. **DISCUSSION**: At the start of military flying training, those aircrew identified as having a lower isometric neck strength and lower +Gz tolerance may benefit from targeted training to enhance performance and reduce the incidence of flight-related neck pain. Whilst these are not statistically significant findings, with a larger sample size, a more robust estimate could have been drawn.

Learning Objectives

1. This 5-year follow up review aids in identifying possible predictors of neck pain in military aircrew.
2. The audience will learn about the potential targeting of preventative strategies for neck pain.

[369] THE MEDICAL COLLEGE OF WISCONSIN MILITARY AIRCREW NECK AND BACK PAIN STUDY: BASELINE FIGHTER PILOT PAIN AND FUNCTIONAL ASSESSMENT DATA

Rachel Cutlan[1], Keri Hainsworth[1], Cory Everts[2], Alok Shah[3], Amy Nader[1], Narayan Yoganandan[1], L. Tugan Muftuler[1], Timothy Meier[1], Hershel Raff[1], Peter Le[4], Chris Dooley[5]
[1]*Medical College of Wisconsin, Milwaukee, WI, United States;* [2]*Wisconsin Air National Guard, Madison, WI, United States;* [3]*Zablocki Veterans Affairs Medical Center, Milwaukee, WI, United States;* [4]*Air Force Research Laboratory, Wright-Patterson AFB, OH, United States*

(Original Research)

INTRODUCTION: Up to 97% of fighter pilots report neck pain from high +Gz forces, but the etiology has not been clearly defined (PMID: 21614872). This study will explore the etiology of chronic neck pain and acute activity-related flare-ups using pain and functional assessments, structural and advanced MRI scans, and inflammatory and stress biomarkers using annual baseline assessments and intermittent assessments linked to flight exposures. Correlations of baseline pain and functional data with flight history are presented here.

METHODS: Wisconsin Air National Guard (WIANG) fighter pilots participated in demographic and flight history surveys, anthropometric measurements, and pain and functional assessments. Pain assessments included eight validated questionnaires focused on the intensity, characteristics, and interference of neck and back pain. Functional assessments included cervical range of motion (CROM) and neck strength movements to assess neck functionality. **RESULTS:** Twelve males and one female participated with a mean age of 39 (range: 28-46) years, 2268 (500-3500) total military flight hours and a Neck Disability Index (NDI) of 7 (1-18). Most flight hours (69.0%) were flown in the F-16, with 5.8% in the F-35 that WIANG pilots began flying in Spring 2023. NDI was negatively correlated with all six bending CROM movements ($r>0.62$, $p<0.04$) and positively correlated with F-16 flight hours ($r=0.43$, $p=0.14$). The number of flight hours in the past year was negatively correlated with all eight

neck strength assessments except flexion (r>0.7, p<0.007). **DISCUSSION:** These baseline results highlight the complex relationships between total and recent military flight time, neck and back pain, and functional disability. Pilots with increased flight time tended to have reduced neck strength and CROM, along with increased pain scores. These functional deficits may interfere with a pilot's effectiveness during flight. Pilots report avoiding neck rotation movements like aerial combat maneuvers and checking six due to anticipation of pain (PMID: 18717118). This study will focus on multiple flight exposures per year to understand the etiology of this pain and differentiate between pain profiles linked to chronic versus acute flight exposures. This information can guide further research in finding methods to reduce the burden of neck and back pain in military aircrew.

Learning Objectives

1. The audience will understand the type of pain experienced by fighter pilots due to their exposure to +Gz forces using results from pain assessments.
2. The audience will understand the functional effects experienced by fighter pilots due to this pain and repeated exposure to +Gz forces.

[370] MODIFICATION OF COBURN-FORSTER-KANE EQUATION TO ACCOUNT FOR HUMAN SEQUESTRATION OF CARBON MONOXIDE IN A CLOSED SYSTEM

Michael Loesche[1], Amran Asadi[1], Brandon Trapp[1], Diana Dayal[2], Esther Putman[3], Jaime Mateus[1]

[1]*SpaceX, Hawthorne, CA, United States;* [2]*UCLA, Los Angeles, CA, United States;* [3]*University of Colorado Boulder, Boulder, CO, United States*

(Original Research)

INTRODUCTION: Mitigating the threat of carbon monoxide (CO) to crewmembers in space involves balancing toxicity with the risks imposed by venting a contaminated atmosphere or early mission termination. The current Spacecraft Maximum Allowable Concentration (SMAC) of CO was derived from the Coburn-Forster-Kane (CFK) equation, which relates inhaled CO levels with carboxyhemoglobin (COHb%), a proxy for toxicity, in an open system. Here we propose a modification to the CFK equation to track the net transfer of CO between the crew and spacecraft in the Dragon capsule, which was generalized to multiple environments. **METHODS:** The CKF equation was numerically solved for a crew of four in a Dragon capsule. The net exchange of CO between Dragon and the crew was tracked. The environmental and COHb% levels were calculated for various exposures and atmospheres. To account for hypobaric atmospheres, the sum of percent deoxyhemoglobin and COHb% was used as a toxic threshold. **RESULTS:** Each crew member sequesters approximately 9.2 mL STPD of CO per COHb%. The modified CFK estimated a 20%-25% reduction in environmental levels at 24 hours dependent on atmosphere. When targeting a CO-Hb of 13.55% as in the NASA SMAC, the modified CFK suggested raising the CO exposure limit to 125 ppm from 100 ppm at sea level. We provide estimated COHb% at CO levels ranging from 50 to 1,000 ppm and in atmospheres ranging from 14.7 psi to as low as 8 psi over a mission duration of 5 days. **DISCUSSION:** Crews may sequester meaningful amounts of CO in a Dragon-like environment. The modified CFK needs to be tested with in-vivo experiments before being utilized for in-flight decision. If verified, these results may lead to raising currently accepted SMAC thresholds in small spacecraft.

Learning Objectives

1. The CFK equation traditionally relates environmental CO to carboxyhemoglobin levels in an open system where CO levels do not change.
2. The CFK equation can be modified to estimate net CO movement between a closed environment and the crew.
3. Crew sequestration of CO may remove meaningful amounts of CO in Dragon-like environments.

[371] EFFECTS OF MILD HYPOBARIC HYPOXIA ON BEHAVIORAL HEALTH AND PERFORMANCE OUTCOMES IN NASA EXPLORATION ATMOSPHERE MISSION 2

Steven Anderson[1], Sheena Dev[1], Bruce Keller[1], Alaa Khader[1], Suzanne Bell[2]

[1]*KBR/NASA Behavioral Health & Performance Laboratory, Houston, TX, United States;* [2]*NASA Behavioral Health & Performance Laboratory, Houston, TX, United States*

(Original Research)

INTRODUCTION: Decompression Sickness (DCS) is a risk during spaceflight extravehicular activities (EVAs). The NASA Exploration Atmosphere (EA) study aims to validate modeling efforts for a novel prebreathe protocol while adequately mitigating risk of DCS. We examined effects of exposure to the mild hypobaric hypoxic chamber environment on behavioral health and performance outcomes in Exploration Atmosphere Mission 2 (EA-2). **METHODS:** Eight participants spent 11 days in NASA's 20-foot chamber at Johnson Space Center (May–June 2023) where they were exposed to an atmosphere consisting of lower pressure (8.2 psia) and higher O_2 (34%), controlling physiologic levels of N_2. One participant left the study at Test Day 3. Participants completed five simulated EVAs during the 11-day test phase. Cognitive performance was measured using the Cognition test battery comprising 10 subtests. Cognitive performance results were examined during pre-test, 11-day test, and post-test phases to identify whether the mild hypobaric hypoxic environment substantially impacted participants' cognitive performance. Cognition test battery outcomes were corrected for practice and battery effects, and then z-transformed based on the average and standard deviation of baseline (pre-test) performance scores across study subjects. Summary scores for accuracy and speed were calculated by averaging across z-transformed scores within the accuracy and speed domain. **RESULTS:** Examining z-scores for outcomes in each of the 10 cognitive subtests indicated that participants' cognitive performance did not substantially change from baseline during the 11-day test or post-test phases in EA-2. Computed z-scores indicated that performance outcomes during 11-day test and post-test phases were all within one standard deviation of the group baseline mean. **DISCUSSION:** The small changes in cognitive performance observed from pre-test to 11-day test, and pre-test to post-test phases suggest that the mild hypobaric hypoxic environment did not substantially impact participants' cognitive performance. Future directions include combining results from multiple EA missions to increase sample size and conducting linear mixed effects models to compare performance across test phases.

Learning Objectives

1. The audience will learn about the NASA Exploration Atmosphere study aims and objectives.
2. The audience will learn about. the cognitive and behavioral impacts of mild hypoxia.
3. The audience will learn about the cognitive and behavioral impacts of mild hypoxia as studied in NASA Exploration Atmosphere.

Wednesday, 05/08/2024 ***2:00 PM***
Grand Ballroom A

[S-64]: PANEL: INFLUENTIAL WOMEN ON THE FRONTIERS OF SPACE MEDICINE EXPLORATION: LESSONS ON LEADERSHIP

Sponsored by ANAHPS

Chair: Marian Sides
Co-Chairs: Mary Cimrmancic, Allen Parmet

PANEL OVERVIEW: *This panel is the fourth annual event of the Mary F Foley Endowment, established in her honor, to perpetuate her passion*

and career long work profiling women in aviation and space medicine. As we build momentum in the era of space travel, this panel will portray the dynamics of influential women on the frontiers of space medicine exploration. Speakers will describe the qualities and virtues that shaped their leadership, and how they distinguished themselves through persistence, courage, and determination. TOPIC: The first presentation will portray the distinguished Thais Russomano, a Brazilian doctor, biomedical engineer, research scientist, and international lecturer in space medicine. She is founder of the Microgravity Center, the first educational and research center in Space Life Sciences in Latin America. She is followed by the presentation of NASA astronaut Nicole Stott, whose book," Back to Earth: What Life in Space Taught me about our Home Planet," imparts hard won lessons on how a response to crisis in space can be applied to life on Earth. The panel will highlight the contributions and influence of former NASA Chief astronaut Peggy Whitson, recipient of the medal for Merit in Space Exploration, who holds the longest record, of an American woman in space of 675 days. She is the first woman to command the International Space Station, twice. Ilaria Cinelli, a biomedical engineer, commander on numerous space analog missions in extreme environments, will be portrayed as a next generation leader in space travel. Presenters will convey how Cinelli's energy in action, inspires others and has cascading influence on the evolution of space exploration. Barbara M Barrett's leadership will be described, as former United States Secretary of the Air Force, and the United States Space Force. Her diversified business and diplomatic career, including instrument rated pilot, trained astronaut, and Ambassador to Finland will be highlighted. APPLICATION. Leadership styles of these influential women will be described. How they navigated challenges that shaped industry operations will be discussed. This event will offer illuminating and inspirational mentoring lessons in leadership development for AsMA members.

[372] ASTRONAUT NICOLE STOTT: HEALING EARTH AND HUMANITY THROUGH SCIENCE AND ART

Aubrey Florom-Smith[1], Cathy DiBiase[2]
[1]*Stanford University, Menlo Park, CA, United States;* [2]*Kennedy Space Center, Titusville, FL, United States*

(Education - Tutorial/Review)

INTRODUCTION: Leaders adept at balancing space exploration and art are unique. Nicole Stott, NASA astronaut, artist, author and advocate for humanity as crewmates on Planet Earth, exemplifies this ability by applying lessons learned in space to preserving our shared planet and inspiring the next generation of explorers and artists.**TOPIC:** Ms. Stott inspires and empowers others to embrace the marvels of space exploration and the restorative aspects of art. As the 10th woman to spacewalk, Ms. Stott experienced physical separation from Earth while viewing the planet as a single entity, which underscores her belief in peaceful cooperation for the betterment of all. As a NASA astronaut and aquanaut, Ms. Stott lived this objective: she spent 18 days in an underwater lunar analog mission, trained with astronauts and cosmonauts around the globe, and spent 104 days in space on the Space Shuttle and the International Space Station conducting science experiments targeting terrestrial benefits. She was also on the final flight of the Space Shuttle Discovery. In 2009, while on the International Space Station, Ms. Stott was the first person to paint a watercolor in space. Her paintings and 2021 book illustrate how urgently Earth requires humanity's care. Healing Earth is not Ms. Stott's only mission: she founded the Space for Earth Foundation, which provides opportunities for children to become "Artonauts" and dream of a future for themselves through space, art, and healing.**APPLICATION:** Ms. Stott's example of connecting science and art to heal the Earth and its inhabitants – including its children – is inspiring. Human beings need to explore and create. Lessons learned from Ms. Stott's career as a NASA astronaut and artist provide guidance for aerospace nurses and other healthcare providers seeking to link these important activities to promote healing.

Learning Objectives

1. Learners will identify two significant leadership characteristics of Nicole Stott.
2. Learners will describe two examples of science and art that promote greater understanding of the need to protect Earth.

[373] PEGGY WHITSON: FROM BIOCHEMIST TO NASA CHIEF ASTRONAUT TO PRIVATE MISSION COMMANDER

Kathleen Samoil
ANAHPS, Calgary, AB, Canada

(Education - Tutorial/Review)

INTRODUCTION: From a background in biochemistry, progressing from NASA scientist to the greatest number of days in space by a woman, commander of multiple space missions, these are only a few demonstrations by our AstroPeggy as a strong contributor to space exploration and aerospace medicine. **Topic:** Following a Bachelor of Science from Iowa Wesleyan College, Dr. Whitson completed her doctorate in biochemistry at Rice University. Continuing at Rice University as an awarded post-doctoral scholar she then moved to the National Aeronautics and Space Administration's Johnson Space Center as the supervisor of the biochemistry research group. This was the beginning of a groundbreaking career in space. Progressing from, the project scientist for the Shuttle-Mir program to astronaut candidacy in 1996, record breaking for the longest time in space by a NASA astronaut, first non-pilot Chief Astronaut, twice commander of the International Space Station, and now mission commander with private space directorate Axiom. **Application:** This presentation will be a discussion of how Dr. Whitson's knowledge is architected through formalized education within a university to career, development within agency responsibilities, and transitioning from the public to private sector within the context of a humble and dedicated explorer. As a biomedical scientist Dr. Whitson's career arc has contributed grately to the advancement of aerospace medicine as both a scientist and astronaut contributor. Dr. Whitson's pioneering is not limited to a career trajectory rather it is the mechanisms for gleaning knowledge, mentorship, role modelling, and dedication as an experimentologist that distinguish her.

Learning Objectives

1. Recognize the contribution of a biochemist non-medical doctor to the advancement of aerospace medicine.
2. Describe possible role conflict that may arise when an individual is both a scientist and a study participant. May include strategies and protective mechanisms as guided by the Declaration of Helsinki.

[374] SECURING THE SPACE ENVIRONMENT: LESSONS IN LEADERSHIP

Karen Klingenberger
U.S. Air Force, Williamsburg, VA, United States

(Education - Tutorial/Review)

INTRODUCTION: Ambassador Barbara Barrett, the 25th Secretary of the Air Force, has noted how dependent people are "in our day-to-day lives on space…our information, our navigation and our communications are all space-dependent. It's ubiquitous, but it's invisible." She was the civilian leader of the Air Force and the inaugural head of the United States Space Force. Earlier, she was Deputy Administrator of the Federal Aviation Administration, Vice Chairman of the U.S. Civil Aeronautics Board, and U.S. Ambassador to Finland. Among other roles, she was a Senior Advisor to the U.S. Mission to the United Nations and worked to open economic opportunities for women in Afghanistan and many other countries. In addition to being a lawyer and accomplished business woman, Ambassador Barrett has been on the leading edge of military and commercial space. **TOPIC**: Ambassador Barrett was active in furthering the peaceful utilization of space by finalizing the

creation of the US Space Force, during her tenure as Air Force Secretary. Ambassador Barrett publicly advocated for an independent branch of the American military dedicated to meeting and protecting the nation's needs in space. She brought her unique credibility to her position as Secretary of the Air Force while championing the inauguration of US Space Force. An instrument rated pilot with experience in flying US and Finnish fighter aircraft, she also trained, in her 50s, at Star City (Russia), culminating in a certification for commercial space travel to the International Space Station. Ambassador Barrett serves as an exceptional example of the powerful contribution that women have made and will continue to make to the future of military and commercial space exploration. **APPLICATION:** Today's space missions operate at the same time that space becomes a larger factor in international power politics. Ambassador Barrett's contributions ensure that American economic reliance on and continued exploration of space occur in an environment secure from future threats. "We have to be first and best in space for the world's safety and especially the defense of America."

Learning Objectives

1. Describe Ambassador Barrett's philosophy regarding worldwide daily dependence on space capabilities.
2. Identify two leadership qualities of Barbara Barrett that apparent in her work to secure our space domain.

[375] FOCUS ON THAIS RUSSOMANO: A VISIONARY LEADER IN INTERNATIONAL SPACE RESEARCH

Annette Sobel
International Academy of Aviation and Space Medicine, Corpus Christi, TX, United States

(Education - Tutorial/Review)

INTRODUCTION: This presentation will describe the life's work, passion, and entrepreneurial activities of Dr. Thais Russomano to advance the field of international space medicine research.
Dr. Russomano's development of advanced research models and interdisciplinary educational programs were well ahead of their time and served as a mechanism to attract young biomedical researchers and students to the field and push the envelope of rapidly advancing databases, advanced analytics and translational medicine applications.**TOPIC:** New technical approaches and methodologies will be described that validated research modeling applicable to the unknowns of space and initiated a bold approach to seeking new knowledge and opportunities for extreme environment research. Through founding the Microgravity Centre (MicroG) at PUCRS university, Porto Alegre, Brazil, Dr. Russomano distinguished herself through boldness and scientific grounding. MicroG is the first Latin American Space Life Sciences research and educational center. Additionally, PUCRS is known for its entrepreneurial, innovative spirit, and as such is consistent with the establishment of MicroG/. **APPLICATION:** The field of space medicine physiology, biomedical engineering, telemedicine, and telehealth has been particularly challenging due to the necessity to develop new models and baseline data readily translatable to extreme environments. This presentation will describe specific examples of successful translation and pathfinding research as well as the highly innovative efforts of the Space Network (Rede Espaço), coordinated by Dr. Russomano, and other synergistic activities such as the Mars One Advisory Board;[1] International Relations Director for the UK-based HuSCO, Human Spaceflight Capitalization Office; and director of two private companies linked to space life sciences and telehealth – InnovaSpace[2] Consultancy (UK) and International Space Medicine Consortium (USA).

Learning Objectives

1. The attendee will understand the significance of the research and educational efforts of women leaders such as Dr. Thais Russomano in advancing the field of space medicine.
2. The attendee will learn about emerging technical and modeling approaches to understand the extreme environment of space.
3. The attendee will appreciate the new scientific and leadership opportunities to participate in international space medicine research.

[376] ILARIA CINELLI: INTERSECTING HEALTHCARE AND SPACE

Amelia Garner Shrader
ANAHPS, Hazel Green, AL, United States

(Education - Tutorial/Review)

INTRODUCTION: Technological advances achieved in space can have applications here on Earth. Ilaria Cinelli is a bioengineer focused on improving healthcare globally and advancing space exploration. The exploration of space offers boundless opportunities for human health advancement. **TOPIC:** Dr. Cinelli is an influential leader in healthcare and space technology on an international scale. Italia Cinelli holds a bachelor's and a master's degree in biomedical engineering from the University of Pisa in Italy. She earned a structured doctorate in neural engineering from the National University of Ireland, Galway. She completed the International Space Studies program at TU Delft, Netherlands, and completed a postdoc in neuromodulation at Tufts University in the US. Ms. Cinelli has served as crew commander on eight analogue missions for the European Space Agency. The European Patent Office commended Ms. Cinelli as one of the 50 Top Voices in Tech for her expertise in space and healthcare. Ilaria's work has spanned many regions of the globe including the UK, USA, Republic of Ireland, the Netherlands, Spain, and Italy. She was recognized by The United Nations Office for Outer Space Affairs as a role model and has invited her to speak about space medicine, engineering and gender equality. Ms. Cinelli has served as a mentor and role model for the Space4Women network of the United Nations Office for Outer Space Affairs since 2020. Ilaria was the youngest President of the Aerospace Human Factors Association from 2013-2021 and also the youngest member of the Mars Society Steering Committee, serving since 2018. Ms. Cinelli was inducted as an AsMA fellow in 2020 and a fellow of the Aerospace Human Factors Association in 2021. **APPLICATION:** As more humans reach space, innovative leaders like Ilaria Cinelli are integral in translating space advances to ground-based applications and vice versa. Applying space technology to advance healthcare is integral in advancing wellness for humankind on planet Earth and beyond. Ilaria's work is a groundbreaking inspiration to female scientists as well as young, emerging leaders in the aerospace field.

Learning Objectives

1. Learners will be able to identify two leadership characteristics of Ilaria Cinelli.
2. Learners will describe how healthcare can be advanced on Earth with application from space technology.

Wednesday, 05/08/2024 ***2:00 PM***
Grand Ballroom B

[S-65]: PANEL: AEROSPACE MEDICINE IN GERMANY AND SWITZERLAND

Sponsored by German Society of Aerospace Medicine

Chair: Oliver Ullrich
Co-Chair: Jochen Hinkelbein

PANEL OVERVIEW: *This traditional panel is sponsored by the German Society of Aerospace Medicine, DGLRM. It covers recent research topics of aerospace medicine in both Germany and Switzerland. The panel consists of five different research papers by different German and Swiss presenters.*

[377] This abstract was moved to the end of the panel.

[378] EXPLORING ALTERNATIVE CPR TECHNIQUES FOR HELICOPTER RESCUE OPERATIONS: HONOURING THE PAST AND PREPARING FOR THE FUTURE OF AEROSPACE EMERGENCY MEDICINE

Lydia Johnson Kolaparambil Varghese[1], Remco Overbeek[2], Felix Liebold[3], Niels Benjamin Adams[2], Jan Schmitz[2], Michael Sebastian Neumann[1], Wolfgang A. Wetsch[2], Jochen Hinkelbein[1]

[1]*Johannes-Wesling-Universitatsklinikum Minden, Ruhr-Universitat Bochum, Minden, Germany;* [2]*Faculty of Medicine and University Hospital Cologne, University of Cologne, Cologne, Germany;* [3]*University Hospital of Leipzig, Leipzig, Germany*

(Original Research)

INTRODUCTION: The confined and dynamic environment of helicopter rescue operations presents unique challenges for traditional cardiopulmonary resuscitation (CPR) techniques. To explore alternative CPR approaches specifically tailored to this context, we conducted a comprehensive scoping review with the aim of providing a high-quality overview of the existing literature. Our objective was to identify and evaluate the potential applicability and effectiveness of alternative CPR techniques in helicopter operations. **METHODOLOGY**: Two independent reviewers performed a rigorous search across five renowned databases, including PubMed, EMBASE, CINAHL, Cochrane, and Web of Science. A search string was designed using specific keywords related to helicopters, non-traditional CPR methods, and chest compression techniques. In order to ensure adherence to the PRISMA guidelines and detect duplicates reliably, we utilized Rayyann, a screening software, as an auxiliary tool during the manual screening process. Rayyann proved invaluable in efficiently identifying and managing duplicate content, while still maintaining a human-driven approach to the screening process. Data extraction was conducted using Excel, while bibliography management was handled using Zotero. **RESULTS**: The initial screening yielded 884 results, which were subsequently narrowed down to 25 relevant publications after removing duplicates and conducting abstract screening. Among the identified papers, only one method, the Koch method, met the inclusion criteria. The Koch compressions demonstrated a higher overall quality score (79%) compared to conventional compressions (63%), showing improved compression depths and reduced exhaustion. The remaining publications focused on comparing manual CPR with mechanical CPR (mCPR). Due to the limited number of papers available, a meta-analysis could not be conducted. **CONCLUSION**: This study highlights the scarcity of evidence concerning alternative CPR techniques in helicopter rescue operations. While the Koch method shows promise as a potential alternative, further research is imperative to develop tailored approaches that address the unique challenges encountered in these scenarios. Advancing our understanding of effective CPR techniques specific to helicopter operations will ultimately enhance resuscitation outcomes and improve emergency medical assistance in these critical situations.

Learning Objectives

1. Understand the unique challenges faced in performing cardiopulmonary resuscitation (CPR) in the confined and dynamic environment of helicopter rescue operations.
2. Recognize the limitations and gaps in current evidence regarding alternative CPR techniques in helicopter rescue operations and identify the need for further research to develop tailored approaches that address the specific challenges encountered in these scenarios.

[379] ANALYSIS OF FIXED-WING MOTORIZED AIRCRAFT ACCIDENTS: INJURY SEVERITY AND CONCOMITANT FACTORS IN THE YEAR 2000–2019

Jochen Hinkelbein[1], Felix Liebold[2], Catherina Hippler[3], Jan Schmitz[3]

[1]*Ruhr University Bochum, Minden, Germany;* [2]*University Leipzig, Leipzig, Germany;* [3]*Uniklinik Koeln, Koeln, Germany*

(Original Research)

BACKGROUND: There is a paucity of research on general aviation accidents in Germany. The authorities investigate only a fraction of all national accidents. The current study analyzes existing accident reports and aims to identify injury severity in regard to concomitant risk factors. **METHODS:** Data of flight accidents was analyzed for aircraft of, 5700 kg maximum takeoff weight (MTOW) over a 20-yr period. Besides descriptive data, concomitant factors (type and category of aircraft, date, occupants and outcome, flight phase, etc.) were analyzed. Statistical analysis was performed using the Chi-squared test. **RESULTS:** The authorities list 1595 aircraft accidents between 2000 and 2019, but only 17.9% of these were analyzed in detail. Accidents of aircraft of, 2000 kg MTOW were over-represented between May and September and between Friday and Sunday. The fraction of fatal accidents was highest during cruise. During landing, significantly more mishaps of larger aircraft occurred. The number of seriously injured or deceased occupants was significantly higher for accidents involving private pilots. An occupancy rate of more than three persons on board correlated significantly with fewer number of deaths. **CONCLUSIONS:** The annual count of aircraft accidents has almost halved during the previous 20 yr. Unfortunately, only a small number of mishaps were further investigated by authorities, which leads to a lack of evaluable data needed for in-depth investigations. The accumulation of larger aircraft mishaps in winter and the superior outcome of professional pilots in terms of safety, as well as the fewer number of mishaps in larger aircraft, should be further investigated.

Learning Objectives

1. The audience will learn about the relevant factors contributing to an GA accident.
2. The audience will learn how to perform a statistical analysis of factors relevant for an accident.

[380] PROINFLAMMATORY MARKERS AND FLIGHT HOURS: PRELIMINARY FINDINGS

Denis Bron[1], Andres Kunz[1], Sibylle Grad[2], Kenneth Kincel[3], Elizabeth Damato[3], Michael Decker[3]

[1]*Aeromedical institute Swiss Air Force, Duebendorf, Switzerland;* [2]*AO Research Institute, Davos, Switzerland;* [3]*Case Western Reserve University School of Medicine, Cleveland, OH, United States*

(Original Research)

INTRODUCTION: A higher prevalence of back complaints in flying personnel compared to the general population is well documented. Various causes have previously been described. While standard analysis approaches including clinical testing, imaging-based evaluation and electrophysiological testing are well established, the role of laboratory analyses are less known. As part of a larger study intended to explore the relationship between musculoskeletal pain and blood serum analytes, this study sought to evaluate the relationship between flight hours and relevant laboratory parameters. **METHODS:** Eighty military pilots and aircrew members were evaluated over a three-year period during their routine health check-ups. The sample was divided into 2 groups based on the median flight hours (150 hours/year). Independent samples T-tests and Mann-Whitney U-tests were used to assess differences in blood serum analytes between

groups. **RESULTS:** The group of aviators showed different mean values for Interleukin-12 (IL-12), Macrophage Derived Chemokine (MDC), Monocyte Inflammatory Protein-1α, (MIP1-α), Vascular Endothelial Growth Factor-A (VEGF-A), and Placental Growth Factor (PlGF). **CONCLUSION:** These results, supported by past literature, suggest that increased flight hours correspond with elevated levels of proinflammatory serum analytes. Additional research is needed to determine whether the changes in serum analytes correspond with severity of musculoskeletal pain/injury.

Learning Objectives

1. The participant will learn that a relationship may exist between amount of flight hours and changes in proinflammatory serum analytes.
2. The participant will discuss the function of the serum analytes that differed based on flight hours.

[381] RAPID CHANGES OF THE NUCLEAR ARCHITECTURE AND GENE REGULATION IN T LYMPHOCYTES IN HYPERGRAVITY

Oliver Ullrich, Cora Thiel
University of Zurich, Zurich, Switzerland

(Original Research)

Earth's constant gravitational pull, various acceleration forces affect human cells and tissues, both physiologically, as in the bloodstream, and through advanced technology, like high-performance aircrafts. Notably, the lymphatic system, a significant component of the human body, responds swiftly to gravity changes, playing a pivotal role in systemic messaging and regulation. This study explored the impact of hypergravity on the three-dimensional structure of chromatin, gene expression, histone modifications, and nuclear morphology. We conducted experiments using human Jurkat T cells exposed to hypergravity at 1.8g and 9g for different durations. Our findings revealed a dynamic gene expression response to hypergravity between 20 seconds and 60 minutes, which was followed by a rapid adaptation. Up-regulated genes tend to centralize within the nucleus, while down-regulated genes move toward the nuclear periphery. The hypergravity-induced up-regulated genes are primarily located on chromosomes 16-22. Notably, this gene expression pattern differed from responses to oxidative stress, heat shock, or inflammation. Our fluorescence microscopy analysis showed rapid cellular responses and epigenetic adaptations, even within 75 seconds of hypergravity. These effects normalized after 60 minutes. Additionally, cytoskeletal analyses indicated a temporary re-organization in hypergravity, which returned to normal levels after 60 minutes. In conclusion, our study demonstrated a robust and dynamic response to altered gravity, surpassing the responses observed with other stressors like inflammation, heat shock, and oxidative stress. We also unveil the influence of hypergravity on the three-dimensional chromatin structure and associated cellular epigenetic regulation through histone methylation. These findings shed light on the profound impact of hyper-gravity on cellular functions and gene expression.

Learning Objectives

1. Recognize the significance of the lymphatic system in responding to gravity changes and its role in systemic regulation.
2. Understand the effects of hypergravity on the three-dimensional structure of chromatin, gene expression, histone modifications, and nuclear morphology.

[338] AEROMEDICAL FITNESS AFTER A SEVERE SPINAL TRAUMA? THE LONG WAY BACK TO THE COCKPIT.

Torsten Pippig
Center of Aerospace Medicine of the German Air Force, Koeln, Germany

(Education - Case Study)

Military fighter aircraft are equipped with rescue systems (ejection seat, parachute) that can save lives and protect against serious injuries, not always. Small civilian aircraft do not have these systems. I report on a 29-year-old fighter pilot and flight instructor of the German Air Force who crashed in a private small plane in the USA in December 2021 and suffered severe spinal trauma: Cover plate fracture of Th12 (A3) and L1 burst fracture (A4) with conus medullaris-type-Syndrome. The initial surgical treatment took place in a special clinic in the USA: L1 laminectomy, T11-L3 segmental pedicle srew fixation using K2M and posterolateral fusion L3-T11). No fracture healing could be seen during the X-ray and CT examination of L1 one year after surgery and a third operation was carried out in November 2022: Reduction and shortening of the previous spinal fusion (this was not loosened!) from Th12 to L2, removal and replacement of L1 body and an autologous spongiosaplasty. 9 months later, the military and civilian specialist orthopedic aeromedical examination and assessment took place at the Centre of Aerospace Medicine of the GAF in Cologne. **DISCUSSION:** The indication for spinal fusion is instability of the spine. This can occur due to wear of the intervertebral discs, vertebral fractures and tumors, spondylolisthesis or osteoarthritis of the vertebral joints. e.g., after trauma, inflammation, degeneration, tumor or osteoporosis, there is an indication for a corporectomy and vertebral body replacement. If the load-capacitay of the vertebarlm body is no longer present e.g., after trauma, inflammation, degeneration, tumor or osteoporosis, there is an indication for a corporectomy and vertebral body replacement **Aeromedical Decision:** The fighter pilot was assessed as "unfit for all military flying duties". In a subsequent waiver process, the airworthiness was reassessed, which speaks for and against military flying duty. It was approved to fly fixed wing aircraft but use as a jet pilot (ejection seat!) and helicopter pilot was excluded. The reasons for this decision will be explained in the following lecture: Pilot/injury/surgery/consequences, workplace and stress, special features of military flight service, prognosis. Civil aeromedical fitness was granted without restrictions 22 months after the aircraft accident. This is not an isolated case; between 2012 and 2022, 9 pilots were examined and assessed in my department after spinal fusion.

Learning Objectives

1. Severe spinal trauma, diagnosis, surgicsl treatment and rehabilition. Outcome and prognosis.
2. Aeromedical fitness. Waiver conditons and waiver process. Which speaks for and against military flying duty.
3. Risk of spinal injuries and spinal fracture when using an ejection seat.

[377] ALTERNATIVE CPR TECHNIQUES IN CONFINED SPACE AND AIRPLANE ENVIRONMENTS: COMPREHENSIVE REVIEW AND RECOMMENDATION FOR PRACTICE

Felix Liebold[1], Remco Overbeek[2], Niels Benjamin Adams[2], Jan Schmitz[2], Lydia Kolaparambil Varghese[3], Michael Sebastian Neumann[3], Wolfgang Wetsch[2], Jochen Hinkelbein[2], Manuel Michno[4]
[1]*University Hospital Leipzig, Leipzig, Germany;* [2]*Faculty of Medicine and University Hospital Cologne, University of Cologne Department of Anesthesiology and Intensive Care Medicine, Cologne, Germany;* [3]*Johannes-Wesling-Universitatsklinikum Minden, Ruhr-Universitat Bochum Department of Anaesthesiology, Intensive Care Medicine and Emergency Medicine, Minden, Germany;* [4]*Research Centre Jülich/University of Zürich, Zürich, Switzerland*

(Original Research)

INTRODUCTIONS: Confined environments can be found in several settings relevant to emergency medical care such as helicopters, pressure chambers, airplanes or road vehicles. The challenges associated with respective rescue operations are distinct and require a variety of adaptions

to the conventional guidelines. This scoping review provides an overview of the existing literature regarding Cardiopulmonary Resuscitation (CPR) in Confined Spaces with special interest in airplane environments and derives concrete recommendations of applicable approaches for practice. **METHODOLOGY:** A systemic literature search was conducted across five renowned databases, including PubMed, EMBASE, CINAHL, Cochrane and Web of Science by two independent reviewers. The following search string was designed including specific key words representing for confined space and air travel: *(CPR OR resuscitation OR ALS OR BLS OR chest compression) AND (confined space OR airplane OR straddling position OR over the head OR adapted technique)*. **RESULTS:** An initial screening yielded 788 results. After duplicates removal, full-text screening and application of all inclusion and exclusion criteria, there were 14 publications to be included into the final review. Among these articles describing alternative CPR techniques, there was one found relevant for airplane travel and 13 articles for confined space. Additionally, nine publications provided useful information pertaining to CPR during air travel or in spatially demanding environments. Different approaches in terms of CPR-quality in a confined space were discussed. The only airplane travel related publication investigated a new mechanical resuscitation device which led to significantly less absolute hands-off time but at the same time less effective ventilation. The other publications included showed that both the Over-the-Head technique and the Straddle Technique offering comparable CPR quality compared with standard lateral CPR. **CONCLUSION:** This work summarizes the current state of research on alternative CPR techniques in aircraft and confined environments. It highlights the critical need for research, particularly in relation to airplane travel, to generate evidence-based recommendations for best practice CPR in the air.

Learning Objectives

1. The participants will gain knowledge about the difficulties regarding CPR in confined space and during airplane travel.
2. The audience will get to know alternative CPR techniques that are applicable in confined space and in aircraft environments.

Wednesday, 05/08/2024 ***2:00 PM***
Grand Hall J

[S-66]: SLIDES: NEUROPHYSIOLOGY- PHYSICAL AND COGNITIVE IMPAIRMENT

Chair: James Devoll
Co-Chair: Benisse Lester

[382] EFFECT OF ACUTE HYPOXIA EXPOSURE ON THE AVAILABILITY OF A1 ADENOSINE RECEPTORS IN THE HUMAN BRAIN MEASURED WITH [F18]CPFPX PET

Manuel Michno[1], Henning Weis[2], Jan Schmitz[3], Anna Foerges[4], Simone Beer[4], Jens Jordan[5], Bernd Neumaier[4], Alexander Drzezga[6], Daniel Aeschbach[5], Andreas Bauer[4], Jens Tank[5]
[1]*Research Centre Julich/University of Zurich, Zurich, Switzerland;* [2]*University Hospital of Cologne, Nuclear Medicine, Cologne, Germany;* [3]*University Hospital of Cologne, Anesthesia, Cologne, Germany;* [4]*Research Centre Julich, Julich, Germany;* [5]*German Aerospace Centre, Cologne, Germany;* [6]*University Hospital of Cologne, Nuclear Medicine, Cologne, Germany*

(Original Research)

INTRODUCTION: Animal studies suggest that adenosine actions on A1 adenosine receptors (A1AR) protect the brain from oxygen deprivation through adjustments in cerebral blood flow, metabolism, and electrical activity. Given the relevance of cerebral hypoxia tolerance for aerospace medicine, we translated these findings from animals to human beings. Using [F-18]CPFPX, a PET tracer for A1AR, we tested the hypothesis that hypoxia-induced adenosine release reduces A1AR availability in the human brain. Furthermore, we tested the hypotheses that this response is associated with altered psychomotor vigilance and cerebral blood flow. **METHODS:** Ten healthy volunteers (31 ± 8 years, 3f) completed an 110-min bolus plus constant infusion [F-18]CPFPX PET-MRI hybrid experiment: Subjects spent the first 60 minutes of the scan in normoxia followed by 30 minutes of individually adapted normobaric hypoxia to achieve a peripheral oxygen saturation of 70 - 75% (mean gas mixture corresponds to an altitude of 5500m/18000ft), followed by 20 minutes of normoxia. We obtained blood samples to calculate metabolite-corrected steady-state A1AR distribution volumes (VT). We measured brain perfusion via arterial spin labelling in high temporal resolution. We conducted a 3-minutes psychomotor vigilance test (PVT) every 10 minutes. We continuously measured heart rate and peripheral blood oxygen saturation. **RESULTS:** Mean peripheral oxygen saturation was 97% during normoxia and 73% during hypoxia exposure ($p < 0.0001$). Hypoxia reduced A1AR availability in the cerebral cortex by 14% ($p = 0.03$). Compared to normoxia, brain perfusion increased during hypoxia by 34% in cortical gray matter ($p < 0.0001$). Heart rate increased by 20% ($p < 0.001$). PVT mean reaction time was longer by 12 ms ($p = 0.002$). **DISCUSSION:** Our study is the first to show that acute oxygen deprivation corresponding to 5500 m altitude reduces A1AR availability in the human brain. The finding is consistent with hypoxia-induced cerebral adenosine release leading to increased A1AR occupancy. Given adenosine's known actions on the brain, A1AR could contribute to variability in hypoxia tolerance and serve as target for countermeasures.

LEARNING OBJECTIVE

1. The availability of A1AR in the human brain consistent with increased adenosine release.
2. Adenosine actions on A1AR may protect the brain from oxygen deprivation.

Learning Objectives

1. Acute Hypoxia reduces the availability of A1AR in the human brain consistent with increased adenosine release.
2. Adenosine actions on A1AR may protect the brain from oxygen deprivation.

[383] PERCEPTUAL AND COGNITIVE SKILLS AFFECTING PILOTS' ASSESSMENT OF THE ROLL-ANGULAR DISPLACEMENT DURING SIMULATED COORDINATED FLIGHT TURNS

Andreas Brink[1], Michailis Keramidas[1], Arne Tribukait[2], Ola Eiken[1]
[1]*Royal Institute of Technology, Stockholm, Sweden;* [2]*Karolinska Institutet, Solna, Sweden*

(Original Research)

BACKGROUND: Pilots undergoing coordinated flight turns or centrifugation, whilst devoid of visual cues, exhibit substantial interindividual variation in their perception of roll tilt. The objectives of this study were to investigate whether, and to what extent, specific perceptual and cognitive abilities can account for this inter-individual variability. **METHODS:** Twelve experienced fixed-wing pilots were subjected to centrifuge tests on two separate occasions, with a six-month interval between them. The subjective visual horizon (SVH) was measured in darkness using an adjustable luminous line during three 6-minute centrifuge runs, each involving different roll tilts: 25° (1.1 G), 56° (1.8 G), and 66° (2.5 G). Initial and final SVH settings were recorded for each G plateau. During the second occasion, the SVH settings were temporarily interrupted at each plateau (visual distraction task). In addition, verbal estimations of experienced G loads were provided by the pilots. After the centrifuge tests, 1-g environment, the pilots were questioned about the relationship between G load and roll tilt, and they were asked to adjust the luminous line so that its slope corresponded with specified angles. **RESULTS:** The pilots underestimated their roll tilt throughout each G plateau, average SVH being 4° to 28° less than the actual roll angle at the different G loads. The visual distraction task did not affect the SVH settings. A multiple

regression analysis indicated that the chain of tested capacities - perception of G load, knowledge of relation between G load and bank angle, accuracy when indicating angles in 1 g - significantly contributed to the SVH. **DISCUSSION:** Thus, the tested chain of skills appears to influence the pilots' ability to assess the degree of roll tilt during simulated coordinated flight turns. Notwithstanding, SVH was typically markedly smaller than predictions based on the specific abilities. Presumably, SVH is also dependent on subconscious processing, linking the sensation of bodily weight to a visually imagined horizon.

Learning Objectives

1. Participants will gain insight into the role of the vestibular system in pilots' perception of roll tilt during coordinated flight turns and centrifugation, and how it interfaces with cognitive processes, shedding light on the complexities of pilot perception.
2. Participants will understand the challenges posed by the nonlinear relationship between G load and bank angle perception, and how the brain's reliance on otolith information for spatial orientation can affect pilots' ability to accurately estimate roll tilt, highlighting the need for potential training regimens to improve this capability.

[384] A COMPARATIVE STUDY OF UTRICULAR FUNCTION BETWEEN HEALTHY AIRCREW AND GROUNDCREW USING SUBJECTIVE VISUAL VERTICAL TEST

Karthikeyan Sankaran, Rahul Pipraiya
Institute of Aerospace Medicine, Bengaluru, India

(Original Research)

INTRODUCTION: The perception of gravitational vertical is crucial for maintaining an upright posture, gait, and majority of motor functions. Multimodal integration of visual and vestibular information plays a major role in the way that verticality is represented. The direction of gravito-inertial vectors can be ascertained via otoliths (utricle & saccule), which are also useful for navigation. Objective of the study was to determine and compare utricular function between aircrew and ground crew using Subjective Visual Vertical (SVV) test. **METHODS:** SVV tests, including Vertical Static Tilt, Dynamic Clockwise and Dynamic Anticlockwise, Vertical Static Tilt Right & left were performed on 100 volunteer subjects comprising of 50 healthy aircrew and ground crew each. Degree of tilt was assessed by measuring the angle between perceived and true verticals. The difference in the degree of perceived tilt between aircrew and ground crew was analysed using Student's unpaired T-test. **RESULTS:** The obtained mean values of Static SVV, Dynamic Clockwise, Dynamic Anticlockwise, vertical static tilt right & left SVV in ground crew were +0.99°±0.41°, +4.35°±1.85°, -5.81°±3.24°, -0.75°±1.45° & -0.33°±2.30° respectively and were +0.70°±0.35°, +3.6°±1.83°, -4.46°±3.46°, -0.66°±0.92° & +0.21°±1.09° respectively in aircrew. The perceived degree of tilt was significantly lesser in aircrew as compared to groundcrew ($p<0.05$) in Static SVV, Dynamic Clockwise & Dynamic Anticlockwise SVV test. The difference between the two groups was not statistically significant ($p>0.05$) for the Vertical static tilt right & left SVV tests. **DISCUSSION:** Due to frequent and continuous exposure to the aviation environment, aircrew exhibit a better perception of verticality than ground crew, as evidenced by the degree of tilt in the vertical static, dynamic clockwise and anticlockwise SVV tests. The firing rates of the utricular hair cells may be proportionally dependent on membrane displacements that change depending on the angles of head tilts due to their mechanical characteristics. In other words, head tilts less than 30° would primarily stimulate the lateral region of the utricle and cause a mild deviation of the hair cells in the opposite direction of head motion. Scant scientific literature on the subject is available, thereby limiting comparative analyses with other studies.

Learning Objectives

1. The use of SVV test battery as an invaluable tool for a better understanding of utricular function.
2. This knowledge may be applied in early recognition and treatment of utricular dysfunction in aircrew and space crew.

[385] VIBROTACTILE FEEDBACK AS A COUNTERMEASURE FOR SPATIAL DISORIENTATION IN EARTH-G, MARTIAN-G, LUNAR-G, AND 0-G ANALOGS

Vivekanand Vimal, Paul DiZio, James Lackner
Brandeis University, Waltham, MA, United States

WITHDRAWN

[386] DOES FLIGHT RELATED NECK PAIN EFFECT COGNITIVE AND PSYCHOMOTOR PERFORMANCE IN MILITARY ROTARY-WING REAR CREW?

Richard Vail[1], Stephen D.R. Harridge[1], Nicholas Green[2], Marousa Pavlou[1], Peter Hodkinson[1]
[1]*King's College London, London, United Kingdom;* [2]*RAF, London, United Kingdom*

(Original Research)

INTRODUCTION: Military rotary-wing operations require sustained levels of cognitive and psychomotor performance from aircrew to ensure safety and operational effectiveness. Significant flight-related neck pain (SFRNP) is common amongst rotary-wing aircrew, potentially affecting their performance. This study aimed to examine the effect of SFRNP on psychomotor and cognitive performance in a cohort of military rotary-wing aircrew in the operational flight environment. **METHODOLOGY:** A field study was conducted using a dual-task paradigm with 40 military operational CH-47 rear crew (39 male, 1 female). The primary outcome variable was the Dual Task Effect (DTE) (% change between single and dual task conditions) for cognitive and psychomotor performance on a novel simulated flight-task test battery. These data were stratified post-hoc for those with or without SFRNP. This study received favourable opinion from the UK Ministry of Defence Research Ethics Committee (MODREC). **RESULTS:** 65% (n=26) of participants reported SFRNP during the test flights. Mean intensity of SFRNP was 2.5 on the Numerical Pain Rating Scale. Pre-flight, there was a significantly greater deterioration in psychomotor performance under dual task conditions for the SFRNP group (DTE -15.8), compared to the non-neck pain group (DTE 1.5) ($p=.01$). Deterioration in dual-task performance (DTE) for both the cognitive and psychomotor conditions was slightly worse following the operational flight sortie; however, no significant differences were observed after the operational flight sortie in either the SFRNP or non-neck pain group ($p=>.05$). **DISCUSSION:** SFRNP was found to be present amongst this sample of military rotary-wing aircrew. There was a detectable change in the cognitive and psychomotor performance of the aircrew using the dual-task paradigm. Whilst there was evidence that SFRNP was associated with reduced psychomotor dual-task performance, operational flight exposure did not affect aircrew performance in this study. Future research could consider the relationship between the pain intensity and its effect on performance.

Learning Objectives

1. Psychomotor dual-task performance was reduced in military rotary-wing rear crew with significant flight-related neck pain.
2. Operational flight exposure was not associated with reduced dual-task performance in aircrew with or without significant flight-related neck pain in this study.

[387] QUANTIFYING OVERESTIMATION OF HEAD TILT DURING SUSTAINED AND REPEATED EXPOSURE TO HYPER-GRAVITY

Victoria Kravets, Aadhit Gopinath, Torin Clark
University of Colorado, Boulder, Boulder, CO, United States

(Original Research)

INTRODUCTION: Dynamic changes in gravity experienced during space travel present immediate challenges for astronauts, and the

associated neurovestibular impairment during the first crucial hours in a new environment poses increased risk of spacecraft mishaps when manual control is required or the possibility of injuries during emergency egress or Extravehicular Activities. This research seeks to address a significant knowledge gap by characterizing the extent and temporal dynamics of neurovestibular impairment within the initial hour following a gravity transition, offering valuable insights into the timeline and severity of impairment during the adaptation period. **METHODS:** We utilized a human centrifuge to generate a net force of 1.5*g* along the longitudinal body axis of our subjects for 1 hour. The amount of over/underestimation of head tilt was used to provide an indirect inference of the time course of neurovestibular adaptation to the change in gravity and was monitored by passively tilting the head to a random roll angle every 3 minutes while collecting subject visual vertical (SVV) measures through a head-mounted display. Pre- and post- centrifugation SVV measures were also collected to establish a baseline perceptual response and to monitor readaptation to 1*g*. Testing was repeated on two consecutive days to explore the effect of memory of recent gravity transitions on adaptation trajectories. This protocol was approved by the University of Colorado-Boulder Institutional Review Board. **RESULTS:** Thirteen subjects (7 males and 6 females; ages 26.8±6.1 years) completed the study. During the hour of centrifugation, subjects consistently overestimated head tilt (by an average of 41±22% of actual head tilt angle on day 1 of testing and 45±28% on day 2 of testing). The subsequent readaptation phase demonstrated a rapid readjustment back to baseline perceptual measures. Notably, significant inter-individual differences were observed throughout the study. **DISCUSSION:** Despite the potential ramifications related to vestibular impairment following a gravity transition, minimal data has been collected to systematically examine adaptation over the crucial first hours following a gravity transition. The results of this study offer insight into the diverse range of adaptation trajectories that may occur and can be used to inform computational models further exploring the adaptation process.

Learning Objectives

1. The audience will learn about how tilt estimation changes in altered gravity.
2. The audience will learn about the effect of repeated exposure to altered gravity on tilt estimation in novel environments.

Wednesday, 05/08/2024 ***2:00 PM***
Grand Hall K

[S-67]: PANEL: MEDICAL AND HUMAN PERFORMANCE CONSIDERATIONS FOR COMMERCIAL LOW EARTH ORBIT

Sponsored by Aerospace Human Factors Association

Chair: Anna Clebone Ruskin
Co-Chair: Brian Musselman

PANEL OVERVIEW: *INTRODUCTION: Astronauts have historically been selected on the basis of mission requirements and strict medical and physical guidelines. The advent of commercial space travel offers an opportunity for non-astronaut passengers to experience spaceflight. TOPIC: As the commercial space industry expands to include commercial space travel and possible future colonization of the Moon and Mars, future space travelers may require accommodation for a wide variety of physical and medical conditions. These accommodations may include the need for physical prehabilitation, management of stress and noise, limiting discomfort such as nausea and vomiting, and overall integration of a new class of space travelers into a space vehicle. APPLICATION: Physical prehabilitation is currently used by anesthesiologists and surgeons, and seeks to optimize a patient's physical status before the planned surgery and anesthesia. The goal is to ensure the best possible outcome after surgery. Concepts from pre-operative clinic 'prehabilitation' could be applied to potential spaceflight passengers, and could in the future even launch a new medical subspecialty of the 'space tourist physician.' Similarly, commercial space passengers may not expect stressors that commonly occur during launch, orbit, and re-entry. They will experience these stressors in a cramped environment without an immediate exit. Contributors to this stress include noise, space sickness, and claustrophobia. Current data and future directions on describing and evaluating the acoustic environment of space flight vehicles will be reviewed. Non-pharmaceutical and pharmaceutical strategies for managing nausea from space sickness will also be explored. Finally, an effective human system integration approach needs to be applied to space vehicle design to ensure it is optimized for all potential space travelers. As more people travel in space, the need for medical accommodations will increase. Current science, as well as future research can be leveraged to meet this need.*

[388] PHYSIOLOGICAL STRESSOR OPTIMIZATION

Jaclyn Edelson
University of Chicago, Chicago, IL, United States

(Education - Tutorial/Review)

INTRODUCTION: As technology advances and space accessibility becomes more financially inclusive, space tourism for lay-people may become a budding industry. Similar to optimizing lay-people for the physiological stressors of surgery, physicians may have a role in optimizing space tourists for the physiological stressors of the journey. **TOPIC:** Historically, physicians have played a close role in monitoring astronaut health and safety in previous missions to space. This role will likely change as space exploration expands beyond the elite fitness of historic astronauts to lay-people that desire a tourist experience in space. **APPLICATION:** Physicians can use principles learned from patient optimization on Earth in the setting of a pre-operative clinic and 'prehabilitation', and apply them to preparing space tourists for their time beyond Earth's atmosphere. These principles include how to assess risk for individual passengers, and what minimal standards of health may be needed to enjoy the journey. It is also important to hypothesize and outline what responsibilities, expectations, and consequences may be for a "space tourist physician" before the role exists in widespread practice. **RESOURCES:** Tew GA, Ayyash R, Durrand J, Danjoux GR. Clinical guideline and recommendations on pre-operative exercise training in patients awaiting major non-cardiac surgery. Anaesthesia. 2018;73(6):750-768. DOI: 10.1111/anae.14177. Committee on Standards and Practice Parameters; Apfelbaum JL, Connis RT, Nickinovich DG; American Society of Anesthesiologists Task Force on Preanesthesia Evaluation; Pasternak LR, Arens JF, Caplan RA, Connis RT, Fleisher LA, Flowerdew R, Gold BS, Mayhew JF, Nickinovich DG, Rice LJ, Roizen MF, Twersky RS. Practice advisory for preanesthesia evaluation: an updated report by the American Society of Anesthesiologists Task Force on Preanesthesia Evaluation. Anesthesiology. 2012 Mar;116(3):522-38. doi: 10.1097/ALN.0b013e31823c1067. PMID: 22273990

Learning Objectives

1. Express how principles of pre-operative evaluation and prehabilitation are relevant to pre-flight evaluation for potential space tourists.
2. Discuss what responsibilities and expectations exist for a physician in the budding space tourism industry.

[389] ASSESSING THE IMPACT OF ACOUSTIC ENVIRONMENTS ON COMMUNICATION AND AUDITORY HEALTH

Abby Silbaugh
University of Chicago, Chicago, IL, United States

(Education - Program/Process Review)

BACKGROUND: The acoustic environment in space flight vehicles and habitats remains a major operational concern. Risks associated with noise, radiation, and ototoxin exposure include reduced speech intelligibility and permanent shifts in hearing thresholds. This presentation

assesses key elements of the NASA Hearing Conservation Program (HCP), reviews data availability in critical areas, and provides a prioritized list of recommendations for future study. **OVERVIEW:** Data collected in terrestrial environments primarily inform auditory damage risk criteria and recommendations on the use of hearing protective devices. A comprehensive understanding of short- and long-term changes in hearing sensitivity in spacecraft environments is required to mitigate unique habitability concerns and safety risks. Noise level monitoring and periodic audiometric testing are critical components of the HCP, but whether existing approaches can sufficiently characterize changes in hearing sensitivity and its impact on communication must be rigorously evaluated. This presentation discusses 1) the extent to which pure-tone audiometry can detect changes in hearing sensitivity affecting speech discrimination; 2) the limitations of existing retrospective studies investigating transient and permanent shifts in hearing thresholds; and 3) NASA Johnson Space Center (JSC) data availability and reporting. A workshop composed of relevant specialties across military and civilian spheres assembled primary peer-reviewed papers and JSC data in the following areas: pre- and post-flight audiograms, On-Orbit Hearing Assessments, Sound Level Meter measurements, and Acoustic Dosimeter measurements. Data quality and accessibility were evaluated, and reviewers generated a prioritized list of recommendations for further research. **DISCUSSION:** NASA's Hearing Conservation Program and effective programs in other professional disciplines use accurate, scientifically-based standards and countermeasures. Increasing interest in commercial and long-term space flight expands the variety of astronaut medical and physical conditions requiring accommodation, establishing the need to rigorously characterize the impact of the acoustic environment on auditory health and safety. This work is of broad interest to professionals who may be in a position to contribute to the scientific knowledge base, increase data accessibility, or implement additional testing and countermeasures in this area.

Learning Objectives

1. Recognize the impact of acoustic conditions in space flight vehicles on auditory health and communication and review current approaches to hearing conservation.
2. Understand current methodologies and data utilized in monitoring auditory health in space environments, recognizing areas of potential improvement and further research needs.

[390] SPACE MOTION SICKNESS - NON-PHARMACOLOGIC AND PHARMACOLOGIC INTERVENTIONS

Anna Clebone Ruskin
University of Chicago, Chicago, IL, United States

(Education - Tutorial/Review)

INTRODUCTION: Being selected as an astronaut comes with an understanding that one is willing to undergo physical discomfort. As commercial orbital and suborbital flights increase, the range of individuals who become space flight participants, and thus experience the physically unpleasant circumstances of space flight will increase. **TOPIC:** 'Space motion sickness,' is caused by modification of signals, due to microgravity, in the neuro-vestibular and visual systems. A multi-modal approach to this neurogenic problem incorporates multiple interventions, each of which may have a weak effect but when combined may potentiate each other. **APPLICATION:** This presentation will review various non-pharmaocolgic and pharmaocolgic interventions to space motion sickness. Non-pharmacologic interventions are ideal due to the decreased potential for side-effects and can be started weeks prior to the anticipated flight. One of the simplest approaches is avoidance of recreational alcohol. A more complex intervention is motion exposure. This could be as basic as spinning for a few minutes daily in a roller-chair, or as intense as using a spatial disorientation trainer (which spins a person in multiple axes but at low speed) for several hours a day in the weeks leading up to the flight. Eating ginger candy, and wearing bracelets that apply pressure to the P6 acupressure point are also useful during the actual motion. Pharmacologic interventions all have potential side effects, but could be used under the supervision of a physician or other medical officer. Famotidine works on the H1 receptor to decrease stomach acid, and a single dose has relatively few side effects. Other drugs may be more efficacious, but have the potential for sedation, which precludes use in pilots and other crew members who are essential for flight safety. Ondansetron is a serotonin receptor antagonist used for peri-operative nausea treatment and prophylaxis, however it can cause some sedation, headache, and constipation and is contraindicated in patients with long QT syndrome. Diphenhydramine and other H2 blockers, as well as scopolamine, an anticholinergic, cause significant sedation along with a dry mouth and dizziness. Dextroamphetamine is a stimulant, but should be avoided when possible due to the potential for addiction and sudden cardiac death. A risk for polypharmacy and unanticipated side-effects also exists if multiple drugs are used.

Learning Objectives

1. Similar to other neurogenic problems, space motion sickness benefits from a multimodal approach, in which several interventions may potentiate each other.
2. Non-pharmacologic modalities to prevent and treat space motion sickness have fewer side effects. In the weeks before the flight, these may include avoidance of recreational alcohol and motion exposure. During the flight, eating ginger candy, and wearing bracelets that apply pressure to the P6 acupressure point are also useful.
3. Pharmacologic interventions for space motion sickness require medical supervision, and may be contraindicated in some travelers. Famotidine, ondansetron, scopolamine, and diphenhydramine will be discussed.

[391] EVALUATING STRESS IN FUTURE SPACE PASSENGER OPERATIONS

Elizabeth Combs, Josephy Tierney
U.S. Air Force, San Antonio, TX, United States

(Education - Tutorial/Review)

INTRODUCTION: Suborbital commercial space flights became a reality in July 2021. Commercial companies are currently design low earth orbit destinations, which can support commercial space passengers. While the medical evaluations and standards are continuing to be addressed, one facet of space flight that may benefit from further evaluatedion is passenger stress. Stress is well understood in modern literature as a nonspecific response to demands or response to a stimulus that disrupts homeostasis. In commercial aviation, these demands range from emergencies to negative passenger interactions. Passengers may experience additional stress from delays, external personal interactions, or from the novelty of the experience. **TOPIC:** Increased stress can manifest in both cognitive and physiological changes which present in a variety of different ways. As space flight operations increase; passenger stress has the potential to negatively impact operations. **APPLICATION:** This presentation will address current methods of evaluating stress in passengers. It will detail non-invasive use of biomarkers in current stress research and potential future applications to space flight passengers. The presentation will also detail current stress survey methods and best practices. It will evaluate the usefulness and limitations of the different stress measures for space passengers.

Learning Objectives

1. The audience will learn about common ways to currently assess stress in aviation and their use in space passenger operations.
2. The audience will learn about limitations of evaluating stress in space passenger operations.

[392] HUMAN SYSTEMS INTEGRATION IN SPACE SYSTEMS DESIGN

Brian Musselman[1]
[1]*Star Harbor, Denver, CO, United States*

WITHDRAWN

Wednesday, 05/08/2024 ***2:00 PM***
Grand Hall GH

[S-68]: SLIDES: ACCIDENT ANALYSIS AND SURVIVAL

Chair: Douglas Boyd
Co-Chair: Charles Dejohn

[393] ANALYSIS OF HUMAN FACTORS IN AIRCRAFT ACCIDENTS/INCIDENTS IN CIVIL AVIATION IN INDIA FROM YEAR 2000 - 2023 USING HFACS AND FAHP

Srihari Enakal
Directorate General Of Civil Aviation, New Delhi, India

(Original Research)

INTRODUCTION: Despite the advent of technology and various safety measures in place Human Error still remain to be the leading cause of Aircraft Accidents/Incidents across the world. This study is intended to find the various causative factors of these Accidents/Incidents from the published AAIB/COI reports in the last 24 years in India and analyze the human errors in these accidents, also suggest measures to reduce Human Error related Accidents/Incidents thus improving overall Aerospace Safety. **METHODOLOGY:** All the Aircraft Accidents/Incidents occurred between Jan 2000 - Oct 2023 in Civil Aviation in India have been considered for this study. Each of these Accidents/Incidents have been analyzed in detail in order to identify the role of Human Errors in these accidents by using the Human Factors Analysis and Classification System (HFACS) and Fuzzy Analytical Hierarchy Process (FAHP) for ensuring the quantitative and qualitative assessment of aircraft accidents/incidents. **RESULTS & DISCUSSION:** There were a total of 276 Aircraft Accidents/Serious Incidents in the last 24 years i.e, from January 2000 – 30 October 2023 in Civil Aviation in India out of which 133 were major Aircraft Accidents & 143 were Serious Incidents. A total of 453 people including Crew & passengers lost their life and 190 were seriously injured in these Aircraft Accidents/Serious Incidents. This study has reiterated that Human Error remain to be the leading cause of aircraft accidents (58%). The study also had made analytical assessment of HFACS using the Fuzzy Analytical Hierarchy Process (FAHP). The statistical analysis was carried out using SPSS. This study also gives an insight into the capabilities of integration of analytical tools into the HFACS framework in comprehensive assessment of aircraft accidents and thus implementing safety measures for Aerospace Safety.

Learning Objectives

1. The participants will understand the impact and trend of Human Errors in the Aircraft Accidents/Incidents in Civil Aviation in India in the last 24 years.
2. The participants will get to know the full potential of integrating analytical framework with HFACS in assessment of dynamic factors of aircraft accident investigations.
3. This study will enable the participants to utilize the data and to the compare with the data from around the world.

[394] DIRECT COMBAT-RELATED U.S. ARMY AVIATION INJURIES 2003-2014

Frederick Brozoski, Sandra Conti, Jennifer Dudek, Valeta Chancey, John Crowley
U.S. Army Aeromedical Research Lab, Fort Novosel, AL, United States

(Original Research)

INTRODUCTION: The U.S. Army Aeromedical Research Laboratory, a partner in the Joint Trauma Analysis and Prevention of Injury in Combat (JTAPIC) partnership, conducted retrospective reviews to investigate injuries sustained by occupants of Army rotary-wing (RW) aircraft involved in combat damage incidents (CDIs) (i.e., incidents in which enemy weapon systems damaged an Army RW aircraft). Previous reviews provided an overview of injuries sustained during direct and indirect events (DEs and IDEs). This review analyzed occupant injuries occurring during DEs to identify potential improvements in aircraft- and personnel-borne protective equipment. **METHODS:** A retrospective review was conducted on injuries sustained by occupants of Army RW aircraft involved in CDIs between 2003 and 2014. All Black Hawk, Apache, and Chinook CDIs were reviewed. Personnel casualty information was linked to CDI information by matching the airframe, incident date, and circumstantial information. Information on aircraft- and personnel-borne protective equipment was gathered for each occupant when available. Injuries sustained during DEs (CDIs in which the enemy weapon directly caused occupant injuries) were coded using the Abbreviated Injury Scale (AIS). Descriptive statistics were used to describe the frequency and distribution of injuries and injury mechanisms. **RESULTS:** Within the study period, 45 direct injury events were suffered by 75 of 264 individuals exposed to CDIs. The extremities were the most injured body regions, with the lower extremities suffering more injuries than the upper extremities. Penetrating injury was the primary injury mechanism for all body regions except the head. Blunt force trauma caused all reported head injuries. Injuries to each AIS body region were predominantly minor (AIS 1) and moderate (AIS 2). **DISCUSSION:** Injuries to U.S. Army aircraft occupants (pilots, crew, and passengers) by direct contact with enemy weapon effects during the study period were relatively infrequent and minor, considering the intensity of operations during the study period. Second, of the injuries that did occur, penetrating trauma was the most frequent mechanism, but these were mostly minor. Third, the lack of event data, especially regarding the use of, or performance of, aircraft- or personnel-borne protective equipment, prevents any detailed analysis leading to recommendations, specifically regarding personal protective equipment performance.

Learning Objectives

1. The audience will understand the frequency and severity of injuries sustained by occupants of U.S. Army aircraft exposed to direct contact with enemy weapon systems.
2. The audience will understand the need for improved data collection, particularly regarding personal protective equipment, from in-theater combat damage events to allow retrospective review and guide potential improvements in occupant protection.

[395] MISHAP EXERCISE DESIGN THROUGH THE LENS OF A GAMER

Liam Milburn
Flight Operational Medicine Clinic, APO AE, United States

(Education - Program/Process Review)

BACKGROUND: Aerospace medicine clinics are responsible for performing initial mishap investigations when an event occurs. Training for aerospace medicine technicians and physicians explains the "how" of the process. Providers and technicians often lack the experience with initiating mishap protocols. The missing component is actual implementation, the complexity and the time it takes to process the initial stages of the investigation. This presentation will demonstrate how to design and implement a mishap investigation into military exercises. **OVERVIEW:** Modern tabletop game design has had twenty-five years of continuous process refinement. Current adventure modules account for difficulty tiers, narrative flow, immersion, and consequences of player actions;
this exists through the entire module and can be expanded to large campaigns. Prior to this, early modules consisted of disconnect encounters which fit a theme of the overall adventure. Individual encounters inconsequential to any overarching narrative. Current military exercise design is based on the latter design philosophy. Individual scenarios which fit the theme of the overall exercise, designed to test a specific team's response. Teams are tested whether they are capable of performing a single set of tasks, but not the sustained operations which would realistically occur. This presentation approaches exercise design from a modern gaming design perspective. **DISCUSSION:** Familiarity at managing the initial stages of a

mishap is best obtained through practical experience and training. A mishap exercise which utilizes all facilities within a medical facility, and ideally incorporates line side personnel, will accurately demonstrates unique limitations of each site. Through use of modern game design techniques, mishap investigation exercises can be created regardless of scale, and addition or exclusion of non-line side personnel. This approach is less about beating a set time for completion, rather stresses maintaining the integrity of the investigation over a prolonged period of time.

Learning Objectives

1. The audience will better understand the limitations present military exercises pose to mishap investigations.
2. The audience will be able to identify gaps in mishap training at their home stations and how to best to address those limitations.
3. The presenter will demonstrate holisitic approach to mishap exercise design and training.

[396] POSTMORTEM CARBON MONOXIDE PRODUCTION IN A FATALLY INJURED HELICOPTER PILOT

Turan Kayagil
NTSB, Washington, DC, United States

(Education - Case Study)

INTRODUCTION: On July 19, 2021, a Robinson Helicopter Company R44 II was destroyed when it impacted the water in Albemarle Sound near Point Harbor, North Carolina. The noncertificated pilot and passenger were fatally injured. Although postmortem toxicology testing of cavity blood from the pilot revealed an elevated carboxyhemoglobin of 19%, the National Transportation Safety Board (NTSB) investigation did not identify any likely source of carbon monoxide exposure. **BACKGROUND**: Carboxyhemoglobin is a marker of carbon monoxide (CO) exposure. Nonsmokers normally have carboxyhemoglobin levels of less than 1-3%, while heavy smokers may have levels as high as 10-15%. Elevated carboxyhemoglobin in postmortem blood after an aviation accident is commonly attributable to smoke inhalation during post-crash fire, and may also be an indication of in-flight CO exposure. Rarely, CO may be formed in cavity blood after death, particularly after water immersion. **CASE PRESENTATION:** The helicopter pilot's body was recovered after prolonged water immersion. His autopsy revealed no evidence of thermal injury or airway soot. Fragments of the helicopter displayed no fire damage. The cabin heating system could not be examined, but would unlikely have been in use given warm weather. The pilot reportedly did not smoke. The Federal Aviation Administration Forensic Sciences Laboratory measured carboxyhemoglobin at 19% in the pilot's cavity blood using spectrophotometry, with confirmation by gas chromatography. No passenger specimen was available. The NTSB investigation found that the pilot likely had experienced spatial disorientation after continuing visual flight into instrument meteorological conditions, and that postmortem CO production likely had increased the carboxyhemoglobin level in the pilot's cavity blood after his death. **DISCUSSION**: Postmortem production of CO rarely is an appropriate forensic interpretation of abnormal carboxyhemoglobin elevation in a crash-involved pilot. This case illustrates circumstances under which such an interpretation should be considered. A confirmed carboxyhemoglobin result was obtained in a cavity blood specimen from a body that had been immersed in water. No likely source of abnormal CO exposure was identified, and the crash could be explained from available evidence without positing CO-related pilot impairment. The case is presented by the investigating NTSB medical officer.

Learning Objectives

1. Understand possible explanations for elevated carboxyhemoglobin levels measured in postmortem blood specimens in aviation accident investigations.
2. Identify circumstances under which postmortem carbon monoxide production should be considered as a potential cause of carboxyhemoglobin elevation.

[397] -PLANE CRASH EXTREME SURIVIVAL- 4 CHILDREN, 40 DAYS IN THE AMAZON JUNGLE: SEARCH, RESCUE AND SURVIVABILITY ANALYSIS

Diego M Garcia
National University of Colombia, Bogota, Colombia

(Education - Program/Process Review)

BACKGROUND: The miraculous extended survival of four Indigenous children in the Amazon jungle following a plane crash is a testament to crashworthiness engineering and human resilience. Various factors contribute to the survival of individuals in plane crashes. These factors encompass tolerable levels of G-forces, aircraft crashworthiness, and post-crash considerations. This remarkable event underscores the significance of aircraft cabin delethalization, survival skills and resources in extreme conditions, and the importance of cross-service efforts in search and rescue missions. **OVERVIEW:** Four Indigenous children endured 40 days of survival in the unforgiving Colombian Amazon rainforest after a plane crash that claimed the lives of three adults, their mother included. The successful search and rescue mission involved a collaborative effort between military teams, Indigenous volunteers, and aerospace medicine professionals, highlighting the operational challenges and interdisciplinary approaches required in complex operations like this. Survival factors constitute a crucial aspect of accident investigations, encompassing various specialties and responsibilities. These include documenting impact forces and injuries, evacuation procedures, survival equipment, wilderness literacy, community emergency planning, and search & rescue efforts. **DISCUSSION:** This extraordinary event holds operational and resilience engineering significance, showcasing the remarkable ability of individuals to survive under extreme conditions. It emphasizes the critical role of aerospace medicine and the necessity for comprehensive training and resources to respond to such challenging emergencies. This incident also underscores the vital importance of cross-service and international cooperation in conducting search and rescue missions, transcending military-civilian boundaries. Empirical case findings often highlight the importance of training crew members and passengers in survival and evacuation procedures, emergency equipment use, and effective emergency responses. Identifying survival factors in aviation accidents is not only essential for learning from past events but also for sharing crucial information with organizations responsible for enhancing occupant survivability.

Learning Objectives

1. Understand the Multifaceted Factors Contributing to Survival in Aviation Accidents: Explore the various factors that influence the survival of individuals in aviation accidents, including tolerable G-forces, aircraft crashworthiness, and post-crash considerations. Gain insights into how these factors are crucial in enhancing occupant survivability and resilience during catastrophic events.
2. Appreciate the Interdisciplinary and Collaborative Nature of Search and Rescue Missions: Recognize the significance of cross-service and international cooperation in conducting search and rescue missions during aviation accidents. Understand how collaborative efforts between military teams, Indigenous volunteers, and aerospace.
3. Emphasize the Role of Aerospace Medicine and Training in Enhancing Survival: Highlight the importance of aerospace medicine and comprehensive training in preparing individuals to respond effectively to challenging emergencies. Learn how empirical case findings contribute to the identification of critical survival factors and how this knowledge can be used to enhance safety measures and occupant survivability in aviation accidents.

[398] OPTIMIZATION OF RNA-ANALYSIS FOR MOLECULAR PATHOLOGY IN AIRCRAFT ACCIDENT INVESTIGATION

Michael Schwerer
German Air Force Centre of Areospace Medicine, Cologne, Germany

(Original Research)

INTRODUCTION: Modern medico-legal aircraft accident investigation includes the diagnosis of pathological conditions such as hypoxia, cardiocirculatory disease, or cellular stress burden in the victims using RNA-based forensic genetics. Following current guidelines, tissue samples from autopsies are fixed in 4% formalin solution. For histological assessment, the specimens are subsequently embedded in paraffin wax. Such formalin-fixed, paraffin-embedded (FFPE) material is reliably protected from degradation. However, fragmentation and cross-linking of nuclear acid strands impairs RNA extraction and downstream molecular analysis using reverse-transcription based PCR (RT-PCR). This study compared different methods to retrieve RNA from FFPE samples. **METHODS:** FFPE heart tissue specimens obtained in 21 forensic autopsies between the years 1967 and 2019 were investigated. RNA extraction was carried out using automated magnetic bead-based protocols as well as manual silica-column-based procedures. Commercially available chemistries for the extraction process itself as well as for a pre-treatment to remove the paraffin wax from the tissue were used (Promega, Mannheim, and Qiagen, Hilden, Germany). Self-established procedures from our laboratory were co-evaluated. The effectiveness of RNA extraction was assessed with the Quanti-Fluor-System (Promega). The sensitivity for the detection of lowly concentrated RNAs was studied using RT-PCR for spiked-in miRCURY controls (Qiagen) on a Quant-Studio 5 thermal cycler (Thermo-Fisher, Darmstadt, Germany). **RESULTS:** RNA extraction results not applicable for further RT-PCR analysis were observed in a significant subset of magnetic-bead-based experiments, but were rarely seen when silica-column-based techniques were used. Pre-treatment with either commercially available chemistry or self-established protocols was unavoidable to obtain high-level RNA yields. Employing optimized procedures, the detection of RNAs in concentrations as low as 0.00002 femtomol per microliter was possible. **DISCUSSION:** Successful RNA-based molecular pathology depends on a maximum of extraction efficiency. Under optimized conditions, even lowest concentrations of nuclear acids can be demonstrated on the cellular level. Hence, even minimal pathological changes can be detected and interpreted in accident investigation.

Learning Objectives

1. The participant will get to know the possibilities of molecular pathology in modern aircraft accident investigation.
2. The participant will learn about the limitations of molecular pathology depending on the quality of substrate material and how to improve the results with optimized laboratory protocols.

Wednesday, 05/08/2024 ***2:00 PM***
Grand Hall I

[S-69]: SLIDES: IS THE SKY THE LIMIT? MED OPS IN COMMERCIAL SPACE FLIGHT

Chair: Harriet Lester
Co-Chair: Micah Kenney

[399] OPPORTUNITIES IN COMMERCIAL SPACE FOOD SYSTEM

Chuyan Chen
Axiom Space, Houston, TX, United States

(Education - Program/Process Review)

BACKGROUND: Through decades of National Aeronautics and Space Administration (NASA) experience in human spaceflight, one of the most vital elements to crew wellbeing and performance continues to be the food system. When NASA announced in 2022 the scheduled retirement of the International Space Station (ISS), the opportunity emerged for commercial space food system development. In support of designing its commercial successor, Axiom Space has been compiling valuable learnings from operations of three Private Astronaut Missions (PAM) and development of Extravehicular Activity Services (xEVAS) spacesuit. **DESCRIPTION:** When evaluating a space food system suitability to human crew, a comprehensive and sustainable system should be key design priorities. The development of a food system that is both holistic and sustainable is a formidable goal. The challenges of food safety maintenance, nutritional degradation, and sensory acceptability remain crucial to address. As mission durations extend for longer periods, the sustainability of the food system comes into focus. Technological development to address the limitation of resources has resulted in the proven ability to grow and consume leafy greens abroad the ISS. Further technological advancements should aim to alleviate the upmass cost and stowage resource burdens. **DISCUSSION:** Axiom Space PAM utilized existing food technologies which include thermostabilized, freeze-dried, and commercially off the shelf (COTS) products, produced and packaged on-ground and stowed as flight cargo. Much of the mission food costs came from the severe cost to send upmass. The food procurement process involved key collaboration with NASA and commercial food suppliers. Partnership with commercial food industry has also proved instrumental in the continuous development of xEVAS spacesuit. Leveraging the capabilities of existing food industry infrastructure is essential while technological advancements look to overcome the acknowledged gaps.

Learning Objectives

1. Challenges associated with development of a holistic and sustainable space food system.
2. Considerations and lessons learned to be applied to resolve stated challenges.

[400] COMMERCIAL SPACE – THE FINAL FRONTIER

Michael Harrison[1], William Powers[1], Michelle Hong[1], John Marshall[1], Kendall Howie[2], Chuyan Chen[2]
[1]*Axiom Space Inc & Hercules Medical Group, Houston, TX, United States;*
[2]*Axiom Space Inc, Houston, TX, United States*

(Education - Program/Process Review)

BACKGROUND: The "firsts" that have occurred over the past decade of commercial spaceflight have included both anticipated and unanticipated historic events. The pace of operations has increased for multiple commercial space companies during this period and the tempo is only likely to increase over the next decade. This presents both opportunities and challenges that must be addressed to achieve the goal of making space accessible to all and establishing a sustained presence of commercial crews in space. **OVERVIEW:** Several commercial companies are engaged in designing and flying a commercial space station in low Earth orbit (LEO). Achieving this ambitious goal will require transitioning many activities to the commercial sector or engaging in collaborative activities between governmental and commercial space companies – the product of some of these efforts will also provide benefit to those living on Earth or further commercial opportunities for companies that can offset other costs associated with spaceflight. This panel will discuss collaborative efforts with established governmental space agencies as well as the process for helping new countries develop a corps of career astronauts; the intricacies of developing the next generation of spacesuits with larger ranges of anthropometric capacity; and the considerations in providing nutritious, shelf-stable, and culturally important food. **DISCUSSION:** Space is hard. Commercial space endeavors to make space accessible to all and to support a sustained presence of astronauts who do not necessarily fit the traditional government mold. Accomplishing this aim with require deliberate, collaborative, and innovative approaches to selecting and supporting astronauts, designing and maintaining spacesuits for their missions, and establishing a food system that meets both their physical and psychological health needs.

Learning Objectives
1. The audience will learn about the potential for broad collaborative and innovative relationships that are possible in the commercial space industry.
2. The audience will become familiar with the wide-ranging scope of capabilities and assets, such as a food system, that are required to support commercial spaceflight missions.
3. The audience will understand the importance of physical and psychological benefits provided by these support resources, using a comprehensive food system as an illustrative example.

[401] EFFECTS OF MILD HYPOBARIC HYPOXIA ON RESPONSE FROM MILD EXERCISE IN NASA EXPLORATION ATMOSPHERE TESTS

Brett Siders[1], Lori Cooper[2], Nicole Strock[3], Alejandro Garbino[4], Patrick Estep[4], Lichar Dillon[3], Kadambari Suri[3], Monica Hew[3], Constance Ramsburg[5], Karina Marshall-Goebel[3], Andrew Abercromby[3]
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(Original Research)

INTRODCTION: The NASA Exploration Atmosphere study aims to validate a new prebreathe protocol incorporating an alternate habitat atmosphere of 56.5 kPa (8.2psia), 34% O_2, and 66% N2 to control and mitigate decompression sickness risk associated with spaceflight extravehicular activities. This alternate atmosphere results in a mild hypoxic environment (PIO2 of 128 mmHg) that may influence inhabitant physiological responses to exercise. Therefore, the responses to light exercise in relation to the mild hypobaric hypoxic environment were investigated. **METHODS:** Eight participants (4M/4F; age=38.3±9.0 yr; weight=76.0±13.1 kg; peak aerobic capacity [VO2pk]= 3.1±0.7 L/min) were exposed to a mild hypobaric hypoxic environment for 11 days in NASA's 20-foot hypobaric chamber at Johnson Space Center. Chamber conditions alternated daily between a habitat atmosphere of 56.5 kPa/34% O_2 and simulated 6-hour EVA environment, 29.6 kPa/85% O_2. Participants completed pre-mission graded VO2pk tests on a LODE cycle ergometer with ParvoMedics metabolic analyzer. Submaximal aerobic tests were performed pre and during the mission (10-minutes of exercise at a workload of 40% VO2pk). Pre-mission, participants performed submaximal exercise exposed to a breathing air mixture of, 18% O_2 and balance N2, simulating the mildly hypoxic environment within the 20-foot chamber. Linear mixed models (fixed effect: test day; random effects: subject, age) were performed to determine whether physiological responses (oxygen uptake [VO2], carbon dioxide production [VCO2], ventilation [VE], oxygen saturation [SPO2], heart rate [HR], respiratory exchange ratio [RER]) to submaximal exercise performed within the 20-foot hypobaric chamber every 2 days differed from the pre-mission (18% O_2) testing. Results are presented as estimated marginal means with lower and upper confidence limits, with significance set to 0.05. **RESULTS AND DISCUSSION:** Seven of eight participants completed the chamber study. Mixed models for VO2, VCO2, SpO2, HR, and RER indicated negligible impact of the mild hypoxic chamber environment compared to pre-mission testing (all p>0.05). Results for VE indicated a minor impact of chamber environment compared to pre-mission testing (37.0 L/min [30.8, 43.2]), with increased VE at test day 10 (40.4 L/min [34.2, 46.6]; p= 0.029). The aerobic performance data collected suggests limited physiologic responses to mild exercise when performed at normobaric hypoxia and hypobaric hypoxia.

Learning Objectives
1. The audience will learn about physiologic responses to submaximal exercise identified in a mild hypobaric hypoxic environment.
2. The audience will learn about the methodologies used for metabolic data collection in a mild hypobaric hypoxic environment.

[402] EFFECTS OF MILD HYPOBARIC HYPOXIA ON VISUAL FIELD IMPAIRMENT

Monica Yayu Hew-Yang[1], Alejandro Garbino[2], Patrick Estep[2], Brett Siders[3], Lichar Dillon[4], Kadambari Suri[1], Constance Ramsburg[5], Karina Marshall-Goebel[6], Andrew Abercromby[6]
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(Original Research)

INTRODUCTION: The primary objective of the Exploration Atmosphere (EA) study is to validate a new prebreathe protocol necessary before exposure to a suited hypobaric environment during extravehicular activity (EVA) from a habitat 'exploration atmosphere' of 56.5kPa (8.2 psia), 34% O_2, 66% N_2. Prebreathe protocols must be time and resource efficient while also controlling Decompression Sickness (DCS) risk to within acceptable limits. The habitat hypobaric exploration atmosphere also results in a mildly hypoxic environment (piO_2 = 128mmHg). As a secondary objective of the EA study, we characterized the effects of 11-day exposure to a mild hypobaric hypoxic environment on visual performance. **METHODS:** Two, 11-day hypobaric chamber tests were performed (EA-1and EA-2, n=8 each) in NASA's 20-foot chamber at Johnson Space Center where subjects lived in the exploration atmosphere. Subjects also underwent simulated 6-hour EVAs at 85% O_2 and 29.6 kPa during EVA on days 3, 5, 7, 9, and 11. Visual acuity (VA), a measure of spatial resolution, and contrast sensitivity (CS), a measure of ability to distinguish ever finer increments of brightness, were assessed on non-EVA days by using gapped Landolt C testing. The luminance was controlled by using a booth, a light monitor, and a lighting rheostat. EA-1 data had revealed problems in lighting control impacting consistency of the data. Procedures were subsequently updated for the EA-2 test. **RESULTS:** EA-1 data revealed large variance and data recording errors and was removed from the analysis. One participant left the study at Test Day 3 during EA-2. EA-2 ANOVA results showed CS (mean change=0.010 logCSWeber) and VA (mean change, -0.016 logMAR) between pre-test and 11-day test phases; however, neither VA nor CS changes were statistically significant. There were non-statistically significant declines in VA across test phases. **DISCUSSION:** Overall, visual field performance did not exhibit clinically significant changes (3 lines or greater change in LogMar chart) during exposure to the mild hypoxic exploration atmosphere environment compared to pre-test baseline. The consistency and stability of VA data during EA-2 suggests that the mild hypobaric hypoxic environment did not cause clinically significant negative impacts to participants' visual field performance.

Learning Objectives
1. The audience will learn about the EFFECTS OF MILD HYPOBARIC HYPOXIA ON VISUAL FIELD IMPAIRMENT.
2. The audience will learn about the NASA Exploration Atmosphere's MILD HYPOBARIC HYPOXIA impact ON VISUAL FIELD IMPAIRMENT.

[403] KETAMINE FOR ACUTE SUICIDALITY AND APPLICABILITY IN EXPLORATION SPACEFLIGHT MISSIONS

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(Original Research)

INTRODUCTION: The transition to exploration missions places a heightened risk on behavioral health and performance in spaceflight

crew. Isolation in extreme environments, such as Antarctica or Greenland, have provided key insights into behavioral challenges such as confinement, increased autonomy, distance from family, and psychosocial stressors. Although serious psychiatric emergencies during spaceflight have been rare, long duration missions increase possibility of genetic predisposition to mental illness, grief, isolation, helplessness, loss of child or family member, or catastrophic events. Complicated grief and bereavement are associated with the highest rate of suicidal ideation. In recent years, ketamine is increasingly used as an emergent intervention for acute suicidality, promoting its stability, ease of administration, safety profile, and outcomes for reduction of suicidal intent. The goal of this study was to review current literature and collate the understanding of ketamine as a safe, effective pharmacological adjunct for acute suicidality in spaceflight. **METHODS**: This retrospective review of published literature was conducted to gather data related to ketamine use for acute suicidality. In addition, this review gathered information on stability, limitations and utilization of ketamine within extreme environments. **RESULTS**: 55 publications were reviewed for relevance including at least 18 randomized-control trials for ketamine use in behavioral emergencies. **DISCUSSION:** Ketamine is a diverse pharmacologic agent with multiple advantageous indications, including acute suicidality, pain, and sedation. Terrestrial use of ketamine in emergent acute suicidal ideation suggests a rapidly efficacious medication for reduction in mortality, morbidity, and functional impact. Including a multifaceted pharmaceutical in future long-duration mission formularies offers optimization of vehicle storage and expands indications for use with a favorable safety profile. As behavioral stressors expand related to extreme isolation and extended missions, contingencies for suicidal ideation and serious behavioral emergencies become increasingly important to recognize. Although this review is not intended to re-develop current ISS intervention strategies, it is the first to discuss the benefits of ketamine in spaceflight as a potential safe, effective multifaceted tool for future exploration missions and in particular, as a treatment for acute suicidal ideation.

Learning Objectives

1. The audience will gain an appreciation of the current literature on terrestrial ketamine use in acute suicidality.
2. The audience will gain an understanding for consideration of ketamine as a possible safe, multifaceted pharmaceutical intervention in spaceflight.
3. The audience will gain an understanding of key features of extended duration, exploration missions that increase the possibility of a behavioral emergency, such as acute suicidality.

[404] SPACE SUPPERS AND COSMIC CULTURES: A CULINARY ODYSSEY

Kendall Howie, Melinda Hailey, Lindsey Hieb, Chuyan Chen
Axiom Space, Houston, TX, United States

WITHDRAWN

Wednesday, 05/08/2024 ***2:00 PM***
Grand Suites 2 & 3

[S-70]: POSTERS: HYPO/HYPER/ TRAINING/FATIGUE

Chair: Jaime Harvey
Co-Chair: Rachelle Lang

[405] BUBBLES AND TROUBLES: DECOMPRESSION SICKNESS IN USAF UNDERGRADUAGE NAVIGATOR TRAINING

Arran Ponte, Chenoa Gentle
U. S. Air Force, Colorado Springs, CO, United States

(Education - Case Study)

INTRODUCTION: This case study describes a recent Decompression Sickness, DCS, case and investigation following an altitude chamber flight and rapid decompression, RD, at Peterson SFB Aerospace Physiology Training Unit, APTU. **BACKGROUND:** Aerospace Physiology units utilize hypobaric chamber training in accordance with AFMAN 11-403 for hypoxia familiarization and to demonstrate physiological effects of pressure changes during slow and rapid decompressions. Flight profiles contain three main segments: a 30-minute prebreathing period of 100% oxygen, a slow decompression hypoxia exposure at FL250 and a RD meeting 4.5 psi differential in barometric pressure. A subsequent risk of these flights is DCS. **CASE PRESENTATION:** Twenty-two-year-old male Undergraduate Navigator student called Peterson's APTU 15 hours post-hypobaric training, to report difficulty breathing, dry cough, pressure and pain in the lungs, and an air bubble feeling in the throat. The student had no history of poor health and held a current Flight class II physical. Symptom onset began after attending dinner in the Cripple Creek area of Colorado Springs at an altitude of 9,500ft MSL. In accordance with hypobaric training emergency procedures, the student was sent to the closest hypobaric therapy treatment center at the UC Health Memorial Hospital. The hyperbaric physician diagnosed the student with a mild case of pulmonary DCS and treated with a USN Treatment Table 5. Student's symptoms subsided and returned to flight after 72 hours with approval of flight surgeon. **DISCUSSION:** Peterson's APTU has a field elevation of 6,200ft MSL, making it one of the highest hypobaric chambers in the world, putting students and crew at a greater risk for DCS. A thorough investigation of this case found that the RD profile exceeded the required 4.5 psi differential due to miscalculating field elevation in relation to psi differential requirements. Flight profile was corrected so that the 4.5 requirement was met. From 2018-2023 Peterson's APTU observed 13 DCS cases throughout 759 chamber flights and 309 RDs: equating to a 1.71% flight and 4.21% RD rate of DCS. Statistical analysis projects a 20% decrease in DCS cases over the next 5 years to experience under 10 cases in the anticipated 660 flights and 269 RDs.

Learning Objectives

1. Individuals can identify how and why DCS may occur and understand risk associated in hypobaric environments.
2. Audience will understand pressure differentials and the physiological impact in flight.
3. Learn about hypobaric training profiles, risks, and requirements for USAF Undergraduate Navigators.

[406] G-LOC DUE TO THE PUSH-PULL EFFECT ON A MILITARY FIGHTER PILOT DURING AIR COMBAT MANEUVERS

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German Air Force Centre of Aerospace Medicine, Koenigsbrueck, Germany

(Original Research)

INTRODUCTION: This case report describes a G-LOC due to a push-pull-effect (PPE) on a Eurofighter pilot performing intercept maneuvers. The thermal burden and dehydration were aggravating factors. **BACKGROUND:** The push-pull-effect (-Gz to +Gz transition) is of great operational relevance. Blood pressure and heart rate respond to sudden changes of gravity. A reduced +Gz-tolerance is the result. Push-pull-maneuvers were associated with approximately 30% of the G-LOC events. **CASE PRESENTATION:** Due to a high administrative workload, the pilot (31-year -old male) had no time for lunch and sufficient hydration. The outside temperature was 86° F and the air conditioning of the building was insufficient. On his second flight of the day, the pilot was practicing intercept maneuvers with his wingman. In preparation for the next intercept, he intended to turn the switch for the harness lock into the lock position but inadvertently he turned off the G-protection system. He turned into an inverted flight for 9 seconds with a maximum of -1.5 Gz. The altitude decreased to 21,600 ft. His wingman was flying at 16,000 ft

and the pilot started the intercept maneuvers with a g load of 6.1 Gz. At 17,400 ft, the positive G exposure stopped and the aircraft descended unexpectedly in a nearly vertical flight. In accordance with the investigation report, the stick had been in the center position for 11 seconds without any input. One second after the voice warning "pull up", the pilot tried to recover the situation with maximum stick input (9,1 Gz). The minimum altitude at this maneuver was 3,520 ft. The pilot was able to stabilize the aircraft and declared an in-flight emergency as a "physiological incidence" and returned safely to the air base. The amnesia in combination with the lack of stick activity suggests that the pilot fell into G-LOC. **DISCUSSION:** Military pilots are aware of the risk of +Gz exposure. The risk of the PPE significantly to reducing the pilot's Gz- tolerance is not well known among high-performance aircrew. As a matter of principle, aeromedical training shall include educating pilots about the harmful effects of push-pull-maneuvers. Contributing factors like thermal heat stress and dehydration have a negative impact on Gz tolerance and should be addressed to flight personnel. Aircrew should be reminded not to rely entirely on the G-protection system as it sometimes does not work, like in this case where the G valve was inadvertently turned off.

Learning Objectives

1. The audience will learn about the harmful effects og push pull maneuvers.
2. The audience will learn about the importance of aeromedical training.

[407] ARE ARMY AVIATORS TRULY MORE "PHYSIOLOGICALLY FIT" THAN THE GENERAL POPULATION? A RETROSPECTIVE ANALYSIS.

Matthew D'Alessandro[1], Ryan Mackie[1], Samantha Wolf[1], James McGhee[2], Ian Curry[1]

[1]*U. S. Army Aeromedical Research Laboratory, Fort Novosel, AL, United States;* [2]*Department of Aviation Medicine, Fort Novosel, AL, United States*

(Original Research)

INTRODUCTION: Aviators are required to maintain a level of physiological fitness as part of their qualifying process, which suggests that they are generally physically healthy. However, it has not been statistically proven that they are more "physiologically fit" than the general population. Even though Army Regulation (AR) 40-501, chapter 4 and the U.S. Army Aeromedical Policy Letters are based on aeromedical subject matter expertise and research outcomes, to our knowledge, a recent, large-scale evaluation assessing the physiological parameters of aviators has not been performed. This analysis is imperative to keep policy makers informed about the current physiological well-being of our aviators. **METHODS:** Our retrospective study compared the physiological metrics of 24,259 Army aviators from the AERO database to 12,001 individuals from the NHANES database representing the general US population. The aviators and general population were grouped by age (16-25, 26-35, 36-45, 46-55 years) and biological gender (male, female) for analysis. Physiological variables assessed included pulse, blood pressure, hematocrit, hemoglobin, lipids, glucose. **RESULTS:** Male aviators had lower pulse rates than the public (ages 26-55, $p < 0.05$). Females had lower pulses across ages ($p < 0.05$). Aviator blood pressure was higher than the public until age 45 ($p < 0.01$), then lower. Male aviators aged 46-55 had higher hemoglobin/hematocrit ($p < 0.01$). Females aged 16-45 also showed higher levels ($p < 0.01$). Male aviators aged 16-25 exhibited higher total cholesterol ($p = 0.013$) and LDL ($p < 0.001$) than the public. Females aged 16-25 had lower total cholesterol ($p = 0.024$). HDL was higher in aviators across most groups ($p < 0.05$). Cholesterol/HDL ratios were lower in aviators for most groups ($p < 0.01$). Glucose was lower in all aviators ($p < 0.001$). **DISCUSSION:** While aviators displayed physiological superiority in some categories, they did not supersede the general population across the board. This indicates a nuanced link between aviation and overall fitness. Targeted monitoring and maintenance programs based on flight physicals and additional monitoring initiatives could better optimize aviator health. Future research should explore additional factors like mental health, sleep, diet for a comprehensive picture of aviator well-being.

Learning Objectives

1. Compare aviator physiology versus the public to help guide policy.
2. Evaluate the targeted health initiatives for aviators based on assessments.

[408] EFFECTS OF ACUTE NORMOBARIC HYPOXIA ON SENSORY AND COGNITIVE PROCESSING

Kiersten Weatherbie, Julia Milo, Kara Blacker

Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States

(Original Research)

INTRODUCTION: Hypoxia impairs cognition and remains a relevant potential threat in military aviation. Developing non-invasive, in-flight sensors to detect hypoxia is critical in preventing physiological-related occurrences. This study validates the use of whether neural markers, the mismatch negativity (MMN) and P3a, and cognitive performance are sensitive to a mask-off acute normobaric hypoxia exposure. **METHODS:** Thirty-one males participated in a repeated-measures, single-blind study. The protocol was approved by the NAMRU-D IRB. There were two visits: a normoxic exposure (21% O_2) and a hypoxic exposure (10.6% O_2), each lasting up to 45 minutes within a normobaric hypoxia chamber. For each exposure, participants completed five blocks of cognitive tasks (Psychomotor Vigilance Task [PVT], Change Signal Task [CST], and Digit Symbol Substitution Task [DSST]) while EEG and physiological measures were recorded; the MMN/P3a was elicited via an auditory oddball paradigm. All variables were analyzed using a 2 (exposure) ´ 5 (block) ANOVA. **RESULTS:** For reaction time (RT) on the PVT, a significant main effect of exposure emerged, $p = .002$, whereby RT was slower during hypoxia compared to normoxia. For both the CST and DSST, we saw no significant changes in performance associated with the two exposures. For EEG, there was no difference in MMN amplitude between exposures, but there was a significant reduction in the P3a amplitude during hypoxia compared to normoxia, $p = .005$. For the MMN to P3a peak-to-peak amplitude, the exposure ´ block interaction was significant, $p = .01$, whereby the reduction in amplitude for hypoxia became more pronounced as the exposure duration increased. **DISCUSSION:** Decreased vigilance performance and impaired underlying sensory processing is strongly evident following a 45 min acute hypoxic exposure. These findings support the need for future developments of non-invasive in-flight O_2 sensors to include neurophysiological monitoring. Furthermore, these results suggest ways to improve hypoxia familiarization training by teaching aircrew about the extent to which different functions are impaired during hypoxia.

Learning Objectives

1. Address the need to develop non-invasive, in-flight sensors for aerospace medical threats.
2. Understand how hypoxia impairs performance on a neural, cognitive, physiological, and behavioral level.

[409] EFFECTS OF BREATHING RESTRICTION, HYPEROXIA, AND HYPOXIA ON NEUROCOGNITIVE FUNCTION

Cammi Borden, Frank Robinson, Stephanie Warner, Kara Blacker

Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States

(Original Research)

INTRODUCTION: Respiratory challenges continue to be a concern in the military aviation community. The DoD is actively pursuing in-flight monitoring technology to alert aircrew to the presence of dangerous respiratory conditions and to detect impairments. Previous work has demonstrated that cognitive and sensory processing are disrupted during hypoxia. Unfortunately, various causes of breathing restriction are not mutually exclusive, nor are breathing restrictions the only

respiratory threat. This study examined the effects of different types of breathing challenges on neurocognitive functioning. **METHOD:** In this repeated-measures, single-blind design, 29 healthy adults completed four sessions. Each session had 3 phases: baseline, exposure, and recovery. For baseline and recovery, participants always breathed 65% O_2 at standard breathing regulator inlet pressure (25 psi). The exposure phase manipulated either O_2 concentration (9.7%) or inlet pressure (25 psi with added downstream resistance or 4 psi). All breathing conditions were controlled by the hypoxia ventilatory research device and delivered to the participant via a CRU-103 regulator and MBU-20/P flight mask. For each session participants performed a reaction time (RT) task while EEG was recorded in response to auditory stimuli. Participants reported hypoxia symptoms afterwards via questionnaire (HSQ). The study protocol was approved by the NAMRU-D IRB. Data were analyzed using 3 (phase) x 4 (condition) repeated-measures ANOVAs. **RESULTS:** For RT, the condition × phase interaction was significant, $p<0.05$, whereby RT was slower for the hypoxia compared to hyperoxia conditions during exposure and recovery phases. For the HSQ, the main effect of condition was significant, $p<0.001$, whereby participants reported more symptoms during hypoxia compared to hyperoxia. Inlet pressure had no detectable effect on HSQ score or RT. Our EEG measures did not show a significant difference with respect to condition. **DISCUSSION:** Our results illustrate a negative impact of hypoxia on RT and the frequency and severity of symptoms compared to hyperoxia. However, we saw no significant effect of inlet pressure on these measures. This suggests that breathing restriction (within the parameters tested here) itself may not have a meaningful effect on neurocognitive function.

Learning Objectives

1. The audience will learn the different effects various breathing restrictions have on physiological, cognitive, behavioral, and sensory performance.
2. The audience will learn about the time course of neural responses from various breathing restrictions in cockpit-like breathing environments.

[410] PRELIMINARY EXAMINATION OF EYE MOVEMENT IN PILOTS DURING DIFFERENT FLIGHT SCENARIOS AND WORKLOAD CONDITIONS

Frank Robinson[1], Nicklaus Fogt[2], Dain Horning[1], Ryan Everidge[3], Gary Ellis[3], Nathaniel Spencer[3], DeAnne French[3]

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(Original Research)

INTRODUCTION: Spatial disorientation (SD) is one of the leading causes of serious mishaps in military aviation. Most training to reduce the likelihood of SD is delivered in a lecture-based format with little opportunity for students to practice risk mitigation strategies. We are developing an interactive SD countermeasures training tool to provide students the opportunity for such practice. We intend to identify attention allocation behaviors that predict the risk of becoming disoriented in simulated flight scenarios. We will then develop a training program to encourage students to mimic the attentional strategies of people who successfully avoid SD. We report here on our efforts to identify such strategies. **METHODS:** Nine qualified pilots flew four different flight scenarios in a fixed-base flight simulator. Participants experienced scenarios related to the black hole illusion, a sloping cloud deck, and two fixed horizon illusions. Each scenario was conducted under three levels of workload: low (no secondary task), medium (an added working memory task), and high (a more frequent working memory task or a visual search task paired with the "medium" working memory task). All combinations of scenario and workload were repeated three times, for a total of 36 flights. Eye movements were captured using a SmartEye system. **RESULTS:** We observed a significant interaction such that the percentage of time spent looking at each instrument depended on the type of instrument and the scenario being flown ($F(90, 9602) = 208.57$, $p < 0.001$). We also observed a significant interaction such that the percentage of time looking at each instrument depended on the type of instrument and the workload imposed ($F(60, 9602) = 29.58$, $p < 0.001$). Flight path error in the black hole illusion scenario increased at high workload ($t(8) = -2.51$, $p = 0.02$). **DISCUSSION:** These results indicate that our flight scenarios induced different demands on the pilots and that our workload manipulation was effective at altering scanning behaviors and flight performance. We continue to collect new data and conduct analyses to identify eye movement tendencies that predict the occurrence of SD in each scenario at different levels of workload.

Learning Objectives

1. Participants will understand how different flight scenarios lead to different scanning behavior.
2. Participants will learn how various changes in workload can affect scanning behavior.

[411] AID TO THOSE IN NEED: ONLINE-BASED NON-INVASIVE NEUROCOGNITIVE INTERVENTION FOR PILOTS WITH AEROMEDICALLY SIGNIFICANT TEST RESULTS

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(Original Research)

INTRODUCTION: Each year thousands of pilots are required to undergo neuropsychological evaluation, often due to a history of alcoholism (HIMS), CVA, TBI, MCI, SSRI use, or ADHD. Of these pilots, it is estimated 18 to over 30% are found to have some form of impairment that grounds them indefinitely. **METHOD:** An online, coached, fee-based cognitive training (CTr) program was examined in 192 pilots residing across the United States, following identified deficiencies by their HIMS neuropsychologist (NP). The 6 to 8 week CTr program included customized assembly of exercises with weekly management and feedback by a trained instructor via email; no exercises resembled presenting stimuli found in NP tests; no office visits were made. Target Training Levels (TTL's) were developed to identify pilots who were likely to be found normal upon follow-up NP re-evaluation (NPRe), using composite z-scores from proprietary training data (PTD) and an online aviator cognitive assessment battery (OA Assess). **RESULTS:** Of 77 pilots reporting NPRe results, 74% passed. One-way MANOVA indicated final PTD and OA Assess scores significantly predicted NPre results [F(1,30)=4.97, p=.014; Wilks Λ=.746)]; significance was lost when pre-training baseline OA Assess scores were used (p=.053). Post-training PTD and OA Assess cut-off scores to establish TTL's were best fit at z=.77 and z=1.46 above non-aviator means, respectively. Logistic regression indicated combined PTD and OA Assess scores best predicted whether or not a pilot would pass NPRe, with 87% accuracy [df (30) $\Delta\chi^2$=5.67, p=.017). Chi-square analyses indicated pilots who reached combined TTL's had an 88% chance of passing their NPRe, while those that did not reach TTL's had a 33% chance of passing (χ^2=7.41, p=.006); the OA Assess TTL alone was less robust but still acceptable (p=.024). **DISCUSSION:** Structured, coached CTr is an effective online-based intervention for use in pilots with neurocognitive deficiency. In addition to strengthening abilities important to flight performance and safety, the program reliably and accurately predicted which pilots would likely succeed in passing far more expensive neuropsychological evaluations, which could reduce personal and organizational costs while hastening return to duty or training. Past CTr studies showed lasting effects and in the aviation environment CTr appears far more appropriate than neurofeedback, direct electrical stimulation, and traditional cognitive rehabilitation.

Learning Objectives

1. Participants will become aware of the need for non-invasive, easily accessible neurocognitive interventions in pilots with known or suspected declines in mental sharpness or abilities.

2. Participants will identify components of online CTr important to a pilot's success.
3. Participants will understand the potential to strengthen cognitive functions in a reliable, long-lasting way that generalizes to neurocognitive testing and daily activities alike.

[412] A NOVEL APPROACH TO SELECTION: ONLINE COGNITIVE ASSESSMENT OUTPERFORMS TRADITIONAL MEANS IN IDENTIFYING THE "BEST OF THE BEST" AND THE "LEAST BEST"

Brian Neff[1], Thomas Schaner[2], John Milanovich[3]
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(Original Research)

INTRODUCTION: Pilots in training, as well as new hires, must not only cope with learning a tremendous amount of novel information on an ongoing basis, but also demonstrate proficiency with applying said information in the cockpit. While traditional means of pilot selection have been of benefit to aviation schools and airlines alike, some pilots predicted to be efficient in moving through programs do not live up to expectations. **METHODS:** This study examined the efficacy of a novel, Online Aviator Cognitive Assessment tool (OA Assess) to predict the number of hours required to complete flight training in 17 aviation student volunteers attending Kent State University, a part 141 program. High school GPA, ACT/SAT scores, academic skill rankings in organization, reading, math, and writing, current college GPA, and years in college were also examined for comparison purposes. **RESULTS:** Correlation matrix analysis indicated significance between the OA Assess and TOTAL number of flight hours required through commercial rating (r=-.85, p=.033), as well as hours to solo (r=-.90, p=.015) and obtain a PPL (r=-.668, p=.035); it also predicted final IFR checkride scores (r=.74, p=.006) and hours required to complete the final CFI course (r=-.99, p=.036); it was not correlated with the commercial phase itself (r=-.37, p=.363). The modified OA Assess z-score was 106 for the top 50% of students, compared to a score of 11 in the bottom 50%. The OA Assess showed significance in 6 out of 7 (85.7%) main comparisons while all other pilot selection variables showed significance in 4 out of 63 (6.3%) combined, with none seen multiple times. **DISCUSSION:** While grades, standardized test scores, and academic skills have been factors used to judge an aspiring pilot's potential, the cognitive assessment tool used here (OA Assess) was far superior to predicting actual time in the cockpit likely required to complete flight training. Directly examining underlying cognitive capacities critical to flight performance and safety, including processing speed, working memory, and executive controls can assist pilots and programs alike with selection-based decision-making in easily accessible, online platforms. Students or new hires with relatively lower "aviator cognition" can be easily identified and may benefit from reliable cognitive training exercises to improve their capacities, before or during training or transitions, thereby potentially reducing both personal and organizational costs.

Learning Objectives

1. Participants will become aware of a novel approach to pilot selection that appears more effective than traditional approaches.
2. Participants will learn about novel ways to understand pilots' actual performance in the cockpit as related to brain functioning, defining the term "Aviator Cognition".
3. Participants will understand the limitations of traditional approaches in lieu of the OA Assess tool (aviator cognition) that readily discriminates between those that are likely to require less hours in the cockpit to complete training or transitions.

[413] EFFECT OF TRANSIENT CEREBRAL HYPOPERFUSION ON EVENT-RELATED POTENTIALS FOR SPATIAL STIMULUS-RESPONSE COMPATIBILITY

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(Original Research)

INTRODUCTION: Adequate cerebral blood flow (CBF) perfusion is crucial to maintaining brain function and performance. This study aimed to determine event-related potentials (ERPs) related to a spatial stimulus-response compatibility (SRC) task under transient cerebral hypoperfusion caused by oscillatory lower body negative pressure (OLBNP). As chronic cerebral hypoperfusion has been associated with decreased ERP amplitude and slower reaction time, we hypothesized that fluctuations in CBF perfusion may also affect ERP amplitude and task performance. **METHODS:** The sinusoidal pattern of an 18-sec period (0.056 Hz) of OLBNP at 0 ~ - 40 mmHg was used to induce transient cerebral hypoperfusion. We measured ERPs for the SRC task and CBF velocity (MCAv) during three 10-min OLBNP (33 cycles of 18-sec periods) and two 10-min control (no-OLBNP) sessions in 9 male subjects (average age, 23.3). Changes in cerebrovascular variables, ERP and task performance data during OLBNP were evaluated in three phases (Phase1: 0 ~ 6 sec, Phase2: 6 ~ 12 sec, and Phase3: 12 ~ 18 sec). The study protocol was approved in advance by the Research Ethics Committee of the Chiba University Graduate School of Engineering [R4-15]. **RESULTS:** One-way repeated-measures analysis of variance (ANOVA) and post-hoc comparison revealed that MCAv decreased significantly in Phase1 and 2 compared to the control and Phase3 ($F(3, 24) = 14.48$, $p < 0.001$). ANOVA also revealed that spatially incompatible stimuli caused significantly increased ERP amplitude ($p < 0.001$) and response times ($p < 0.001$) compared with spatially compatible stimuli. However, we found no significant effect of OLBNP on ERPs or task performance. **DISCUSSION:** Our data demonstrate that OLBNP causes CBF perfusion to fluctuate and that spatial stimulus compatibility affects ERPs and task performance. However, the relationship between fluctuations in CBF perfusion and ERPs and task performance remains unclear. The present results may suggest that a certain robustness of brain function to fluctuations in CBF.

Learning Objectives

1. This study introduces OLBNP as a method to cause fluctuations in CBF with high reproducibility.
2. We also found that changes in brain function during OLBNP are not apparent through task performance.

[414] A VALIDATION OF TASK DEMAND LEVEL TRAINING PROCEDURES IMPLEMENTED IN THE U.S. ARMY AEROMEDICAL RESEARCH LABORATORY MULTI-ATTRIBUTE TASK BATTERY

Jon Vogl, Charles McCurry, Sharon Bommer, Leonard Temme
U.S. Army Aeromedical Research Lab, Fort Novosel, AL, United States

(Original Research)

INTRODUCTION: The Multi-Attribute Task Battery (MATB) is a classic aviation-like multitasking simulation platform that has amassed a rich history in performance assessment literature since its creation in 1992. Recently, the United States Army Aeromedical Research Laboratory (USAARL) has modified the traditional MATB to feature the classic task battery with upgraded features that meet the needs of current research trends in cognitive workload assessment, adaptive automation, and performance modelling. **METHODS:** The four subtasks used within the USAARL MATB were designed to mirror aviation tasks performed by pilots, including system monitoring, communications, compensatory tracking, and resource management. Ten unique task demand levels

were designed to control the event rates of the four subtasks across a spectrum of increasing demand. Twenty-four subjects were trained in the performance of the USAARL MATB using a stepwise approach, increasing demand levels until they were unable to maintain at least a 75% average score across all subtasks during a five-minute simulation. The final demand level reached with a passing score was administered in four sequential ten-minute simulation sessions during a second laboratory visit. **RESULTS:** Multitasking performance was assessed through percentage of time loaded by discrete subtask events (i.e., system monitoring and communications subtask events). Multitasking performance across subjects remained consistent between measurements, showing no significant differences (Task Load (TL)0: $p = 0.783$; TL1: $p = 0.956$; TL2: $p = 0.217$; TL3: $p = 0.627$). Across demand levels, multitasking performance did show significant differences (TL0: $p < 0.001$; TL1: $p < 0.001$; TL2: $p = 0.004$; TL3: $p = 0.033$), indicating a progressively increased multitasking load with higher demand levels. **DISCUSSION:** The USAARL MATB is poised to serve as an adaptable tool to face the challenges put forth by modern research trends in the fields of aerospace medicine and human performance. Offering unique control of dynamic task demand shifts, automation implementation, and data synchronization, the USAARL MATB allows for quick turnaround laboratory studies. The data collected in this study offers support for the training procedure and demand level event rate values included in the USAARL MATB program. The USAARL MATB software is available to be shared with collaborating institutions.

Learning Objectives

1. The audience will understand the historical development of the MATB program and the motivation behind the desired functionality changes.
2. The audience will be able to identify how current research trends can leverage the custom design nature of the USAARL MATB platform in their research.

[415] ANALYSIS OF PHYSIOLOGICAL CHANGES AND HYPOXIA SYMPTOMS DURING THE HYPOBARIC CHAMBER TRAINING

Chung-Yu Lai[1], Kuo-Kuang Jen[2], Shang-Ju Wu[2], Nian-Shen Chen[2], Shih-Yu Lee[1], Hao Su[3], Fang-Ling Li[4], Chung-Yu Liao[1], Shih-En Tang[1], Chien-Lin Kuo[5]

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(Original Research)

INTRODUCTION: Military aircrew must familiarize personal hypoxia symptoms before the flight training. Existing research is limited in its description of the dynamic physiological changes and hypoxia symptoms. Therefore, the primary objective of this study is to examine the relationships between the cardiac data, hypoxia symptoms, and tolerance time. **METHODS:** This retrospective study was carried out between July 1, 2022, and August 31, 2023. Subjects were army, navy, and air force aircrews that underwent an initial aviation physiological course in Taiwan. Data on the time of useful consciousness (TUC), blood oxygen saturation levels, and individual hypoxia symptoms every minute at a simulated altitude of 25,000 feet were obtained from the training document. The analysis of the data was conducted using the statistical software SPSS 24.0. **RESULTS:** This study included a total of 102 subjects from the army, navy, and air force. Their average age was 23.8±2.1 years, with an average body mass index of 23.0±2.5 kg/m^2. The mean TUC at an altitude of 25,000 feet was 3.7±0.9 minutes. The blood oxygen saturation level started at 86.7% in the first minute and noticeably dropped in the second minute (68.0%). By the third minute, it had decreased to 58.3%, followed by a gradual decline from the third to the sixth minute. At the end of the first minute, subjects with a TUC of less than three minutes had an average blood oxygen saturation of 83.1±8.6%, which was slightly lower when compared to those with a TUC of three minutes or more (87.4 ± 7.9%). Around 20% of trainees displayed the hypoxia symptoms within the initial minute. Main symptoms during the first minute included hot flushes (10.9%) and dizziness (5.0%). Subjects with TUC less than three minutes had a higher proportion (17.6%) of experiencing dizziness symptoms within the first minute. **DISCUSSION:** In this study, we presented the variations in blood oxygen saturation and the occurrence of hypoxia symptoms at one-minute intervals during the chamber flight. In addition, we conducted a comprehensive analysis to establish the correlations between the physiological responses, prominent symptoms, and hypoxia tolerance. These findings hold significant value in the development of a real-time monitoring system and the improvement of the training safety measures.

Learning Objectives

1. To understand the dominant hypoxia symptoms during the hypobaric chamber training.
2. To compare the changes in oxygen saturation between the different TUC groups.

[416] INDIVIDUAL VULNERABILITY TO HYPOXIA: THE HMOX2 POLYMORPHISM CONTRIBUTES TO THE CAROTID BODY CHEMOREFLEX BY REGULATING HYPOXIC VENTILATORY RESPONSES.

Pierre Fabries[1], Catherine Drogou[1], Danielle Gomez-Merino[1], Fabien Sauvet[1], Olivier Nespoulous[1], Benoit Lepetit[1], Marie-Claire Erkel[1], Anne-Pia Hamm-Hornez[2], Alexandra Malgoyre[1], Nathalie Koulmann[3], Mounir Chennaoui[1]

[1]*French Armed Forces Biomedical Research Institute - IRBA, Brétigny-sur-Orge, France;* [2]*Aeromedical Center - CPEMPN, Clamart, France;* [3]*Military Health Academy - Ecole du Val-de-Grâce, Paris, France*

(Original Research)

INTRODUCTION: During flights, pilots and crew are exposed to altitude hypoxia. It causes physiological responses (the first is hyperventilation) and can cause incapacities with flight safety impact. This varies depending on both extrinsic and intrinsic factors. Recently, a functional genetic polymorphism in Heme oxygenase-2 (*HMOX2*, rs4786504_T>C), an essential enzyme in heme catabolism, has been associated with high-altitude adaptation in Tibetans. In carotid body, heme oxygenase-2 is sensitive to oxygen availability and mediates the hypoxic response inducing increased breathing, which is different between individuals and linked to tolerance. We hypothesized that *HMOX2* polymorphism influenced the chemosensitivity related to hypoxic ventilatory response (HVR) in Caucasians. **METHODS:** HVR ($FiO_2 = 0.115$) was measured at rest and exercise (30% maximal oxygen uptake) (the Richalet's test) in 84 healthy male and female volunteers. Among chemosensitivity parameters, HVR at exercise (HVRe) is considered the best independent predictor of high altitude hypoxia tolerance. Low chemoresponsiveness is defined when HVRe 0.78 < L.min-1.kg-1. The LAMP-MC technology was used to determinate *HMOX2* polymorphism. To test genotype-phenotype associations with *HMOX2* (two modalities, T/T–C/T vs. C/C genotypes), we used the student's t-test and a Chi-square analysis. This study was approved by CPP SUD MEDITERRANEE III. **RESULTS:** 47.6% homozygous C/C (n=40), 41.7% heterozygous C/T and 10.7% homozygous ancestral T/T (n=44). HVR was significantly higher for C/C subjects than for T allele carriers at rest (0.78 ± 1.16 versus 0.38 ± 0.405 L.min-1.kg-1 respectively, p = 0.043, F = 4.22) and exercise (0.736 ± 0.470 versus 0.534 ± 0.426 L.min-1.kg-1, p = 0.042, F = 4.36). A high HVRe was more frequent in subjects carrying C/C polymorphism versus T allele (p = 0.002, OR = 5.2 [1.69; 16.03]). **DISCUSSION:** In our population, there is a significant association between *HMOX2* polymorphism and chemosensitivity evaluated by HVR. Although significant, this finding must be confirmed in larger samples. This could help to better understand the role of genetic factors in chemosensitivity, the first step in the hypoxia response, in order to provide personalized recommendations and countermeasures.

Learning Objectives
1. Identify vulnerability factors to hypoxia from the first step of detection by carotid body chemoreceptors.
2. Understand the role played by genetic factors involved in chemosensitivity.

[417] THE INFLUENCE OF WORKING MEMORY AND RELAXATION TRAINING ON THE COGNITIVE AND OPERATIONAL EFFICIENCY OF JET PILOTS

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(Original Research)

INTRODUCTION: A useful way to improve jet pilots' efficiency and cognitive functioning was sought. This work attempts to check whether daily, adaptive working memory training or relaxation training using the autogenic method can be effective in improving the cognitive and operational efficiency of pilots. Both high efficiency of working memory and the ability to achieve a state of relaxation are important for the proper performance of military operations and the daily functioning of airmen. Especially during military operations, the tasks performed are extremely cognitively demanding and can cause a lot of stress. **METHODS:** In the main study involving airmen, 44 male and female MiG-29 jet pilots were examined, including 41 men (93%) and 3 women (7%) aged 25–52 (M = 34,550; SD = 7,164). The average flight time on the MiG-29 aircraft was M = 513,360 hours; SD = 379,060 hours. The subjects were randomly assigned to three groups: (1) relaxation training group, n = 15 people (35.7%); 14 men (93.3%) and 1 woman (6.7%); (2) working memory training group, n = 13 people (33.3%); 12 men (92.9%) and 1 woman (7.1%) and (3) inactive control group, n = 13 people (31%); 12 men (92.3%) and 1 woman (7.7%). The efficiency of working memory, attention, resistance to +Gz and the level of +Gz were tested twice (in the pretest - posttest formula). Both in the pre-test and in the post-test, the pilots performed a number of aerial maneuvers using a centrifuge with a high +Gz – roll, loop and Immelmann maneuver. The simulator recorded changes in heart rate and +Gz in individual phases of flight. During the flight on the simulator, the scanning of the pilot's field of view was recorded using an eye tracker (SMI GLASSES). Between pre and posttest, subjects in the training groups performed training sessions at home. Pilots in the control group was inactive. **RESULTS:** Autogenic training was found to improve attentional functioning, specifically the speed of regaining attentional control under rapidly changing stimuli. After the WM training, there was an improvement in the concentration of visual attention. **DISCUSSION:** We conclude that both working memory training and autogenic training can be used to improve the cognitive and operational functioning of pilots flying the MiG-29 jet. It seems, however, that both trainings should be used complementary during the standard training of military pilots. The observed regularities require further, in-depth research.

Learning Objectives
1. The audience will learn about the possibility to use relaxation and cognitive methods during jet pilot training program.
2. The participant will be able to see the scientific process of testing training methods in jet fighter pilot group.

[418] BODY COMPOSITION AS A PREDICTOR OF ISOMETRIC MID-THIGH PULL AND BACK EXTENSION ISOMETRIC HOLD PERFORMANCE IN STUDENT PILOTS

Michelle Jilek[1], Anthony Acevedo[2], Joshua Dorcheus[1], Zachary Zeigler[2], Stephanie Chayrez[1], Jared Blake[1], Christopher Parrott[2], Brittany Nores[1], Carolyn Price Moore[1], Ryan Scott[1]
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(Original Research)

INTRODUCTION: Air Force fighter pilots must be prepared for high-G and long-duration operations. Both mission sets demand optimal body composition, endurance, and strength. Unfortunately, lower back issues, such as pain and injury, are prevalent among fighter pilots, potentially compromising mission success, pilot safety, and long-term health. The purpose of this study is to determine if body fat (%BF) can serve as a predictive indicator of isometric mid-thigh pull (IMTP) and back extension isometric hold (BEIH) performance. This study aims to refine the utilization of %BF as an assessment tool and inform the development of more effective training programs. We hypothesize that a higher %BF will be negatively associated with IMPT and BEIH. **METHODS:** Student pilots (SPs) at Luke Air Force Base (males, n = 195, females, n = 13) completed their Aircrew Conditioning Program Assessment (ACPA) prior to the initiation of their formal B-Course training. %BF was determined through bioelectric impedance analysis (InBody 570), IMTP was assessed using force plates (VALD), and BEIH was measured via a glute ham raise. A linear regression model was employed to investigate the capacity of BF % to predict IMTP and BEIH performance ($p < 0.05$). This retrospective analysis was approved by the Air Force Research Laboratory Institutional Review Board. **RESULTS:** %BF was significantly and negatively correlated to both IMTP (r = -.435, p < .001) and BEIH (r = -.886, p < .001). %BF explained 19% (p < .001) of the variance on the IMTP scores with a beta coefficient of -.425 and 78% (p < .001) of the variance on the BEIH scores with a beta coefficient of -.647. **DISCUSSION:** These findings highlight the role of %BF as a predictive factor for back and lower body strength assessments, indicating that lower %BF is linked to superior IMTP and BEIH performance. Ultimately, %BF may be used to enhance pilot evaluation and training, therefore aiding in mitigating injury, career longevity, and flight safety. Further research is warranted to delve into the underlying mechanisms of this relationship and explore potential interventions.

Learning Objectives
1. The role body composition plays in assessing pilot's ability to perform performance testes.
2. A lower body fat percentage is a strong predictor of better lower body strength and back endurance.

[419] FATIGUE, CONCENTRATION, AND RESPONSIVENESS OF AIR CREW MEMBERS ON (ULTRA-)LONG-RANGE FLIGHTS

Raphael Kneffel[1], Sandra Dühr[2], David Cyrol[1], David Gläsener[1], Janina Post[1], Stefan Sammito[1]
[1]*German Air Force Centre of Aerospace Medicine, Cologne, Germany;* [2]*Special Air Mission Wing Federal Ministry of Defence, Cologne, Germany*

(Original Research)

INTRODUCTION: The scientific literature on the stresses and strains experienced by flight crews during long-range (LR) and ultra-long-range (ULR) operations has mainly focused on the pilots. There are few studies on cabin crews, and even fewer that compare cockpit (COC) and cabin crews (CAB). **METHODS:** Subjective fatigue, concentration, and responsiveness of 11 all-male COC members and 46 CAB (24 female) – the average age was 35.3 (SD = 8.7) – were examined at takeoff and landing via visual analogue scales (VAS). Included were 4 outbound flights from Germany to Canberra (AUS), Las Vegas, Dulles (USA), and Hiroshima (JPN), as well as the 4 corresponding return flights from Papeete (PYF), Las Vegas, Los Angeles (USA), and Seoul (KOR). In three flights a connection flight between first destination and second departure airport was conducted but not included in this analysis. Flight durations ranged from 9:50 to 19:43 h. Each itinerary, outbound plus corresponding return flight, was categorized in east and west by outbound direction. **RESULTS:** Overall, highly significant increases in fatigue and decreases in concentration and responsiveness were observed across all flights ($p < 0.001$). For outbound flights, CAB reported a higher reduction in concentration ($p = 0.017$) and responsiveness ($p = 0.131$) than COC, the latter effect being non-significant; the change in fatigue did not differ ($p = 0.998$). For return flights CAB reported greater exhaustion in all three dimensions, the

results were not significant ($p > 0.05$). Further analyses revealed a poorer recovery of fatigue ($p = 0.392$) and concentration ($p = 0.126$) after flying eastward compared to westward. No effect was found for responsiveness ($p = 0.609$), t-tests performed were not significant. **DISCUSSION:** LR and ULR-flights cause flight crew members to become increasingly fatigued, with CAB surprisingly reporting greater levels of exhaustion than COC. Although the differences were small, these findings may indicate an underestimation of CAB workload. The results comparing layovers in the east and west appear to replicate the relevant literature; however, further studies are needed to improve statistical power.

Learning Objectives

1. The participants will learn that (ultra-)long-range flights led to increased fatigue and reduced concentration and responsiveness in flight crew members.
2. The participants will learn that cabin crews reported greater levels of exhaustion, compared to cockpit crews.

[420] THE INFLUENCE OF HELMET-MOUNTED DISPLAYS ON MUSCULAR ACTIVATION AND FATIGUE

Lucas Haberkamp[1], Andrew Spencer[1], Nicholas Robinson[1], Charles A. Weisenbach[1], Peter Le[2]
[1]*Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States;* [2]*U.S. Air Force Research Lab, 711th Human Performance Wing, Wright-Patterson AFB, OH, United States*

(Original Research)

INTRODUCTION: Recent advancements in helmet-mounted displays (HMDs) seek to enhance flight performance. Unfortunately, these advancements could have unintended biomechanical consequences beyond increased physical loading. Providing additional visual and auditory information may amplify neck muscle activation, potentially leading to muscular fatigue and elevated risk of neck pain. Existing research indicates a connection between visual stressors and increased neck muscle activity; however, the effect of an HMD's visual and spatial auditory cues on neck muscle activation remains unclear. **METHODS:** 11 participants performed a flight task in the motion-enabled Disorientation Research Device. The Varjo VR-2 headset presented HMD symbology, out-the-window scenes, and cockpit visuals. We used a within-subjects, repeated measures 3x2 factorial design, encompassing two spatial audio conditions (off/on) and three HMD symbology formats: current display format, forward-referenced attitude format, and conformational attitude referenced. To measure neck muscle activity, we continuously collected surface electromyography (EMG) data from the bilateral sternocleidomastoids, cervical extensors, and levator scapulae. EMG data were normalized to maximum voluntary exertions performed pre-flight. We extracted median frequency and median muscle activation from EMG data. We employed a linear mixed-effects model to analyze the influence of timing, display format, and spatial audio. **RESULTS:** Employing spatial audio decreased left levator scapulae muscle activation ($p<.01$). No other muscles showed significant differences between spatial audio and display formats. During the simulated flight, the right levator scapulae's activation decreased ($p<.01$), while the left cervical extensor's activation increased ($p<.01$). Notably, the median frequency increased for both the right levator scapulae ($p=.02$) and left cervical extensor ($p<.01$). **DISCUSSION:** Our findings underscore the potential biomechanical implications of HMDs. The reduction of left levator muscle activation with spatial audio is encouraging but warrants further investigation. As the flight task proceeded, signs of muscle fatigue were evident in the right levator scapulae and the left cervical extensor. This fatigue, indicated by increased median frequency, raises concerns about potential HMD usage and its relationship to neck pain. These findings highlight the need for ergonomic considerations in HMD design and use.

Learning Objectives

1. Discuss how a helmet-mounted display's visual and spatial auditory cues may influence neck muscle activation and fatigue.
2. Provide insights into the efficacy of using neck muscle activity as a marker of cognitive workload in a dynamic simulated flight environment.

[421] FATIGUE, SLEEPINESS, AND RISK-TAKING BEHAVIOR IN MILITARY AVIATORS

Elizabeth Damato, Kenneth Kincel Jr, Hannah Boehringer, Michael Decker
Case Western Reserve University, Cleveland, OH, United States

(Original Research)

INTRODUCTION: Fatigue and sleepiness reduce aviator performance and safety. Past studies have supported a link to poor judgement and increased risk-taking. Our objective was to determine whether fatigue and sleepiness altered risk-taking behavior in military aviators. **METHODS:** This study was approved by Institutional Review Boards at Case Western Reserve University and the Air Force Research Laboratory. Fatigue and sleepiness were measured using the Multidimensional Fatigue Inventory (MFI) and the Epworth Sleepiness Scale (ESS). Risk taking behavior was measured using the Balloon Analogue Risk Task (BART). The study participants consisted of 50 military aviators (45 male 5 female). Using Mann-Whitney U-tests, group means were compared to determine whether differences existed between aviators who endorsed fatigue and/or sleepiness and those who did not. **RESULTS:** Two groups emerged based on reported levels of fatigue and sleepiness. Group 1 exhibited a mean MFI general fatigue score less than 9 and a mean ESS score less than 10. Group 2 had a mean MFI general fatigue score greater than 9, a mean ESS score greater than 10, or both. Group 2 (16.00 ± 0.52) popped a greater number of balloons than Group 1 (13.81 ± 0.82) when performing the BART ($p=.043$). Group 2 (3.99 ± 0.10) also applied a greater number of pumps per balloon than Group 1 (3.54 ± 0.18; $p=.041$). **DISCUSSION:** The study results identified a relationship between levels of fatigue, sleepiness, and risk-taking behavior in military aviators, further supporting the threat that fatigue and sleepiness pose to aviator safety. These findings provide support for the use of the BART or other risk-taking measure to evaluate the effectiveness of fatigue and sleepiness mitigation strategies.

Learning Objectives

1. The audience will understand the prevalence of fatigue and sleepiness among military aviators.
2. The audience will be able to communicate the relationship between fatigue, sleepiness, and risk-taking behavior.

[422] EVALUATION OF COGNITIVE ENHANCEMENT EFFECTS OF DONEPEZIL IN MILITARY ROTARY-WING AVIATION

Samantha Wolf, Isaiah Persson, Ryan Mackie, Amanda Kelley
U.S. Army Aeromedical Research Lab, Fort Novosel, AL, United States

(Original Research)

INTRODUCTION: Pharmaceuticals like modafinil and mixed amphetamine salts have been studied extensively with respect to cognitive enhancement. The results have been mixed and tend to be moderated by individual differences in baseline level of function. A systematic review of cognitive enhancement techniques in healthy, rested adults identified donepezil as an alternate pharmaceutical strategy for cognitive enhancement. **METHODS:** We evaluated the cognitive enhancement effects of a single dose (5 milligrams [mg]) of donepezil in healthy, rested Soldiers using a randomized, placebo-controlled, within-subjects, double-blind experimental design. The independent variable was drug (donepezil 5 mg, placebo) and abstract reasoning ability was included as a moderator variable. The primary outcomes were cognitive ability (attention, visual information processing, memory), marksmanship performance, and flight performance on a subset of aviators. Participants were 23 male, U.S. Army active-duty Soldiers. Eight participants were rated aviators and completed three simulated flights. **RESULTS:** Out of nine tasks (including three simulated flights), only one significant difference between drug conditions was found. The effect was seen on one of the simulated flights, performed only by rated aviators. Rated aviators comprise approximately 36 percent of participants who completed the study ($n = 8$). **DISCUSSION:** The findings from this study do not support continued evaluation of a single dose of donepezil to enhance cognitive function or performance. The secondary objective of the study was to evaluate

any negative side effects of the drug administration. Again, the findings are not supportive of any further effects, and reported side effects were minimal. Further research, particularly that focuses on the role cognitive workload and intrinsic motivation may play, is required prior to recommendations regarding donepezil and its enhancement properties.

Learning Objectives

1. Participants will learn about cognitive performance and cognitive enhancement with pharmaceutical intervention.
2. Participants will learn whether, and if so, to what extent, donepezil enhances cognitive function and performance in healthy, rested Soldiers.

Wednesday, 05/08/2024 ***4:00 PM***
Grand Ballroom CD South, EF

[S-71]: PANEL: THE 14TH ANNUAL RAM BOWL

Sponsored by American Society of Aerospace Medicine Specialists

Chair: Allen Parmet
Co-Chairs: Rebecca Blue, Roy Allen Hoffman, Joanna Nelms

PANEL OVERVIEW: *The 14th Annual RAM Bowl features participants from the Air Force, Navy, Army, Mayo Clinic, UTMB and international representatives competing for the Louis H. Bauer Trophy. Aerospace Medicine Residents are required to demonstrate multiple competencies to satisfy the requirements of ACGME and ABPM and serve as specialists in the field.*

[423] THE 14TH ANNUAL RAM BOWL

Allen Parmet[1], Rebecca Blue[2], Rahul Suresh[3], Joanna Nelms[4], Roy Allen Hoffman[5], Alex Garbino[6], Walter III Dalitsch[7], Mary Cimrmancic[8], John Barson[9]
[1]*University of Southern California, Kansas City, MO, United States;* [2]*UTMB, Scottsdale, AZ, United States;* [3]*NASA/JSC, Galveston, TX, United States;* [4]*TX ANG, Austin, TX, United States;* [5]*U.S. Navy, Falls Church, VA, United States;* [6]*NASA/JSC, Clear Lake, TX, United States;* [7]*U.S. Navy, Dayton, OH, United States;* [8]*Marquette University, Milwaukee, WI, United States;* [9]*U.S. Army, Atlanta, GA, United States*

(Education - Program/Process Review)

The 14th Annual RAM Bowl features participants from the Air Force, Navy, Army, Mayo Clinic, UTMB and international representatives competing for the Louis H. Bauer Trophy. Aerospace Medicine Residents are required to demonstrate multiple competencies to satisfy the requirements of ACGME and ABPM and serve as specialists in the field. Multiple tools are available for developing appropriate didactic knowledge in aerospace medicine, public health, epidemiology, biostatistics and health care management. Residents participate in a college bowl format that test aerospace medicine competencies including the flight environment (atmosphere, radiation, vibration, acceleration, and microgravity), clinical aerospace medicine, aircraft and space vehicle systems/operations, accident investigation, historical events, aerospace physiology, human factors, ergonomics, medical standards, Federal Aviation Administration regulations, passenger transport, restraint and escape, cockpit resource management and aeromedical transportation. Questions are divided into toss-up and bonus questions. Multiple rounds of competition will lead to the selection of an individual victor and awarding of the Louis H. Bauer Trophy to the top team, sponsored by the American Society of Aerospace Medicine Specialists.

Learning Objectives

1. The contest will enable participants to prepare for ABPM examinations in Aerospace Medicine.
2. Attendees will receive an intense review of Aerospace and Preventive Medicine.

THURSDAY, MAY 09, 2024

Thursday, 05/09/2024 ***10:00 AM***
Grand Ballroom A

[S-72]: PANEL: PHYSIOLOGIC EPISODES IN HIGH-PERFORMANCE AVIATION: NATO WORKING GROUP FINDINGS

Chair: Ryan Mayes
Co-Chair: Erik Frijters

PANEL OVERVIEW: *Tactical aviation has a long history of physiologic episodes (PHYSEPs) associated with flight in challenging environments. However, in the last decade, pilots of multiple high-performance aircraft (fighter/attack jets and trainers) have experienced a higher-than-expected rate of these episodes in multiple services. In order to facilitate dialogue across nations regarding PEs, a North American Treaty Organization (NATO) working group was formed in 2018. With over 20 members from 10 NATO and partner nations, this group seeks to develop a better understanding of the potential causes of PHYSEPs, compare PHYSEP presentation and experience across nations and airframes, and create international consensus on causes, mitigations, and response where appropriate. This panel will present a summary the NATO working group's final report, including findings and recommendations, an overview of a proposed multinational aircrew experience study, an envisioned "end state" for how to mitigate the impact of physiologic episodes in high-performance aviation, and three presentations covering the group's "exposure matrix." The exposure matrix presentations will each describe the exposures experienced in high-performance aviation and analyze which are most critical for physiologic episodes; environmental exposures, breathing gas and equipment, and individual factors will all be discussed along with combined stressors.*

[424] PHYSIOLOGIC EPISODES IN HIGH-PERFORMANCE AVIATION: NATO WORKING GROUP FINDINGS AND NEXT STEPS

Ryan Mayes
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Program/Process Review)

BACKGROUND: in-flight physiologic episodes (PHYSEPs) among high-performance aircraft pilots have been attributed hypoxia or g-induced loss of consciousness (GLOC). Accordingly, training, pilot selection, and incident response investigations have been centered around this paradigm. However, as jet life support systems and aircrew flight equipment have improved, it stands to reason that these traditionally-attributed causes of PHYSEPs may be incomplete. In the last decade, multiple PHYSEPs have been noted among 4th- and 5th-generation fighter pilots in multiple services that do not appear to be connected to hypoxia or GLOC. **DESCRIPTION:** In order to facilitate international information sharing and create a consensus understanding of PHYSEPs, a North American Treaty Organization (NATO) working group was formed in 2018. This group has 20+ members representing 10 NATO and partner nations. The group expects to finalize its report in 2024, which will include findings and recommendations, PHYSEP classification and definition, a matrix of exposures present in the high-performance aviation environment, supporting factors such as training, sensors, and organization, and a construct for a multi-national study. **DISCUSSION:** PHYSEP symptom presentation can vary widely, and the cause of PHYSEPs are multifactorial

and variable; PHYSEPs are often a normal physiologic response to abnormal physiologic environments. An understanding of the multiple exposures that may lead to symptoms and of the potential outcomes of those exposures, is critical to understanding PHYSEPs. Not all relevant exposures and outcomes are well-understood, and the multifactorial nature of PHYSEPs requires an understanding of the interactions between exposures and physiologic responses; this requires specialized knowledge and a comprehensive and systematic assessment by a specialist. A current understanding of the rapidly evolving state of PHYSEP science is critical to assessment of PHYSEPs. A future aircrew experience study comparing PHYSEPs across multiple nations and airframes will be discussed.

Learning Objectives

1. Understand the findings and recommendations of the NATO working group.
2. Describe the differing presentations and potential causes of physiological episodes.

[425] PHYSEP END-STATE: TRAINING, ORGANISATIONAL, AND CULTURAL PROCESSES.

Adrian Smith
RAAF Institute of Aviation Medicine, Adelaide, Australia

(Education - Program/Process Review)

BACKGROUND. PHYSEPs are complex, multifactorial phenomena. Whilst it may be tempting to strive towards a system where PHYSEPs do not occur, this may not be an achievable goal in the context of high-performance aviation. **OVERVIEW.** We suggest that an achievable goal is a system where the impact of PHYSEPs is minimized. A PHYSEP-tolerant system can generate a balanced measured response to PHYSEPs should they occur, in a manner that does not unnecessarily degrade aircrew confidence or operational capability. **DISCUSSION.** Characteristics that contribute to a resilient and PHYSEP-tolerant system include training, organisational, and cultural factors. The training elements of a PHYSEP-tolerant system include an ongoing education programme that supports aircrew with information to contextualise unusual symptoms in flight, and promote a measured response by rehearsing emergency procedures and post-PHYSEP actions in a way that sustains confidence in the platform and life support systems. Training should focus on awareness of unusual symptoms or degraded performance in flight rather than focusing on specific causes. Organisational elements of a PHYSEP-tolerant system include a robust assessment process that defines a scaled classification of PHYSEPs, and investigation processes underpinned by evidence-based, data-driven, SME-informed assessments. Cultural elements of such a system include a safety culture where unusual symptoms declared in flight are not stigmatized, but are evaluated and assessed on their merit. Underlying all of these factors is clear and timely communication between commanders, aircrew, and support personnel including flight surgeons. A robust PHYSEP-tolerant system can sustain aircrew confidence and preserve operational capability by delivering a timely and proportionate response to PHYSEPs.

Learning Objectives

1. The audience will learn about the characteristics of a PHYSEP-tolerant system.
2. The audience will learn about the importance of sustaining aircrew confidence in platform and life support systems in any response to PHYSEPs.
3. The audience will learn about the importance of clear communication in any response to PHYSEPs.

[426] PHYSIOLOGIC EPISODE EXPOSURE MATRIX: METHODS, OVERVIEW AND ENVIRONMENTAL EXPOSURES

Vivienne Lee[1], Nic Green[2], Erik Frijters[3], Adrian Smith[4], Roope Sovelius[5], Michael Decker[6], Oliver Erley[7], Ryan Mayes[8]
[1]*QinetiQ, Farnborough, United Kingdom;* [2]*RAF Centre of Aviation Medicine, Henlow, United Kingdom;* [3]*Center for Man in Aviation, Soesterberg, Netherlands;* [4]*Institute of Aviation Medicine, Edinburgh, Australia;* [5]*Aeromedical Centre Finnish Defence Force, Helsinki, Finland;* [6]*Naval Medical Research Unit -Dayton, Dayton, OH, United States;* [7]*Military Aviation Authority, Cologne, Germany;* [8]*USAFSAM, Wright-Patterson AFB, OH, United States*

(Education - Program/Process Review)

BACKGROUND: It has previously been documented by a number of nations that pilots of high-performance aircraft have reported symptoms during flight, these are have become known collectively as in-flight physiologic episodes (PHYSEPs). The NATO HFM RTG-312 group has been developing a PHYSEP 'exposure matrix'. During 2023, this matrix has been progressed to provide a more detailed description of the relevance of each 'exposure' in the potential development of PHYSEPs and the knowledge gaps that exist. This presentation will provide an overview of the exposure matrix, and detail one of the four exposure matrix categories. Broadly, the exposure matrix describes cockpit environmental conditions (detailed in this presentation), life support equipment design and function, breathing gas delivery, and underlying pilot state. The matrix consists of exposures that have been assessed for the level of available evidence in the context of PHYSEPs, the likely frequency that a pilot will be exposed to each factor, the efficacy of the mitigation, the significance for PHYSEPs, and finally, the research priority as assessed by RTG-312 panel members. For each exposure, each of these parameters have been assessed as either 'high', 'medium' or 'low'. **OVERVIEW:** For environmental conditions, the key categories are low ambient pressure (altitude) and high +Gz acceleration, where the exposure frequency for both is considered to be high and the significance of both, in the context of PHYSEPs, is considered high (either in terms of likelihood, severity of symptoms or both). The level of evidence and knowledge associated with both these exposures is considered to be high. The efficacy of cockpit pressurisation and increased concentrations of oxygen in breathing gas to mitigate against low altitude is considered high in a well designed and functioning life support system. In contrast, while G protection systems are usually effective, they may not always provide adequate protection, particularly when combined with variations in underlying pilot state. DISCUSSION: Taking the rating of these factors together, it is concluded that the research priority for low ambient pressure and +Gz acceleration, in the context of PHYSEPs, are low and medium respectively.

Learning Objectives

1. Understand the the importance of factors relevant to high performance aircraft in the development of physiologic episodes.
2. Understand the research priority of environmental exposures in the context of physiologic episodes.

[427] PHYSIOLOGIC EPISODE EXPOSURE MATRIX: BREATHING GAS AND EQUIPMENT

Nicholas Green[1], Vivienne Lee[2], Erik Frijters[3], Adrian Smith[4], Roope Sovelius[5], Michael Decker[6], Oliver Erley[7], Ryan Mayes[8]
[1]*UK Royal Air Force Centre of Aviation Medicine, Henlow, United Kingdom;* [2]*QinetiQ, Farnborough, United Kingdom;* [3]*NL Center for Man in Aviation, Soesterberg, Netherlands;* [4]*RAAF Institute of Aviation Medicine, Edinburgh, Australia;* [5]*Finnish Defence Force Aeromedical Centre, Helsinki, Finland;* [6]*Naval Medical Research Unit - Dayton, Dayton, OH, United States;* [7]*Luftwaffe Center for Air and Space Medicine, Cologne, Germany;* [8]*USAFSAM, Wright-Patterson AFB, OH, United States*

(Education - Program/Process Review)

BACKGROUND: During every flight in high performance aircraft, aircrew are exposed to breathing gas characteristics that differ from the normal ambient, terrestrial environment. While some of the physiological effects are well understood, the HFM-312 Exposure Matrix identified that the impact of breathing system specification and performance has been less well explored and may have the potential to provoke unwanted physiological changes, particularly when experienced in combination with other stressors. **OVERVIEW**: The Exposure Matrix indicates

that the physiological impact of failure to deliver sufficient oxygen at increased cabin altitude is generally well known. Furthermore, this is a relatively rare event in high performance aviation due to the redundancy built into breathing systems. However, the oxygen concentration delivered can also lead to an arterial partial pressure of oxygen that is greater than sea level values, particularly when using on-board oxygen generation systems. High and fluctuating oxygen concentrations may increase the risk of acceleration atelectasis following sustained G maneuvers and have also been implicated in reducing cerebral blood flow with (as yet) unknown significance. Although the purity of breathing gas has been identified as a potential source of concern, no robust evidence of contaminated breathing gas in flight has been found. More significant is the delivery of gas flow from the breathing regulator and mask to provide an adequate response to breathing demand. Fluctuations in mask cavity pressure through the ventilatory cycle, perceived consciously or subconsciously as increased breathing resistance, could promote hyper or hypoventilation. High cognitive demand or other factors such as increased work of breathing from pilot flight equipment may increase this risk. **DISCUSSION**: Standards exist both nationally and internationally to ensure that the breathing gas supplied to high performance aviators causes minimal physiological disturbance. However, such standards must always strike a balance between performance and practicality. The final HFM-312 report will indicate that research is required into the physiological effects of mask cavity pressure change during the breathing cycle to refine existing standards. More understanding is also needed as to whether greater than sea level equivalent (or varying) arterial oxygen partial pressure has any meaningful impact on aviator performance.

Learning Objectives

1. The audience will learn about the knowledge gaps around breathing gas delivery in high performance aviation and how these might contribute to physiologic episodes.
2. The audience will learn where future research efforts on aircraft life support systems should be focussed to minimise the risk of physiologic episodes.

[428] PHYSIOLOGIC EPISODES EXPOSURE MATRIX: INDIVIDUAL FACTORS AND COMBINED STRESSORS

Erik Frijters
Royal Netherlands Air Force, Soesterberg, Netherlands

(Education - Tutorial/Review)

BACKGROUND: Aircraft life support systems are designed to sustain normal pilot physiology in military aircraft. However, pilot requirements differ greatly during normal flying conditions, aggressive manoeuvring and for egress/survivability purposes. Adding to this complexity, individual tolerances for physiological stressors can be different for each pilot. Tolerances can also vary during the day, are subject to fatigue, nutrition status, dehydration, heat stress, medical status, etc. The occurrence of a Physiologic Episode (PHYSEP) is likely an interaction between a combination of many factors. Since the introduction of high-performance military fighter jets, the occurrence of PHYSEPs has been a factor in reduced mission effectiveness and/or compromising pilot flight safety. Introduction of new aircraft, or changes to existing life support systems may cause a surge in PHYSEPs, even without system failures. The NATO HFM-312 research task group has been developing a PHYSEP 'exposure matrix'. One of the relevant elements in this matrix is the role of individual aircrew factors and combined stressors. **DESCRIPTION:** Some individuals may be more susceptible to physiological changes caused by aircraft life support systems than others. Combined stressors, such as discomfort caused by thermal burden, poor ergonomics, or inadequate mask and helmet fit can act as a margin degrader, which may increase the likelihood of the occurrence of a PHYSEP. These stressors may also interact with respiratory considerations, such as supplied oxygen concentration, inspiratory and expiratory pressures, seat posture, and pilot flight equipment. An understanding of the cumulative effect of these exposures, and how they can contribute to PHYSEPs, is critical in finding methods to mitigate and prevent PHYSEPs. **DISCUSSION:** The NATO HFM-312 panel aims to better understand the interaction between aircraft life support systems, individual factors and the effect of combined stressors on pilot physiology. By bringing together experts from 10 different NATO countries and by comprehensively examining exposures present in the tactical aviation environment, these complex interactions and PHYSEP relevance is better understood. This may help improve aircrew training, medical response, and system design to minimise undesirable physiological stimuli in the cockpit, improving flight safety and mission effectiveness.

Learning Objectives

1. Understand the interaction between aircraft systems and individual factors in the occurrence of Physiological Episodes.
2. Understand the role of combined stressors in the occurrence of Physiological Episodes.

Thursday, 05/09/2024 ***10:00 AM***
Grand Ballroom B

[S-73]: PANEL: MEDICAL EDUCATION PERSPECTIVES ON MEDICAL READINESS FOR THE OPERATIONAL ENVIRONMENT

Chair: Robert Krause

PANEL OVERVIEW: *This panel brings together professionals involved in various roles in medical education for United States Navy physicians. Panelists represent different health professions, with varied deployment experience, different command and control missions, and a civilian with specialty training in medical education and preparing units for deployment. Four of the five panelists have extensive first-hand deployment expertise. The first panelist is a previous Navy Internal Medicine Residency program director who will discuss medical education for multidisciplinary teams in the context of TeamSTEPPS to integrate learners with varied experience and clinical expertise. The second panelist will provide insight into his experience progressing from Health Professions Scholarship Program, to Flight Surgeon, to Navy Residency in Aerospace Medicine, and Senior Medical Officer of the USS John C. Stennis (CVN-74). Third, a rich discourse in pharmacogenomics and personalized medicine as they relate to modern Naval medical education will be provided. The fourth panelist is an experienced Naval provider who will provide unique insight on self-prescribed just-in-time training. Lastly, the fifth panelist will provide an overarching approach to multidisciplinary team medical education with a focus on the intersection of leadership, communication, and agility in a competency-based medical education framework.*

[429] JUST-IN-TIME-TRAINING: A LIVED EXPERIENCE

Jed Juachon
Stanford Alumni, San Deigo, CA, United States

(Education - Tutorial/Review)

INTRODUCTION: Just-in-time training (JITT) is an focused on as needed education. This can be a valuable model for the uptake of information related to novel techniques or technology. **TOPIC:** While engaged in clinical practice a new piece of technology was introduced. This device had the potential to expedite delivery and potentially improve patient outcomes. Dedicated time for education was unavailable due to clinical practice commitments. This presentation reviews a lived experience of a practitioner's self determined education prescription and how it ended up being engaged in the care of a critically ill patient. **APPLICATION:** Carving time for continuing medical education is challenging in the context of a busy clinical practice. This presentation provides a case study for attendees to use for reflection and a possible justification case to have designated JITT models related to novel or infrequently utilized techniques and technologies.

Learning Objectives
1. Define just in time training (JITT) within the medical education frame.
2. Describe a case where just in time training was an effective use of time for medical eduation.

[430] PHARMACOGENETICS AND PERSONALIZED MEDICINE.

Matthew Pena
Kaiser, Sacramento, CA, United States

WITHDRAWN

[431] THE NAVY I GREW UP IN: RENEWING OPERATIONAL READINESS COMPETENCY

Roy Hoffman
U.S. Navy, Dayton, OH, United States

(Education - Program/Process Review)

BACKGROUND: In the Navy I grew up in every new physician left their internship year anticipating that their first duty station would be in an operational unit as a general medical officer (GMO) of some variety. Deployments with those units required a rapid adaptation in your medical practice from a hospital setting with extensive services and layers of support to an unfamiliar location with minimal ancillary services and limited access to specialty care. The experience and training gained during medical school, internship, and additional operational medical training all coalesced around this common career path with known risks and limitations, but most importantly etching the responsibility of ensuring the readiness of those operational units into the core military physician competencies they would retain for the rest of their career. **OVERVIEW:** Today's post internship military physician is driven towards a vastly different career path focused on going straight to residency, time in the clinic, and preparing for leadership positions within military medicine. This results in some military physicians finding themselves in their first operational unit for the first time as a mid-grade officer with minimal operational medicine skills and a lack of prior operational experience. Gaps in delivering readiness have emerged and efforts are now underway to rudder shift to an operational focus within the Aerospace Medicine community. Policy, instructions, and training curriculum are being revised to harmoniously blend the change in physician career path with an expertise in delivering operational readiness and direct medical support. **DISCUSSION:** These ongoing efforts are extremely timely as the requirement for operational medical support has significantly increased due to a focus on the Pacific and its tyranny of distance. The future military physician will need to retain an expertise in both their medical specialty and operational readiness throughout their entire military career. The foundational framework being laid today will help to facilitate this requirement.

Learning Objectives
1. The participant will recognize the change in military physician career paths over the last couple of decades.
2. The participant will appreciate the need to keep policy and instructions up to date with changing readiness requirements.
3. The participant will understand how blending clinical and operational expertise provides for the best operational unit readiness support.

[432] INTERDISCIPLINARY MEDICAL EDUCATION

Justin P Lafreniere
U.S. Navy, Baltimore, MD, United States

(Education - Tutorial/Review)

APPLICATION: Medical education is key to providing a ready medical force within the United States Navy. Force generating multidisciplinary clinical teams poses a series of challenges. Military-specific curricula vary widely across U.S. Navy residency programs, despite guidance otherwise. Barriers include accreditation requirements with sometimes overly proscriptive and 'required' training experiences, although in recent years the ACGME has made attempts to encourage curricular innovation thru a waiver process. To our knowledge, deliberate interdisciplinary training experiences, as part of a military-specific curriculum, are minimal within U.S. Navy residency programs compared to similar civilian programs, even though graduates of military programs are likely to serve as part of a multidisciplinary team in much higher risk environments than their civilian counterparts. As a recovering U.S. Navy Internal Medicine program director recently turned Group Surgeon for Atlantic-based Fleet Surgical Teams, I've developed a dramatic perspective shift regarding military- specific curricula in residency programs and how best to train our learners to perform in the multidisciplinary operational environment. Most recent graduates approach their operational experience from a very physician-centric perspective, only to quickly encounter other members of the operational clinical team with greater breadth and depth of experience (who may also be junior in rank). Nowhere is this more evident than during team-based trauma training in which all members of Fleet Surgical Teams participate. Reactions to this experience vary, and present opportunities for multidisciplinary teachers to reinforce patient safety topics common to previous hospital-based experiences. These include: balancing leadership within a formalized hierarchy, leaning on the principles of Team STEPPS for how to create shared responsibility, cross monitoring, shared mental models, and closed-loop communication. This begs the question, if the mission of military medical education is to force generate operationally-relevant teams, should their not be more of an enterprise-wide, robust investment in teaching team-based care as part of a military-specific curriculum?

Learning Objectives
1. At the end of this presentation learners will be able to describe three challenges of providing high acuity clinical experience to service members within the US Navy.
2. At the end of this presentation learners will be able to recognize two key priorities of future medical education activities for multidisciplinary teams within the US Navy.

[433] ARCHITECTING A COMPETENCY BASED MEDICAL EDUCATION FRAMEWORK FOR MULTIDISCIPLINARY MEDICAL EDUCATION

Kathleen Samoil
Simon Fraser Univeristy, Burnaby, BC, Canada

(Education - Tutorial/Review)

INTRODUCTION: Standardized training opportunities exist for multidisciplinary teams. It may be that these opportunities can be enhanced by principles from competency based medical education (CBME) to team training. **TOPIC:** CBME is a model for the delivery, design, and evaluation learners and activities targeted to specific learning objectives. CMBE can be used across the learning continuum, from undergraduate, to post-graduate (residency & fellowship), and to continuing medical education (CME). CBME requires appropriate matching of (1) learning objectives to (2) educational intervention to (3) evaluation technique. If any are mismatched it may threaten or inaccurately reflect the attainment of learning objectives. **APPLICATION:** An example of a standardized Naval medical education course is the Fleet Surgical Team (FST) Shipboard Surgical Trauma Training (S2T2). Learners approach this multidisciplinary course with a broad range of clinical experience, and heterogeneity of rank. This robust, respected, and desired course is designed around a series of cases experienced by Naval providers. It may be that advancements in CBME architecture provide an opportunity to evolve rich medical education practices to align with this framework. A key tenet is the coordination of (1) learning objectives to (2) educational intervention to (3) evaluation technique. The underpinning of evaluation is within CMBE and readily lends itself to informing further education interventions. This assessment can be used to inform the prescription of further education interventions at both the individual and team level.

S2T2 is a highly regarded and sought after CME course with a history of preparing competent agile practitioners within high performing teams.

Learning Objectives
1. Describe the three unique elements of competency based medical education.
2. List two challenges of medical education in a team environment.

Thursday, 05/09/2024 ***10:00 AM***
Grand Hall J

[S-74]: SLIDES: AMSRO- YOUNG INVESTIGATOR

Chair: Dani Carroll
Co-Chair: Susan Northrup

[434] PIONEERING SPACE SURGEONS: MATCHING SKILLS TO MISSION NEEDS - DETERMINING THE ESSENTIAL SURGICAL EXPERTISE FOR MARS MISSIONS

Dora Babocs[1], Matthew Mark Melin[2], Siddharth Rajput[3], Gustavo S Oderich[4], Rowena Christiansen[4]
[1]*Advanced Aortic Research Program, Department of Cardiothoracic & Vascular Surgery University of Texas Health Science Center at Houston, Houston, TX, United States;* [2]*Mayo Clinic, Gonda Vascular Center, Wound Clinic, Rochester, MN, United States;* [3]*Department of Vascular Surgery, Royal Australasian College of Surgeons, Sydney, Australia;* [4]*University of Melbourne Medical School, Melbourne, Australia*

(Education - Program/Process Review)

BACKGROUND: Limited on-board spaceflight resources underscore the importance of prevention and mitigating major surgical interventions. Spaceflight medical care must consider the presentation type/severity, available resources, allocations, and resupply, and crew skill sets. While resource limitations and crew skills might indicate a 'traditional' surgical approach, minimally-invasive techniques have potential benefits despite practical challenges in the space environment. **OVERVIEW:** This study investigates surgical approaches during long-duration spaceflight through a comprehensive literature analysis. In austere (resource-limited) environments, traditional surgical techniques require less specialized equipment. However, risks include invasiveness, larger incisions, and bleeding management and fluid containment issues. Minimally-invasive techniques offer benefits such as faster healing and recovery, shorter in-patient stays, improved visualization, body compartment 'containment', and reduced infection risks. Spaceflight utilization could enhance safety, allow swift return to duties, or pre-evacuation stabilization. Terrestrial surgical approach optimization is relevant for high-risk cases, extreme environments, and austere settings. Medical care in extreme and austere environments should integrate ethical considerations, such as certain presentations in that context being deemed not survivable. **DISCUSSION:** An optimal surgical approach necessitates thorough planning, sound decision-making, a significant skill set, sound operator capacity, and utilization of available technological adjuncts. Emerging assistive technologies and minimally-invasive endoscopic methods present future promise, subject to restraints including cost, reliance on imaging (mass/volume constraints), and requiring specialized equipment and sterilization. NASA's Human Research Roadmap identifies altered sensorimotor functions, especially during critical procedural tasks, as a key spaceflight risk. Space exploration requires an integrated multi-disciplinary approach for success. In venturing beyond our planet, understanding the effects of space travel on human health, and developing appropriate medical responses becomes paramount. The synergy between traditional and cutting-edge surgical techniques could shape the future of space medicine and ensure the well-being of astronauts on their cosmic journeys. This abstract is being submitted as part of the AMSRO Young Investigators Panel.

Learning Objectives
1. The audience will gain an understanding of the comparative advantages and disadvantages of traditional surgical techniques and minimally-invasive surgical techniques.
2. Listeners will explore the advantages and challenges of employing minimally-invasive surgical techniques during spaceflight missions and their relevance for healthcare on Earth, particularly in resource-constrained and high-risk settings.
3. The audience will learn about the importance of including ethical considerations in determining whether to provide or withhold medical care in extreme and austere environments.

[435] THE INFLUENCE OF SPACE ENVIRONMENT ON CARCINOGENESIS: A COMPREHENSIVE REVIEW

Hossein Akbarialiabad[1], Nafise Niknam[2], Mohsen Farjoud Kouhanjani[2], Dedee Murrell[3], Mohammad Shafie'e[5], Seyed Ali Hosseini[2], Zahra Akbari[4], Seyedeh Maryam Mousavi[2], Armita Jokar Derisi[2], Najmeh Sadeghian[5], Marta Jurga[6], Lydia Johnson Kolaparambil Varghese[7], Rowena Christiansen[8]
[1]*UNSW Medicine, Sydney, Australia;* [2]*Shiraz University of Medical Sciences, Shiraz, Islamic Republic of Iran;* [3]*Department of Dermatology, St. George Hospital, University of NSW, Sydney, Australia;* [4]*Kerman University of Medical Sciences, Kerman, Islamic Republic of Iran;* [5]*Student Research Committee, Faculty of Medicine, Mazandaran University of Medical Sciences, Sari, Islamic Republic of Iran;* [6]*Wrocław Medical University, Wrocław, Poland;* [7]*Space Medicine Group, European Society of Aerospace Medicine, Cologne, Germany;* [8]*The University of Melbourne Medical School, Melbourne, Australia*

(Original Research)

INTRODUCTION: Space radiation and microgravity's impacts on astronaut health and cancer risk are active areas of research and are reaching critical importance as we enter the era of long-duration space exploration. While some evidence shows no increased spaceflight-induced cancer risk, others reveal potential post-mission genetic changes. Our review dives deep into this topic, consolidates current research, and sheds light on the potential oncogenic effect of spaceflights. **METHODS:** We critically analyzed 129 studies from an initial pool of 13,837. The majority were from the U.S., Germany, China, and Japan. Metrics considered include cancer types, frequency among astronauts, post-spaceflight genetic mutations, and cellular reactions to space environments. We focused on microgravity and ionizing space radiation effects. A holistic approach, considering the cumulative impact of space stressors, was adopted. All studies met ethical standards. **RESULTS:** Thyroid, breast, hematopoietic, and lung cancers were among the most studied malignancies. Among all nations, only the USA and Russia have undertaken research utilizing actual space mission conditions and human models. Intriguingly, some specific space settings seem to activate tumor suppressor genes, possibly hindering tumor growth. Microgravity affects cells both to stimulate and deter tumor development. DNA damage and impaired repair mechanisms were consistently linked with ionizing space radiation. **DISCUSSION:** The variety of findings underscores the challenge of determining space travel's oncogenic behavior. While some findings are comforting, others point to potential risks. The protective potential of some space settings and microgravity's dual effects are exciting areas for future research. However, the risks associated with space radiation cannot be ignored. Upcoming studies should adopt an integrated approach, considering the combined influence of space stressors on cancer. This knowledge is crucial for astronaut safety and understanding the long-term feasibility of space colonization. This abstract is being submitted as part of the AMSRO Young Investigators Panel.

Learning Objectives
1. To understand the impact of space environment conditions, such as microgravity and radiation, on cancer development and progression.
2. To determine the gaps in current research and highlight the need for integrative studies that examine the collective effect of space stressors on carcinogenesis.
3. Brainstorming to design a practical strategy to solve the challenges and limitations in future research.

[436] IMPACTS OF PHARMACOGENOMICS ON NASA GROUND SUPPORT AND SPACEFLIGHT PHARMACEUTICAL CARE

Thomas Diaz[1], Sincy Mathew[2], Tina Bayuse[3]
[1]*UNC Eshelman School of Pharmacy, Chapel Hill, NC, United States;* [2]*JES Tech, Houston, TX, United States;* [3]*KBR, Houston, TX, United States*

(Original Research)

INTRODUCTION: Pharmacogenomics has become the cornerstone of precision medicine, allowing healthcare providers to utilize genetic test results to guide medication selection and dosing. The use of pharmacogenomic data in astronauts may improve safety outcomes and avoid the risk of therapeutic failure in flight. The Johnson Space Center (JSC) Pharmacy is responsible for providing medications for ground support and in-flight medical kits in support of crew health and safety. This study aims to characterize the drug-gene associations that exist amongst a list of medications in order to stratify the risk of safety and efficacy outcomes of medication use for future ground and spaceflight operations. **METHODS**: The JSC Pharmacists compiled a list that includes a selection of medications that either have been or could be included in NASA ground support and spaceflight medical kits. The list of medications was cross-referenced with international pharmacogenomic sources and guidelines which provide evidence-based clinical guidance for various genetic polymorphisms: (1) Clinical Pharmacogenetics Implementation Consortium (CPIC); (2) Dutch Pharmacogenetics Working Group (DPWG); (3) Canadian Pharmacogenomics Network for Drug Safety (CPNDS); (4) French National Network of Pharmacogenetics (RNPGx); (5) United States Food and Drug Administration (FDA). Consequently, the medications in the JSC Pharmacy's list with actionable drug-gene associations was scrutinized. **RESULTS**: Of the 226 unique medications on the list, 24 (10.6%) medications have an actionable drug-gene association that may require therapeutic management based on guidance from at least one source. There are five additional medications with a drug-gene association that may affect safety, efficacy, or pharmacokinetic parameters, but their impact has yet to be fully elucidated in the literature. **DISCUSSION**: The findings of this study reveal that a considerable portion of the medications on the list analyzed possess actionable drug-gene associations. Personalized medication strategies may mitigate the risk of adverse drug reactions and optimize therapeutic efficacy to prevent medical emergencies which can compromise mission success. Ultimately, pre-emptive pharmacogenomic testing may be a valuable tool for mission planning in the context of future ground and spaceflight operations. This abstract is being submitted as part of the AMSRO Young Investigators Panel.

Learning Objectives

1. The audience will understand the significance of pharmacogenomics in NASA mission planning and its potential to optimize safe and efficacious therapeutic outcomes during spaceflight.
2. The audience will gain insight into the actionable drug-gene associations identified among medications stored in the JSC pharmacy.

[437] FUNCTIONAL AND MORPHOLOGICAL EFFECTS OF REPETITIVE OCCUPATIONAL HYPOBARIA ON THE SPINAL CORD

Sven-Erik Sönksen[1], Sven Kühn[2], André Gens[3], Frank Weber[3], Carla Ledderhos[3]
[1]*German Armed Forces Hospital Hamburg, Hamburg, Germany;* [2]*Federal Armed Forces Central Hospital Koblenz, Koblenz, Germany;* [3]*German Air Force Center of Aerospace Medicine, Cologne, Germany*

(Original Research)

INTRODUCTION: Non-hypoxic hypobaria is associated with subcortical white matter hyperintensities (WMH) on fluid-attenuated inversion recovery (FLAIR) magnetic resonance imaging (MRI) in the brain. In addition, axial injuries and decompression sickness during diving associated with hyperbaria are long-known phenomena, but little is known about the effects of isolated hypobaria on the spinal cord. **METHODS**: To assess whether the spinal cord is affected after repeated non-hypoxic hypobaria, we examined 19 altitude chamber personnel and 28 controls using spinal multiparametric MRI and posturography. The results are part of the German contribution to the NATO Research Group in Human Performance (RTG: Human Performance 274). **RESULTS**: We found neither WMH nor significant differences in total white matter, in dorsal, lateral and ventral columns, or in the two corticospinal tracts with regard to diffusivity, fractional anisotropy and magnetization transfer ratio nor any differences in posturographic parameters. Furthermore, there were no signs of atrophy or degeneration of the myelon. **CONCLUSION**: Customary hypobaric exposure in altitude chamber personnel appears unlikely to cause WMH in the spinal cord.

Learning Objectives

1. The participant will be able to understand functional and morphological effects in the spinal cord due to repetitive hypobaric non-hypoxic exposures.
2. The audience will learn about different kind of psychometric testing.

Thursday, 05/09/2024 ***10:00 AM***
Grand Hall K

[S-75]: PANEL: VIRGIN GALACTIC - YEAR 1 OF COMMERCIAL SPACEFLIGHT IN REVIEW: MEDICAL, ENGINEERING & RESEARCH OPERATIONS

Chair: Duncan Hughes

PANEL OVERVIEW: *This panel presents an overview of multiple aspects of medical engagement in suborbital spaceflight operations including the spaceflight system, flight crew, spaceflight participants (SFPs), and the many challenges inherent in supporting high-frequency operations in a fast-paced, rapidly evolving, commercial setting. The first presentation focuses on both company and medical operations including the astronaut journey, spaceflight medical support, and interdisciplinary integration with multiple teams and organizations. The second presentation addresses spaceflight participant medical screening, disease conditions, and lessons learned during the first year of commercial operations. The third presentation highlights the principles of biomedical and systems engineering (BASE) needed to integrate medical considerations into commercial operations and future vehicle design. The final presentation outlines the utility of the suborbital platform for biomedical science and highlights the medical functions required to effectively integrate research into spaceflight missions.*

[438] OVERVIEW OF COMPANY AND MEDICAL OPERATIONS FOR COMMERCIAL SUBORBITAL SPACEFLIGHT

Johnene Vardiman
Virgin Galactic, Las Cruces, NM, United States

(Education - Program/Process Review)

BACKGROUND: The medical support requirements for suborbital spaceflight differ from traditional orbital missions because of differences in spaceflight systems, mission profiles, population of potential spaceflight participants (SFPs), level of training provided, locations, and frequency of operations. Additionally, the medical role in design and testing versus high-cadence commercial operations varies significantly. **OVERVIEW:** An overview of the suborbital spaceflight system and profile is provided with a focus on the medical aspects pertinent to the different phases of flight. Highlighted are SFP medical screening and risk mitigation, medical support before, during, and after missions, contingency planning, and medical considerations for operating in a remote location. Additionally, we discuss the multidisciplinary integration of medicine to successfully support private spaceflight and research missions, lessons learned from the transition to commercial service, and future challenges of scaling medical operations. **DISCUSSION:** Providing support when transitioning from the design and testing stage of a spaceflight system to commercial operations can be a challenging process. Operational medical requirements to support a short-duration,

piloted spaceflight system with multiple layperson SFPs in austere environs requires the entire spectrum of capabilities including aviation, aerospace medicine, SFP and crew education, emergency response, and mission control. Provision of the highest standard of aerospace medical screening and support for commercial suborbital operations is a constantly evolving process that requires flexibility, multidisciplinary collaboration, and the ability to quickly pivot to fulfill design, operational, and medical needs.

Learning Objectives

1. To learn about the development of a suborbital space medicine program.
2. To learn about the changes in transitioning from conceptional to an implemented suborbital medical program.
3. To learn about the scope of projects, breadth of work with internal and external stakeholders, knowledge, and skills needed as an aerospace medicine professional working in a suborbital space medicine program.

[439] MEDICAL SCREENING AND OPERATIONAL IMPLICATIONS FOR SUBORBITAL SPACEFLIGHT PARTICIPANTS

Karen Ong, Johnene Vardiman-Ditmanson, Duncan Hughes
Virgin Galactic, Las Cruces, NM, United States

(Education - Program/Process Review)

BACKGROUND: Commercial suborbital spaceflight has unique medical considerations given the short duration of training and flight, dynamic phases of flight, and the spaceflight participant (SFP) population. Astronaut screening paradigms are discussed specific to this mission set. **OVERVIEW:** We provide an overview of the medical screening process for prospective suborbital spaceflight participants, discuss risk assessment and mitigation for a variety of medical conditions and pharmaceutical agents, and lessons learned after a year of commercial spaceflight operations. We highlight challenges in attending to the physical, mental, and emotional health of crew, mission specialists, SFPs, and family, friends, and guests. **DISCUSSION:** Medical support for missions requires not only consideration of the physiological and medical implications of the spaceflight profile but also integrating operational support and risk mitigation for medical, psychological, and emotional needs through multidisciplinary collaboration with training, engineering, maintenance, customer operations, and commercial teams.

Learning Objectives

1. The participant will learn about unique medical considerations for commercial suborbital spaceflight.
2. The participant will learn about multidisciplinary risk mitigation during commercial suborbital spaceflight.

[440] APPLICATION OF BIOMEDICAL AND SYSTEMS ENGINEERING (BASE) PRINCIPLES IN COMMERCIAL HUMAN SPACEFLIGHT

Kristen Taraszewski
Virgin Galactic, Plymouth, MN, United States

(Education - Program/Process Review)

BACKGROUND: Historically, biomedical engineers working in human spaceflight served as liaisons between the medical and engineering communities. In the evolving world of spaceflight, it is no longer adequate to simply hire an individual to implement biomedical and systems engineering (BASE) principles. Rather, the broad adoption of BASE practices by the entire space medicine community will improve safety and efficiency for the design, build, and operational stages of commercial human spaceflight. **OVERVIEW:** A brief overview of BASE principles is tailored to medical personnel working in a commercial spaceflight setting, covering fundamental concepts and terminology, processes, generation of requirements, and entrepreneurial thinking. The goal of this review is to improve efficiency with a specific focus on requirements, environmental control systems, the engineering review process, and standard business practices. **DISCUSSION:** The integration of medical requirements into commercial spaceflight engineering and operations is a complex and multidisciplinary process. In the rapidly changing environment of commercial space, BASE is an essential skillset for medical teams to understand engineering processes, effective requirement generation, and the design review cycle. Ultimately, BASE practices contribute to the agility and efficiency required to ensure the future of commercial spaceflight operations is safe, sustainable, and profitable.

Learning Objectives

1. Attendees will learn about the evolving need for the broad adoption of Biomedical and Systems Engineering (BASE) principles in commercial space.
2. The audience will gain exposure to BASE principles for medical personnel working in commercial spaceflight applications.
3. This session will discuss the use of BASE practices for the integration and execution of medical requirements in commercial spaceflight engineering and operations.

[441] MEDICAL SUPPORT FOR SUBORBITAL RESEARCH, EDUCATION, AND TRAINING OPPORTUNITIES

Sirisha Bandla
Purdue University, George Washington University, Tustin, CA, United States

(Education - Program/Process Review)

BACKGROUND: Access to research platforms in space for scientific or industrial purposes has historically been financially and logistically challenging. Parabolic flights offer limited duration microgravity exposures and orbital missions are infrequent and cost prohibitive. Suborbital spaceflight provides an intermediate platform for frequent, reliable, affordable, and repeat access to microgravity (and hypergravity) for research, training, and educational purposes. **OVERVIEW:** We provide an overview of flown biomedical sensors and platforms, previous research projects, and potential opportunities for biomedical research and mission specialist training. We discuss the role of the medical department in screening prospective researchers and payloads, integrating research projects/platforms with existing equipment and training, and post-flight support which may include medical procedures such as biological sampling or imaging. **DISCUSSION:** Given the financial and logistical challenges of orbital space experiments, the suborbital platform can serve as a testbed and training platform for future orbital experiments, many of which may involve biomedical research and potentially hazardous payloads. Immediate access to SFPs who were in microgravity just minutes prior provides a unique opportunity. Further, the increased frequency and lower cost of suborbital flights provides an attractive platform for educational payloads bolstering academic outreach and community involvement. Medical support for payload screening can help mitigate the risks to SFPs and crew, provide lessons learned for worn payloads, and improve the odds of successfully accomplishing more complex orbital space research objectives.

Learning Objectives

1. The audience will learn about the types of human-tended research being conducted onboard suborbital flights - that are now offered on a routine basis, and lessons learned for future research flights.
2. The audience will learn about various research being conducted on suborbital flights that lend to risk-reduction and further investigation on orbital flights - building a robust community for space-based research.
3. The audience will learn about our medical support and operations for commercial human spaceflights.

Thursday, 05/09/2024 ***10:00 AM***
Grand Hall GH

[S-76]: SLIDES: OCCUPATIONAL HAZARDS AND PROTECTION

Chair: Joanna Nelms
Co-Chair: Jeff Lawson

[442] SKIN PROTECTION STRATEGIES FOR AEROSPACE PROFESSIONALS WITH A FOCUS ON SUNSCREEN CHALLENGES IN THE UNITED STATES

Nikki Su[1], Tess Tarasen[2], Lesley Flynt[3], Kristine Ferrone[4], Rami Al-Rohil[5], Ashley Tarasen[6]
[1]*University of California, Los Angeles, Los Angeles, CA, United States;* [2]*Embry-Riddle Aeronautical University, Prescott, AZ, United States;* [3]*MD Anderson Cancer Center, Houston, TX, United States;* [4]*Aerospace Corporation/NASA, Houston, TX, United States;* [5]*Duke University, Durham, NC, United States;* [6]*American Institute of Dermatopathology, Los Angeles, CA, United States*

(Education - Tutorial/Review)

INTRODUCTION: Airline pilots, cabin crew, and astronauts have approximately twice the incidence of melanoma and non-melanoma skin cancer, and are more likely to die from melanoma, compared to the general population. Frequent flyers are also considered "occupationally exposed" to cosmic radiation. The demand for air travel is expected to double from 4 billion to 8 billion passengers between 2019 and 2040, underscoring the need for standardized skin protection strategies for aviation and aerospace professionals. **TOPIC:** Pilots and cabin crew are occupationally exposed to cosmic radiation, including ultraviolet A (UVA) radiation, a known carcinogen and inducer of melanoma. Solar and galactic cosmic radiation damage DNA directly, and indirectly, through the formation of reactive oxygen species, skin structural degradation, immunomodulation, and impairment of DNA repair mechanisms. Skin cancer is primarily attributed to UV radiation, genetic predispositions, and immunosuppression. Ionizing radiation attributes to an increased skin cancer incidence in atomic bomb survivors, nuclear power plant workers, and radiologists. Most UVB is blocked by the airplane window. However, in-flight UVA measurements from a pilot's seat have shown that the UVA carcinogenic effect during a 56-minute flight at an altitude of 30,000 ft. is equivalent to that of a 20-minute tanning bed session. Sunscreen use has been shown to reduce the incidence of melanoma and non melanoma skin cancer. In the United States, sun protection factor (SPF) products are regulated by the Food and Drug Administration (FDA) as over-the-counter drugs. SPF generally refers to only UVB protection, and offers no information regarding protection from UVA. Of the 14 FDA-approved filters, only zinc oxide and titanium dioxide are generally recognized as safe and effective (GRASE I); of these, only zinc oxide has an absorption spectrum to include UVA. The combination of UVA/UVB filters, antioxidants, DNA repair enzymes, nicotinamide, and retinoids may provide daily skin protection strategies for those serving in the commercial and military aviation and aerospace industries. We recommend that the Federal Aviation Administration's (FAA) preflight checklist IMSAFE be updated to IMSoSAFE to include "solar radiation". **APPLICATION:** The significantly increased incidence of melanoma and non-melanoma skin cancer in aerospace professionals underscores the need for daily skin protection methods.

Learning Objectives

1. The audience will learn about the increased incidence of, and mortality from, melanoma in pilots and cabin crew.
2. The audience will learn about the benefits of a daily skin protection routine while understanding SPF shortcomings for aerospace professionals in the United States.

[443] ALTITUDE-INDUCED DECOMPRESSION SICKNESS EVIDENCE REPORT AND PROPOSED EVALUATION PROTOCOLS

Michael Wolf[1], Wiaam Elkhatib[2], Richard Lang[2]
[1]*Mayo Clinic Rochester, Rochester, MN, United States;* [2]*Naval Medical Center San Diego, San Diego, CA, United States*

(Education - Program/Process Review)

BACKGROUND: Evolving research suggests cockpit decompression at altitude occurs more frequently and at lower altitudes than previously reported. Aerospace decompression sickness (DCS) can present subtly and lead to morbid neurological sequelae, requiring high clinical suspicion maintained by pilots, first responders, and physicians. Current literature reflects a paucity of guidance detailing decision-making response algorithm. This report intends to address this knowledge gap by reviewing published guidelines to develop treatment decision protocols for medical providers. **OVERVIEW:** Aviation DCS mechanistically overlaps with its well-studied correlate in divers with a growing literature body stimulated by prior serial fatal aviation accidents within the United States Air Force U-2 community. Following narrative literature review on the occurrence of decompression injuries resulting from altitude exposure, best clinical practices were formatted as flow charts for algorithmic and universal approaches to medical care. Inflection points in decision-making incorporate both telephone/virtual and face-to-face evaluation with progressive escalations of treatment according to tiered level of care indicated. Three flow charts were developed for procedure following rapid decompression at altitude for utilization in clinical standard operating procedures, practice guidelines, or emergency response. These encompass presence of clinical symptoms at ground-level, self-assessment screening protocol for seeking care, and pre-hospital treatment guidelines for use in a Basic Life Support response system. **DISCUSSION:** Cockpit decompression at altitude occurs relatively infrequently, though the potential for morbid resulting injury mandates high clinical suspicion when indicated. Clinical sequelae overlap with correlates in the hyperbaric environment, which should be recognized by pilots, aircrew, relevant military personnel, air traffic controllers, and those who provide medical services to them. Established management frameworks facilitate prompt recognition of and initiation of treatment for decompression injuries at altitude. The proposed schema in this report thus serve to prevent related adverse medical incidents while guiding clinical decision making.

Learning Objectives

1. The audience will understand updates about how aerospace decompression sickness (DCS) can to lead to morbid neurological sequelae, and the monitoring methods used including high clinical suspicion maintained by pilots, first responders, and physicians.
2. The audience will learn about current published guidelines in managing acute altitude decompression sickness (DCS) and their utility in developing updated treatment decision protocols for medical providers presented in this process review.

[444] EFFECTIVE TRAINING ON THE USE OF EARPLUGS - AN ISRAELI AIR FORCE EXPERIENCE

Faina Feldman[1], Sharon Gil[1], Aya Ekshtein[1], Yuval Kozlov[2], Oded Ben-Ari[1]
[1]*Aeromedical Center, Israeli Air Force, Ramat-Gan, Israel;* [2]*The Hebrew University of Jerusalem, Jerusalem, Israel*

(Original Research)

INTRODUCTION: In the Israeli Air Force (IAF) both aircrew and ground crew are exposed to harmful noise during their work. By law, the employer is obligated to instruct and train employees on the proper use of hearing protection. The most common hearing protection is earplugs made of sponge. The objectives of this study were to evaluate the effectiveness of the use of sponge earplugs among IAF members in relation

to previous instruction. **METHODS:** Data was collected from subjects who had been routinely evaluated at the Israeli Aeromedical Center between March 2020 and May 2021. Using the 3M E-A-Rfit Dual-Ear Validation System, noise reduction achieved with earplugs was measured. Participants who did not achieve at least 20dB (out of the maximum 29dB declared by the manufacturer) noise reduction were instructed on proper earplug use by the examiner and were reexamined. This study was approved by the Institutional Review Board. **RESULTS:** A total of 133 IAF members were examined with an average age of 24.6±6.7 years. There was a male and ground crew predominance (90% and 67%, respectively). Less than 50% of study participants had been previously instructed on proper earplug use, and less than 40% properly used the earplugs. Participants who had not been previously instructed achieved statistically significant lower attenuation value (16.2dB) compared to those who had been previously instructed (18.98dB, p=0.011). Participants who did not achieve the required attenuation value and were instructed on proper earplug use by the examiner significantly improved their attenuation values by an average of 8.5dB (p<0.001). **DISCUSSION:** Hearing impairment is a major health concern for military personnel. There are various hearing protection measures. Earplugs are low cost and commonly available and offer a 29dB noise reduction. However, proper use is not intuitive and straightforward as one may think, as less than 40% of our cohort was found to have used earplugs correctly. On the other hand, concise instruction on the use of earplugs greatly improved the attenuation.

Learning Objectives

1. Implementing periodic instruction on the proper use of earplugs may help reduce noise induced hearing loss.
2. Concise instruction on the use of earplugs greatly improved the attenuation values by an average of 8.5dB.

[445] IN-FLIGHT ULTRAVIOLET A (UVA) MEASUREMENTS FROM A PASSENGER SEAT

Tess Tarasen[1], Nikki Su[2], Lesley Flynt[3], Kristine Ferrone[4], Rami Al-Rohil[5], Ashley Tarasen[6]

[1]*Embry-Riddle Aeronautical University, Prescott, AZ, United States;* [2]*University of California - Los Angeles, Los Angeles, CA, United States;* [3]*MD Anderson Cancer Center, Houston, CA, United States;* [4]*The Aerospace Corporation/NASA, Houston, TX, United States;* [5]*Duke University, Durham, NC, United States;* [6]*American Institute of Dermatopathology, Los Angeles, CA, United States*

(Original Research)

INTRODUCTION: Airline pilots and cabin crew have approximately twice the incidence of melanoma, and a 46% greater likelihood of dying from melanoma, compared to the general population. Pilots and cabin crew are occupationally exposed to cosmic radiation, including ultraviolet A (UVA) radiation, a known carcinogen and inducer of melanoma. The International Commission on Radiologic Protection (ICRP) also considers frequent flyers as occupationally exposed to cosmic radiation. Airplane windows block most UVB, however, previously published in-flight UVA measurements from a pilot's seat found that a 56-minute flight at a cruising altitude of 30,000 feet had the same UVA carcinogenic effect as a 20-minute tanning bed session. To gain further insights into UVA exposure of both cabin crew and passengers, we conducted in-flight UVA measurements from a passenger seat window, and subsequently compared these data with previously published measurements from the cockpit. **METHODS:** UVA radiation measurements were performed using a SolarMeter Model 4.2 from a passenger's seat window of a Airbus 321 traveling from St. Paul, MN to Phoenix, AZ departing at 14:45 in September of 2022. The SolarMeter Model 4.2 measures UVA radiation 320-400nm. We measured UVA radiation at ground level, and an elevation of 10,000, 15,000, 20,000, 30,000, 34,000, and 36,000 feet above sea level. **RESULTS:** The amount of UVA radiation at a cruising altitude of 36,000 feet was 250 μW/cm^2. Ground level measurements during taxi varied from 27-100 μW/cm^2. Additional measurements taken during ascent were 30 μW/cm^2, 25 μW/cm^2, 20 μW/cm^2, 13 μW/cm^2, and 130 μW/cm^2 at 10,000, 15,000, 20,000, 30,000, and 34,000 ft. respectively. **DISCUSSION:** UVA is a known carcinogen and inducer of melanoma. Pilots and cabin crew have a significantly increased incidence of melanoma, and are more likely to die from melanoma, compared to the general population. We found that in-flight measurements from a passenger's seat had similar UVA exposure as previously published measurements from a captain's seat in the cockpit. Pilots and cabin crew should consider incorporating daily skin protection strategies to mitigate the risks of cumulative UVA radiation exposure in addition to other forms of cosmic radiation.

Learning Objectives

1. The audience will learn about the increased incidence of, and mortality from, melanoma in pilots and cabin crew.
2. The audience will learn that in-flight UVA exposure has the same carcinogenic effect as that of a tanning bed session.

[446] LUNG FUNCTION CHANGES AFTER ACUTE EXPOSURE TO +GZ AS ASSESSED BY IMPULSE OSCILLOMETRY

Simon Cornelissen[1], Erik Frijters[2], Gary Gray[1]

[1]*Royal Netherlands Air Force - Center for Man in Aviation, Soesterberg, Netherlands;* [2]*Royal Canadian Armed Forces - Environmental Medical Establishment, Toronto, ON, Canada*

(Original Research)

INTRODUCTION: The introduction of fifth generation fighter aircraft has raised concerns regarding the impact of high gravitational forces on lung function. This study aimed to investigate the acute effects of controlled +Gz exposure, up to +9 Gz, on lung function in military pilots using impulse oscillometry (IOS). **METHODS:** This multicenter study was conducted in two phases at facilities in Canada and the Netherlands, involving military fighter pilots undergoing high-G physiological protection training. IOS measurements were obtained using the TremofloTM IOS device, which assesses lung impedance during normal tidal breathing without forced maneuvers. 30 Royal Canadian Forces (RCAF) and 28 Royal Netherlands Air Force (RNLAF) aircrew participants were included in the study. Both performed baseline measurements. RCAF measured within 10 minutes after exposure. RNLAF within 2 minutes. **RESULTS:** Although there was a trend towards a significantly increased compliance, the RCAF study showed no significant differences in IOS parameters pre- and post-high G exposure. The RNLAF study demonstrated significantly reduced resistances and increased compliance, indicating enhanced small airway function post-high-G exposure. These findings showed no acute adverse effects of exposure to repeated +Gz on lung function. **DISCUSSION:** Both the RNLAF and the RCAF studies rule out that the combination of repeated exposure to high-Gz in combination with an anti-G suit and the performance of Anti-G Straining Maneuvers (AGSM) has acute negative effects on airway impedance parameters. The breathing component of the AGSM, likely produced increases in intrathoracic pressure, stretching the small airways and thus decreasing small airway resistance and increasing reactance. The difference between the non-significant trend in RCAF results within 10 minutes and significant changes in the RNLAF study results within 2 minutes, suggests that this effect is transient.

Learning Objectives

1. The audience will learn that acceleration atelectasis does not occur without high concentrations of oxygen in repeated exposure to medium and high +Gz, in combination with AGSM.
2. The audience will learn how the breathing component of the AGSM and high +Gz acutely changes lung function, and that this is a short term effect.

[447] ASSESSMENT OF G-ENDURANCE TOLERANCE OF INDIVIDUALS ON MODAFINIL DURING EXTENDED PERIOD OF WAKEFULNESS

Marur Nataraja

Aeromedical Training Centre, Ghaziabad, India

(Original Research)

INTRODUCTION: Modafinil as an alertness enhancing drug has been authorized for use among aircrew of IAF. This study was conducted with an aim to assess the effect of Modafinil on the G endurance tolerance on sleep deprived individuals. **METHODS:** Twelve healthy male volunteers participated in the study on two different days viz. once as part of control group with placebo and second time as part of study group on single dose of Modafinil 200 mg at 2300 h. In the 'between the group' design, relaxed +Gz tolerance & +Gz endurance tolerance were assessed using High Performance Human Centrifuge (HPHC) before and after intervention with Modafinil. Physiological variables like Heart Rate (HR) and Blood Pressure (BP) were measured before, during and after exposure to +Gz in the HPHC. Subjective perception of fatigue was assessed using Chalder's fatigue questionnaire. **RESULTS.** The results were analysed using repeated measures ANOVA which indicated that Modafinil significantly increased the HR and BP among the subjects in the study group ($p<0.05$). However, these parameters were maintained steady during exposure to +Gz stress. Subjective perceptions of sleepiness and fatigue were significantly attenuated with Modafinil ($p<0.05$). The G Endurance tolerance of participants on Modafinil was significantly increased as compared to those in the control group ($p<0.05$). **DISCUSSION:** The findings of our study suggested the possible sympathomimetic action of Modafinil resulting in significant sustained elevation in both blood pressure and heart rate. The intervention with Modafinil showed significant effects on G endurance tolerance due to a strong ergogenic effect of the drug. The subjective perception of work effort of doing Anti-g Straining Maneouvre (AGSM) was less among participants in study group as compared to control group.

Key Words: G tolerance, Modafinil, SACM, Fatigue, HPHC

Learning Objectives

1. The participant will be able to understand that Modafinil is helpful in maintaining alertness during extended duration of wakefulness. The subjective perception of sleepiness and fatigue would be significantly attenuated with administration of Modafinil.
2. The participant will be able to understand that intervention with Modafinil does not interfere with the relaxed G-tolerance of an individual. However, it significantly increases the G-endurance tolerance due to modest sympatho-mimetic effects and a strong ergogenic effect of Modafinil enabling better combat capability.

Thursday, 05/09/2024 ***10:00 AM***
Grand Ballroom AB

[S-77]: PANEL: UTMB – 30 YEARS OF EXCELLENCE: HOW WE BUILD THE FUTURE OF AEROSPACE MEDICINE.

Chair: Ronak Shah
Co-Chair: Serena Auñón-Chancellor

PANEL OVERVIEW: *"We believe in the success of every human who endeavors to travel to the skies." This is the vision statement of the Aerospace Medicine team at the University of Texas Medical Branch (UTMB). The purpose of this panel is to share major educational updates seen in the past 1 ½ years, provide a look at both current and future operations, and explain the internal and external variables that impact both the short-term tactical and long-term strategic thinking of the team. The first presentation will be an overview of the new Master of Science in Aerospace Medicine. It will explore the thought process behind transitioning from the historical Master of Public Health degree, what curriculum components were changed and what new, innovative approaches are now being implemented. The second presentation will provide insight into ongoing consortium efforts and international training pathways. As the field of Aerospace Medicine evolves, it does so on both a domestic and global scale. The presenter will share aspirations of the consortium, current efforts at UTMB for international support, and ideas for future growth. This will be followed by an in-depth look at the newly formed 4-year combined Emergency Medicine/Aerospace Medicine residency as UTMB seeks to expand training opportunities. The speaker will elucidate the rationale behind the idea itself, what resources were needed to execute a plan, and how this endeavor was truly a collaborative effort between different institutional departments and different boards. From here the panel will segway into research efforts. More specifically, the presenter will discuss the driver behind an enhanced focus on research education and training as well as specific projects that both past and present UTMB residents have undertaken. The panel will conclude with a perspective from the UTMB Aerospace Medicine Chief Resident. The goal is to share not just the faculty point of view, but to balance that with the perception of the individual who is recipient of the very education that UTMB Aerospace Medicine provides. Overall, the goal is to demonstrate how mindful actions at UTMB have brought this program – now in its 30th year - one step closer towards its vision.*

[448] MASTER OF AEROSPACE MEDICINE, ADAPTING CURRICULUM TO LEARNER NEEDS

Amy Kreykes, Serena Auñón-Chancellor, Ronak Shah
UTMB, Galveston, TX, United States

(Education - Program/Process Review)

BACKGROUND: Aerospace Medicine board eligibility via the American Board of Preventive Medicine requires completion of a Master of Public Health (MPH), or equivalent, degree. The University of Texas Medical Branch (UTMB) Aerospace Medicine Residency has traditionally provided residents with an education resulting in a MPH degree. Recent nationwide changes to the MPH competencies made by the Council on Education for Public Health (CEPH), feedback from recent graduates, and input from potential employers of Flight Surgeons prompted the University of Texas Medical Branch to re-examine the curriculum and adapt it to better suit the needs of our residents. **OVERVIEW:** A new curriculum comprising a Master of Science in Aerospace Medicine was tailored to UTMB residents based on feedback from identified stakeholders. It includes approximately 100 hours of Aerospace Medicine specific content in addition to the core courses required for board eligibility. Examples of topics covered include complex aeromedical certification, fundamentals of aerospace physiology, women's health in spaceflight, medical operations to include launch and landing efforts, acute care response, risk management, and introductory principles to mishap investigation and response. In addition, UTMB has partnered with a commercial space company that will be providing a customized overview of systems engineering and approach to the development of requirements for non-engineers. We are proud to partner with experts in the field to provide this new curriculum to our residents. **DISCUSSION:** As mission architectures for space and aviation evolve, so too must the education for physicians in pursuit of Aerospace Medicine. Through the lens of a multi-disciplinary core faculty, and the input of both government and industry stakeholders, the UTMB residency is proactively innovating and preparing for the future.

Learning Objectives

1. The participant will be able to identify differences in the former MPH curriculum and the current MS curriculum at UTMB.
2. The participant will have a better understanding of the type of content included in the MS curriculum.

[449] BUILDING PARTNERSHIPS AND INTERNATIONAL TRAINING PATHWAYS

Serena Auñón-Chancellor
UTMB, Galveston, TX, United States

(Education - Program/Process Review)

BACKGROUND: Both domestic and international institutions are seeking opportunities to gain access to education in Aerospace Medicine. **OVERVIEW:** The number of people flying to space and the need for

qualified Aerospace Medicine specialists to serve as their flight surgeon has skyrocketed in recent years. UTMB has continually evolved its curriculum and access to education over the years to help meet the needs of both government and industry. More recently, UTMB has had a large number of requests from several academic institutions both domestic and abroad regarding pathways to develop their own expertise in the field. **DISCUSSION:** UTMB has answered this increased interest by the creation of a formal Aerospace Medicine consortium involving many other large academic institutions. By bringing together our strengths in research, engineering, and the clinical realm, this ensures that both the number and quality of our graduates continues to be optimized. In addition to this, many international countries have sought increased access to formal Aerospace Medicine training as opportunities locally may be limited. UTMB has engaged with many of these entities to provide our support and guidance with these endeavours. Proposals have included development of small educational curriculums and even the creation of a formal training program that aspires to parallel the guidelines of board certified Aerospace Medicine specialists.

Learning Objectives

1. The participant will be able to describe the merits of increased collaboration in the Aerospace Medicine education arena.
2. Participants will be able to describe different pathway opportunities for international training.

[450] A NOVEL 4-YEAR COMBINED EMERGENCY MEDICINE/ AEROSPACE MEDICINE RESIDENCY AT UTMB

Natacha Chough, Ronak Shah, Serena Auñón-Chancellor, Amy Kreykes, Rebecca Blue
UTMB, Galveston, TX, United States

(Education - Program/Process Review)

BACKGROUND: The success of Aerospace Medicine as a specialty is premised on the multi-disciplinary backgrounds of its providers. Over the past 30 years, UTMB has offered categorical and combined ACGME-accredited residency options to produce board-eligible and board-certified Aerospace Medicine physicians for the industry's workforce. Advances in aerospace, including an increase in commercial spaceflight, drive the need for additional training programs to expand the existing pipeline of appropriately trained physicians eligible for hire throughout this growing sector, while still maintaining established medical education standards. **OVERVIEW:** With the advent of UTMB's new Emergency Medicine residency, and the concurrent growth in the aerospace industry driving a need for a greater number of qualified practitioners, the UTMB Aerospace Medicine Division believed it a natural fit to pair these medical specialties together. The development process included initial internal institutional dialogue, a metrics review of past trainees' primary specialty backgrounds, detailed discussions with ABEM & ABPM, hire of appropriate faculty to expand Division support capabilities, and curriculum construction, prior to the release of the final product. Additional educational support from EM/AM colleagues in the commercial space sector will also be incorporated. This pathway received formal approval from both the American Boards of Preventive Medicine and Emergency Medicine, with each component being ACGME-accredited. Applications opened in 2023 for the start of July 2024. We look forward to sharing this novel approach to creating additional training pathways in Aerospace Medicine. **DISCUSSION:** Competent medical support of aerospace endeavors stems from sufficient ACGME-accredited training program opportunities for physicians seeking to specialize in this field. Increasing the number of accredited Aerospace Medicine training programs will produce more graduates qualified to perform this work and match industry growth. This is of global interest to professionals in a position to develop educational programs to address training gaps in their respective communities.

Learning Objectives

1. Learn the driving factors leading to the need for more Aerospace Medicine practitioners.
2. Understand the components involved in the creation of new Aerospace Medicine training programs.

[451] AEROSPACE RESIDENCY RESEARCH: EXPANDING DATA-DRIVEN LITERATURE AND DEVELOPING SCIENTIFIC ACUMEN

Rebecca Blue, Amy Kreykes, Natacha Chough, Serena Auñón-Chancellor, Ronak Shah
UTMB, Galveston, TX, United States

(Education - Program/Process Review)

BACKGROUND: In aerospace medicine, the need for data-driven decision-making and the corollary of data publication and peer review must be balanced against the need for careful and effective protection of patient privacy. Historically, aerospace medical publication has been limited to small cohorts and often delayed presentation of data to allow deidentification of sources. Simultaneously, some historical medical events never reach publication as the risk of violation of privacy is considered too high; as a result, some medical knowledge can only be gained through experience or direct clinical practice. Thus, our community has struggled to aggregate sufficient evidence to support data-driven decision-making on even common spaceflight medical events and has further struggled to communicate rationale behind common practices. With the expansion of the commercial spaceflight industry, the ability to pursue rapid aggregation and presentation of medical findings is critical for the evolution of aerospace clinical practice to keep pace with current and future operations. Simultaneously, new physicians entering aerospace practice must be capable of reviewing data from even limited sources to determine impacts to clinical practice and validity of evidence sources. **OVERVIEW:** UTMB is actively pursuing expansion of aerospace resident education and engagement in clinical spaceflight research activities, with objectives including developing robust resident skills in validating and synthesizing data and determining applicability to their own clinical practice. Further, training in research skills allows new graduates to contribute meaningfully to future scientific literature, further evolving data-driven clinical practice. This presentation will review the development of a training architecture to educate residents and develop research skillsets. **DISCUSSION:** As the commercial industry has led to rapid development of expansive and variable operational environments for human spaceflight, physicians entering aerospace medical practice must similarly expand their skillsets in understanding, aggregating, and applying clinical experience to their own medical practice. In providing an educational framework to understand and engage in clinical research, we can offer a foundational pathway for future clinical practice evolution and evidence-based medical practice as well as for the ethical presentation of future medical findings for the benefit of all.

Learning Objectives

1. Attendees will learn about UTMB's approach to residency research education and engagement.
2. Attendees will hear about prior and ongoing resident research efforts in Aerospace Medicine.

[452] PUTTING IT ALL TOGETHER: PERSPECTIVE FROM THE CHIEF RESIDENT

Rebecca Mendelsohn
UTMB, Galveston, TX, United States

(Education - Program/Process Review)

BACKGROUND: Upon graduation, many Aerospace Medicine residents are embarking on entirely new career paths compared to their predecessors just a decade ago. To ensure that trainees continue to receive cutting-edge education in this rapidly evolving field, the University of Texas Medical Branch (UTMB) has updated its curriculum to incorporate innovative and invaluable academic and rotational experiences into its Aerospace Medicine residency program. **OVERVIEW:** This fall, UTMB introduced a Master of Science in Aerospace Medicine into its first-year curriculum. This program provides a multi-faceted foundation of knowledge in Aerospace Medicine and, of note, introduces an approach to systems engineering thru the lens of a commercial space provider. To combine this academic knowledge with real-world experience, the

program includes longitudinal rotations at NASA's Johnson Space Center. In the second year, trainees are afforded the opportunity to create unique experiences that will benefit their specific career choices. This year, residents have cared for altitude-related maladies in the Himalayas, collaborated on projects with the UK's Civil Aviation Authority in London, joined USAF colleagues in CBRN training exercises, and drafted emergency medical protocols for new commercial space companies. **DISCUSSION:** With the advent of the commercial space industry, the field of aerospace medicine is rapidly expanding, requiring training programs to adapt to new educational and training needs. UTMB's program advances the field of aerospace medicine by ensuring that trainees are receiving the experiences and education that they need in these new roles.

Learning Objectives

1. During this presentation, the audience will learn about cutting-edge approaches to aerospace medical education.
2. After this presentation, the audience will be familiar with the impact of real-world rotational experiences on creating unique educational pathways for Aerospace Medicine Residents.

Thursday, 05/09/2024 ***10:00 AM***
Grand Suites 2 & 3

[S-78]: POSTERS: OUT OF THIS WORLD POSTERS

Chair: Yael Barr
Co-Chairs: Jamie Harvey, David Alexander, Andrea Hanson

[453] DEATH IN SPACE: END OF LIFE CARE AND MISSION PLANNING

Imelda Muller, Jace Bradshaw
Johns Hopkins, Baltimore, MD, United States

(Education - Program/Process Review)

BACKGROUND: Several models have been developed to build architecture around the most likely medical conditions that will be encountered during space missions (eg. Integrated Medical Model (IMM), Long Duration Lunar Orbit and Lunar Surface (LDLOLS) Models). With longer duration space missions, the list of possible medical conditions that will be encountered continues to grow. Palliative care and expectant management must be woven into the gold standard of space medicine. **OVERVIEW:** The IMM was used to identify 100 likely medical conditions that could be encountered over a particular range of mission capabilities. With NASA's plans for long duration space flight and expansion into the solar system, implications of additional pathologies must be considered, such as chronic disease states. Given the material constraints inherent in interplanetary flight, it is prudent to consider higher morbidity and mortality rates similar to those encountered in austere terrestrial environments. While several individuals have died in space, no such event has involved crew-based care for a dying individual while also continuing a long duration space mission. The care of a dying crew member has mission impacts beyond a reduction of manning and the operational, biological, and psychological implications must be thoroughly considered. Preparedness for space missions of any duration should include a plan for palliation and death of a crew member. This training for crew members should include identification of medications/resources that can be allocated for end of life care and integration of personal and cultural practices. Lessons from austere terrestrial environments and prolonged military field care can be applied to end of life care in space. **DISCUSSION:** What does a "good death" look like in Space? While the answer to this question is incredibly personal and diverse, principles of palliative care should be applied to the developing model of celestial medicine. Unlike the management of other medical conditions, a major advantage of expectant management and palliative care are the minimal resources and training necessary to execute this response effectively. These principles can be integrated into the ever-changing architecture of space medicine and could ultimately help minimize detrimental mission impacts of an otherwise catastrophic loss.

Learning Objectives

1. Identify gaps in knowledge related to palliative and end-of-life care on space missions.
2. Describe operational, biologic, and psychological implications of a crew member's death, particularly during long duration space travel.
3. Describe how basic principles of palliative and end-of-life care in both resource rich and poor terrestrial environments can be applied to short and long duration space missions.

[454] EVALUATING THE VALUE OF A NEW 'SPACE HEALTH' CURRICULUM THROUGH THE LENS OF STUDENT REFLECTIONS

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(Education - Program/Process Review)

BACKGROUND: In 2022, the University of Melbourne Medical School launched a new integrated 'Discovery' subject stream as a core component of the graduate medical curriculum. 'Flagship' MD1 Discovery subjects included "Human health in the space environment" (24 weeks). Each student cohort completes three assessments: a group video project, a written report, and a final reflective Space4Health 'spinoff' presentation. Active reflection spans personal insights into the value of what has been learned from the subject and researching 'spinoffs', and how this could apply to future professional practice. Analysing these reflections allows assessment of whether two course objectives of creating awareness of the translational value of space research, and an appreciation of many key qualities for success that students can carry forward into their future careers, are being achieved. **OVERVIEW**: Although the reflective element was a key assessment and marking rubric component, not all students specifically included it, or referred to their future professional practice. Out of 22 students, 17 provided at least one slide specifically describing the translational benefits of space research, its value, or applicability to their professional practice. 14 students included clearly identifiable personal reflections. Only 11 directly referred to their future professional practice. **DISCUSSION**: Some themes emerged. This included consideration of capacity to apply spaceflight countermeasures to analogous terrestrial health conditions, and recognising the relevance of human space research to future career areas. There was thoughtful recognition of the value that both space exploration and space research can bring to improving life on Earth, including areas such as global health and food insecurity, and the impact of climate change. To build a better understanding of the unique context of the space sector, students progressively work through the NASA/LEGO 'Build to Launch' series and associated 'brainstorming' activities. In their reflections, students recognised many key qualities associated with successful space projects and missions, including teamwork, inter-disciplinary collaboration, flexibility, curiosity, creativity, innovation, resourcefulness, problem-solving skills and lateral thinking, lifelong learning, and research as a driver of best practice. These findings indicate that the 'space health' course creates multi-layered value and is achieving the relevant objectives.

Learning Objectives

1. Participants will learn about the approach to assessment for the University of Melbourne MD1 subject, "Human health in the space environment" and how this includes an element of student reflection on lessons from the course.
2. The audience will gain an understanding of two of the key course objectives for the subject and how well these have been achieved based on an analysis of student reflections.
3. Participants will leave with an appreciation of the key qualities associated with successful space projects and missions that were recognised by students in their reflections.

[455] BETHANECHOL AS A TREATMENT FOR ANTICHOLINERGIC-INDUCED URINARY RETENTION IN SPACE

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(Education - Case Study)

INTRODUCTION: *Urinary retention (UR) is a critical medical concern that can and has been encountered by astronauts during space missions, especially given the use of anticholinergic medications for managing space motion sickness. Anticholinergics, although beneficial in mitigating motion-induced ailments, possess the downside of inhibiting bladder smooth muscle contractions, leading to UR. This scenario underpins the necessity of exploring potential countermeasures to ensure astronauts' health and mission success. Bethanechol, an older and relatively forgotten cholinergic agonist, is a promising candidate for addressing this issue, given its FDA approval for treating postoperative, postpartum urinary retention, and overflow incontinence on Earth.* **BACKGROUND:** *Existing literature elucidates Bethanechol's efficacy in counteracting anticholinergic-induced UR, particularly from medications like tricyclic antidepressants, neuroleptics, and anticholinergics, as highlighted in terrestrial medical texts. The primary benefit of Bethanechol's use in spaceflight over that of terrestrial applications is that it could significantly mitigate the need for urinary catheterization, a common intervention for UR, which carries a heightened risk of urinary tract infections, especially in the confined, microgravity environment of space. Medication management also alleviates the logistical and comfort challenges associated with catheter management on missions.* **CASE PRESENTATION:** *A healthy male had a documented overdose of Oxybutynin resulting in an anticholinergic induced UR. The individual suffered from multiple mild anti-cholinergic symptoms including dry mouth, dizziness, blurry vision, alongside developing UR. He was given 3L of fluids and developed symptoms of UR twice (2.5 hours apart). He refused catheterization both times. His UR was successfully reversed during both UR episodes with Bethanechol administration with symptom resolution within 24 minutes and without the need for catheterization. This highlights bethanechol as a therapeutic agent for anticholinergic-induced UR.* **DISCUSSION:** *This abstract investigates Bethanechol's efficacy in terrestrial cases of urinary retention, extrapolating its known benefits to microgravity conditions. This exploration could significantly contribute to developing a robust medical protocol for non-invasive management of UR, ensuring the well-being of crew, and consequently, the overall success of long-duration space expeditions.*

Learning Objectives

1. Understand the mechanism by which medication-induced urinary retention takes place.
2. Understand the infection risk associated with urinary catheterization in spaceflight.
3. Understand the utility of Bethanechol in the terrestrial environment and how to apply this to spaceflight.

[456] NOVEL EDUCATIONAL APPROACH IMPACTING FUTURE HUMAN SPACEFLIGHT ENGINEERS AND CLINICIANS

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(Education - Program/Process Review)

BACKGROUND: As human spaceflight rapidly expands with the progression of NASA's Artemis program and future missions to Mars, developing human spacecraft designs and operations that ensure crew survival and performance become essential to mission success. These developments require combined efforts from both engineers and physiologists; however, the training of each field results in varying language profiles and problem-solving strategies. Therefore, integrating engineering and physiological disciplines is necessary for creating successful human spacecraft and habitat designs that avoid serious consequences during mission operations. **OVERVIEW:** In response to this need, the University of Colorado Boulder's Medicine in Space and Surface Environments (MiSSE) course incorporates content from both engineering and medical disciplines in classes composed of aerospace engineering, bioastronautics, and integrative physiology undergraduate and graduate students. This course is taught both in the classroom and in a field simulation at the Mars Desert Research Station (MDRS) in Hanksville, Utah. Throughout the semester, students earn their wilderness medicine and CPR certifications, while developing a rocket and payload design to launch samples at MDRS. During the field portion, students perform simulated EVAs and learn fascinating topics taught by professors with varying backgrounds in emergency and aerospace medicine. The MiSSE course also recently introduced the Mars Emergency Clinic (MEC), a medical examination and treatment bay constructed by the University of Colorado Boulder MEDICS group, for MDRS simulations. We conducted a student survey to assess their adaptability to engineering- and medical-related challenges, as well as to monitor their prospective career goals prior to and following course completion. Qualitative analysis of the responses identified students' application of communication skills and problem-solving techniques (amongst others), and reflected a shift in interest to careers focusing on human interfaces in space. **DISCUSSION:** The MiSSE course successfully establishes and evaluates the integration of aerospace engineering and physiological disciplines demonstrated by the course's structure, composition, and student perspective. This course overall sparks inspiration and intellectual curiosity in the next generation of bioastronautics engineers and aerospace medicine physicians, a necessary step for future human spaceflight mission success.

Learning Objectives

1. Describe the unique facets of the Medicine in Space and Surface Environments course at the University of Colorado Boulder.
2. Understand the impact of a combined aerospace engineering and physiology curriculum on undergraduate and graduate students studying each discipline.

[457] NON-INVASIVE MONITORING OF HEART AND RESPIRATORY RATES USING A CELLPHONE-BASED APPLICATION DURING A SPACE ANALOG MISSION

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(Original Research)

INTRODUCTION: Monitoring the vital signs of astronauts is important to mission success. Vital sign monitoring can often be invasive and obstruct activity. Obtaining an arterial waveform is particularly invasive. This technological demonstration aims to show non-invasive heart rate and respiratory rate monitoring through the use of a cellphone-based application and camera (Presage Health) in a remote setting. **METHODS:** The heart rate and respiratory rate of six adult analog astronauts (50% male, 50% female; ages 18-52) were measured using a cellphone-based application during a six day space analog mission at the HI-SEAS habitat (8200ft altitude) on Mauna Loa, Big Island, Hawaii. The heart and respiratory rates were compared to other data obtained simultaneously by traditional means (pulse oximeter and manually counted respiratory rate). The data were collected at rest, immediately after exercise, and after simulated extra-vehicular activity (EVA). **RESULTS:** The heart rate and respiratory rate of six adult analog astronauts were measured using a cellphone-based application and camera. Approximately 60 measurements were made over the course of 6 days (average 10/person). The data were accurate when compared to traditional means of measurement (pulse oximetry and manually counted respiratory rate). Some limitations of the applications included requiring sufficient ambient lighting, continuous face time, and internet service. **DISCUSSION:** This technology

demonstration shows that heart rate and respiratory rate can be successfully monitored non-invasively and accurately using a cellphone-based application and camera. Non-invasive cellphone-based monitoring of astronauts' vital signs can limit the use of cumbersome wiring and electrode placement. Strengths and limitations of this technology are discussed. This technology may be applicable in a variety of scenarios including austere environments, space stations, and lunar and Martian habitats.

Learning Objectives

1. This technological demonstration shows that heart rate and respiratory rate can be monitored non-invasively and accurately using a cellphone-based application and camera.
2. Cellphone-based monitoring of astronauts' vital signs can limit the use of cumbersome and invasive equipment.

[458] INCIDENCE AND RISK FACTOR ANALYSIS OF SPACE MOTION SICKNESS DURING STS AND ISS MISSIONS

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(Original Research)

INTRODUCTION: Inconsistent definitions of space motion sickness (SMS) across studies have muddied epidemiological descriptions of this operationally relevant condition. The cause of SMS also remains unclear, though some have suspected altered vestibular stimuli. We performed the largest-yet cohort study in US spaceflight operations to produce an updated estimate of SMS incidence and examine potential risk factors: spaceflight experience (naïve vs. non-naïve), launch vehicle (Shuttle vs. Soyuz), age (>50 vs. <50), and sex (male vs. female). **METHODS:** We generated a revised set of SMS symptom criteria based on pertinent literature review: "At least one primary symptom within 72 hours after microgravity exposure: stomach awareness, nausea, vomiting, malaise, anorexia, irritability, or loss of initiative. Dizziness, sweating, flushing, or pallor may accompany any primary symptoms. Coincident diarrhea excludes an SMS diagnosis." Records from Shuttle (STS) and International Space Station (ISS) missions, including crew debriefs, private medical conference (PMC) notes, and Space Medicine Operations Team (SMOT) notes, were coded by NASA Lifetime Surveillance of Astronaut Health (LSAH) for crew-reported symptoms and subjected to clinical text extraction (CTE) for SMS symptoms. The resulting data encompassed US crewmember missions from the STS program (1981-2011, n=644) and ISS Expeditions 1-62 (2000-2020, n=71), with exceptions like payload specialists. We coded each de-identified crewmember mission "Yes," "No," or "Ambiguous" for presence of SMS according to our symptom criteria, calculated overall SMS incidence, and determined relative and absolute risk for each variable of interest. **RESULTS:** Our investigation revealed that 61-66% of US crewmember missions developed SMS. Spaceflight naïve status ($P < 0.0001$), age <50 ($P < 0.05$), and Shuttle launch ($P < 0.01$) were positively associated with SMS. Sex showed no significant association. **DISCUSSION:** We confirmed that most astronauts experience SMS and identified risk factors that may support the vestibular hypothesis of SMS; non-naïve crew may be desensitized to the vestibular stimuli of microgravity, while the relative freedom of head movement in Shuttle over Soyuz vehicles may intensify such stimuli. Future studies can utilize our revised diagnostic criteria and findings to clarify pathophysiology or test mitigation techniques, which will likely prove indispensable for upcoming micro- and low-gravity expeditions.

Learning Objectives

1. Identify symptoms and objective measures of severity that are best included and excluded in a definition of space motion sickness.
2. Name risk factors that have and have not correlated with space motion sickness.

[459] PREDICTING PROCEDURAL NEEDS FOR CIVILIAN SPACEFLIGHT MISSIONS

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(Original Research)

INTRODUCTION: Previously, as NASA screened astronauts, every candidate had undergone extensive medical examinations to ensure minimal potential for medical impacts on a mission. However, this will change as the commercial spaceflight industry grows and a more diverse population of individuals will journey into space. This study was designed to assess the surgical risk of different commercial mission profiles based on public health data standardized to the current commercial astronaut age demographic. **METHODS:** We collected demographic age data for commercial spaceflight participants from publicly available sources. We then utilized public data from the Healthcare Cost & Utilization Project (HCUP) for 2016-2019 to identify the incidence of different inpatient surgical operations based on total discharges. These rates were then standardized to the commercial astronaut age demographic. We assessed the frequency of emergent surgical events for two mission profiles: short-duration missions, e.g. the proposed VAST space station visits, and long-duration potential Mars missions, e.g. the SpaceX Starship missions. **RESULTS:** Demographic data for 53 civilian astronauts was collected. Mean age was 53.9 ± 17.4. 115 different procedures surpass 1% risk for long duration missions. The top 10 surgeries and their modeled risk for short and long duration missions were found to be knee arthroplasty (0.069%, 63.1%), hip arthroplasty (0.052%, 47.3%), Cesarean section (0.050%, 45.4%), spine fusion (0.036%, 32.1%), percutaneous coronary interventions (0.035%, 32.0%), cholecystectomy (0.021%, 19.1%), femur fixation (0.020%, 18.6%), colectomy (0.019%, 17.5%), coronary artery bypass grafts (0.015%, 13.4%), and arthroplasty of other joints (excl. knee/hip) (0.013%, 11.8%). **DISCUSSION:** We found that overall surgical risk for short duration commercial missions is low. However, long duration missions increase the risk of surgical need. Limiting the person-years with crew size or mission duration can help adjust surgical risk. National data may overestimate the risks due to the healthy worker effect. Many of these operations would not be currently possible due to launch limitations and current technology. Evaluating surgeries with >1% risk on long duration missions, preparation for trauma, abdominal emergencies, and soft tissue procedures should be included when designing commercial medical systems. Further studies will prioritize space-relevant emergencies.

Learning Objectives

1. To teach the audience the importance of anticipating an evolving landscape of astronaut demographics.
2. To show the audience how we approached modeling the risk of procedural events by employing national health data.

[460] HARD VACUUM CHAMBER TESTING OF COMMON MEDICATIONS IN SPACEFLIGHT

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(Original Research)

INTRODUCTION: The effect of spaceflight on medication integrity has long been a subject of investigation. The effects of radiation, vibration, humidity variation, and packaging on physical and chemical stability of pharmacologic compounds have been assessed. Hard

vacuum testing of medications has been limited. When depressurization scenarios are considered, it becomes important to know what might happen to medications under these conditions in the event their use is required following vacuum exposure. **METHODS:** Twenty medications commonly supplied for spaceflight (e.g. acetaminophen, promethazine) were subjected to vacuum chamber testing within spaceflight packaging and storage bags at ambient temperatures and 0 C. Medication mass was determined before and after exposure to vacuum. Eight of the medications underwent mass spectrometry to determine if chemical signatures were altered by vacuum exposure. **RESULTS:** No gross physical changes were noted in any of the medications. The spaceflight packaging remained intact. The lowest temperatures were experienced inside the storage bags and the pressure stalled at 8.2e-3 and 6.0e-3 torr in the ambient temperature/0 C chambers, respectively; a finding attributed to endothermic off-gassing from packaging materials. There were no significant differences in the masses of 20 medications following exposure. There were also no differences in the mass spectrometry signatures of 8 medications following exposure. **DISCUSSION:** These results indicate that common medications used in spaceflight are stable in regards to mass and mass spectrometry signatures when exposed to hard vacuum. This is important when considering the possibility of medication use following a full cabin depressurization or if considering the use of a medical kit within an airlock. An area of future research involves the potential off-gassing of packaging materials when exposed to vacuum and how this might affect medication integrity over time. This study is limited by relatively small sample sizes and statistical power in addition to the inability to reach the goal pressure of 10^{-4} torr within the vacuum chambers.

Learning Objectives

1. There is no significant change in mass or mass spectrometric signatures of commonly used medications in spaceflight when exposed to near vacuum conditions.
2. Medications may be exposed to off-gassing from packaging or bags in vacuum.

[461] DEMOGRAPHIC DIFFERENCES AND IMPLICATIONS FOR HEALTH IN COMMERCIAL SPACEFLIGHT PARTICIPANTS COMPARED TO NASA ASTRONAUTS

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(Original Research)

INTRODUCTION: As the commercial spaceflight industry evolves, we should investigate potential differences in the diverse civilian population compared to NASA astronauts. With more civilians flying, in-flight medical risks may begin to trend toward standard population health risks. Our purpose was to compare the two populations and assess potential future commercial crew health risks. **METHODS:** We collected demographic data for both NASA astronauts and commercial spaceflight participants from publicly available sources. We then employed a t-test to assess differences in age and a chi-squared test to assess differences in sex. Next, we utilized public data from the Healthcare Cost & Utilization Project (HCUP) for 2016-2019 to identify the incidence rates of all diagnoses of emergency rooms visits in the US. These rates were standardized to the current commercial astronaut age demographic. The frequency of events for two mission profiles was assessed: short-duration missions akin to planned VAST space station visits and long-duration Mars missions modeled after SpaceX Starship missions. **RESULTS:** Mean age of civilian astronauts was 53.9 ± 17.4 years-old and 43.7 ± 6.3 years-old for NASA astronauts ($p<0.01$). Male to female ratios were not statistically significantly different. The most common diagnoses and their modeled risk on short and long duration missions were: nonspecific chest pain (0.713%; 659%), UTI (0.425%; 769%), superficial injury (0.484%; 734%), abdominal pain (0.672%;722%), septicemia (0.310%, 652%), MSK pain (0.514%; 613%), heart failure (0.203%; 556%), sprains/strains (0.468%; 468%), respiratory symptoms (0.274%; 410%), skin infections (0.345%; 406%). **DISCUSSION:** We found that the current NASA astronauts are significantly younger than civilian astronauts whereas civilian astronauts have a greater age range. Modeling this population's health risk suggests short duration missions are low risk for medical emergencies. However, for long duration missions we should prepare for injuries, infections, and cardiovascular events. Mission designers can limit risk by adjusting crew size and duration. Modeling commercial astronaut risk with standard population health data may help in the design and implementation of inclusive healthcare strategies that ensure the safety and well-being of all space travelers. Future studies will further stratify based on ICD-10 codes.

Learning Objectives

1. To teach the audience the importance of anticipating an evolving landscape of astronaut demographics.
2. To show the audience how we approached modeling the risk of medical events in-flight by employing national health data.

[462] CHRONOBIOLOGY OF GALACTIC COSMIC RAY EXPOSURE: ROLE OF CIRCADIAN RHYTHMS IN DNA DAMAGE RESPONSES, CARCINOGENESIS, AND COUNTERMEASURES FOR SPACEFLIGHT

Nicolas Nelson
UCLA, Los Angeles, CA, United States

WITHDRAWN

[463] OBJECTIVE MEASUREMENT OF EUSTACHIAN TUBE DYSFUNCTION TO DECREASE BAROTRAUMA RISK

Milad Dulloo[1], Martin Robinette[2]
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(Education - Program/Process Review)

INTRODUCTION: Astronauts experience pressure fluctuations while diving, flying and during extra-vehicular activities (EVA). These activities require an ability to equalize the middle ear (ME). The Eustachian tube's (ET) function is ventilating the ME to balance pressures with the ambient atmosphere. Eustachian Tube Dysfunction (ETD) is impaired ventilatory function of the middle ear. It is divided in three subtypes, dilatory (non-opening), baro-challenge induced and patulous (abnormally open). ETD increases the risk of barotrauma which can impact the crewmember's health and mission. ET function varies between individuals and different times due to intrinsic and extrinsic factors. Microgravity and cephalic fluid shift may favor ETD via nasal congestion and swelling of nasopharyngeal tissue. An objective tool to assess the risk of ETD is needed. We propose ETD screening using tympanometry to identify crewmembers with high-risk of barotrauma, ensuring astronauts safety during training and missions. **METHODS:** The physiopathology and etiology of ETD were reviewed. Existing diagnostic tools were evaluated for efficiency and ease of use in a preventive setting. We identified adequate tympanometry tests for screening and defined pass and fail criteria. Three protocols assessing ETD risk pre-dive, pre-flight and pre-EVA were established. Tympanometry data from 28 astronauts was extracted and analyzed to identify current trends. **RESULTS:** Tympanometry is an optimal tool to assess ET ventilatory function. Three relevant tests were identified as well as criteria for screening ETD risk. Resting ME pressure test is an effective tool pre-EVA and pre-flight. The post-deflation test is a reliable to identify high-risk pre-flight. Post-Valsalva and Nine-Step tests are useful pre-dive. Current astronaut data shows a significant number of measures in the high-risk range. Majority of crew is within low-risk range, but several others are in the higher risk. **DISCUSSION:** Data suggest a significant proportion of crewmembers have increased risk. Protocols for pre-dive, pre-flight and pre-EVA screening are recommended to reduce the risk of barotrauma and mission failure. Further research is needed to collect objective data and evaluate risk parameters.

Learning Objectives
1. Function of the ET, and barotrauma risk associated with its dysfunction.
2. Risks of barotrauma in NASA activities and recommendations for preventive risk assessment.

[464] EXPERIMENTAL DESIGN FOR RADIONUCLIDE X-RAY IMAGING IN SPACEFLIGHT

Tejal Gala[1], John Choi[2], Saif Azam[2], Matthew Hartman[2], Max Raynor[2], Scott Fraser[2]
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(Original Research)

INTRODUCTION: Long-term manned spaceflight, such as to Mars, will require inflight medicine, including inflight diagnostic space radiology. Currently, ultrasound is the only imaging modality available inflight, but technical factors limit evaluation through bone or gas, such as for intracranial, pulmonary, or gastrointestinal pathologies. For this reason, X-ray based imaging is necessary, but it has not been utilized due to limited onboard spacecraft resources, such as power. We propose a radionuclide X-ray source to reduce the power requirement, coupled with a digital camera in contrast to prior demonstrations using X-ray film, as an ideal experimental platform for a flight demonstration. **METHODS:** Commercially available exempt quantity radionuclides were coupled with a digital camera using a phosphor screen to convert X-rays to visible photons. The experimental apparatus was built using commercially available lens tube parts connected to the camera via the lens mount. Image subjects included tungsten foil and a tissue sample (cooked meat). Different sources and imaging conditions were examined. **RESULTS:** Three radionuclides were evaluated: Barium-133, Cadmium-109, and Cesium-137. Different amounts of contrast were demonstrated and correlated with the emission spectrum of each radionuclide. Imaging parameters were adjusted to optimize exposure. Optimal exposure time for the tungsten sample was approximately 15 minutes for all three sources but varied for the tissue sample: 15 minutes for Cesium, 10 minutes for Cadmium, and 5 minutes for Barium. **DISCUSSION:** The study demonstrated that it is possible to create a compact, lightweight, low-power, radionuclide-based X-ray imaging system that could be used in a flight demonstration. Further work is required to optimize the images, such as uniformity correction due to the low photon flux levels and short distance from source to sample. While the images obtained are far from clinical diagnostic quality, they are radiographs and demonstrate a feasible path to a flight instrument. In addition to diagnostic space radiology, inflight X-ray imaging is expected to enable minimally invasive interventional procedures, as well as cross-sectional imaging of humans in space for scientific purposes.

Learning Objectives
1. Understand the components of an X-ray imaging system and how to utilize a phosphor screen and radionuclide to create a compact, low-power experimental platform for a flight experiment.
2. Understand the criteria used to evaluate a radionuclide for X-ray imaging.

[465] USING A HUMAN SYSTEM FAILURE MODEL AS AN ALTERNATIVE APPROACH TO MEDICAL PLANNING FOR HUMAN SPACE EXPLORATION MEDICAL SYSTEMS

Muska Miller[1], Veronika Puisa[1], Thomas G. Smith[1], Peter Hodkinson[1], Sergi Vaquer[2]
[1]*King's College London, London, United Kingdom;* [2]*ESA, Cologne, Germany*

(Education - Tutorial/Review)

INTRODUCTION: Human exploration missions e.g. the Lunar Gateway require capabilities necessary to sustain crew life for up to 60 days. Identification of medical risks to inform development of appropriate medical kits has traditionally been an important activity for mission planners and spacecraft design engineers because resources and space are so limited and naturally require prioritization. Traditional medical planning approaches have been based on specific knowledge of environmental hazards e.g. microgravity, radiation, isolation and confinement, and anticipated medical risks. These probabilistic approaches take input on the likelihood of occurrence of medical issues based on e.g. past spaceflight experience and terrestrial analogues to generate medical kits able to respond to predicted medical issues. Alongside these well founded and proven approaches, the European Space Agency (ESA) is keen to explore alternatives that will complement these methodologies by providing a parallel way of thinking. ESA is specifically exploring an approach based on human system failures. **TOPIC:** This alternative approach to medical planning will be presented that explores the common pathways of human system failures (e.g. cardiovascular, respiratory, neurological etc), and the application to spaceflight. This includes how these might occur, the threat they may pose to life or mission, and, the associated diagnostic and treatment commonalities, to generate the medical kit list. These medical kits can then be compared with and tested against those generated from the probabilistic models. By merging the approaches along with expert input, the aim is to provide an opportunity to continue the evolution and improvement in medical planning and kits for exploration missions. **APPLICATION:** Using this human system failure model, life-threatening and non-life-threatening failure modes were identified, along with specific diagnostic tools and management therapies. This information was used to identify common elements to inform the development of a medical emergency kit equipped to treat the diversity of human failure modes, which is irrespective of the underlying diagnosis. The proposed medical kit has been evaluated by healthcare professionals across a range of specialties, including those with pre-hospital experience. Follow up work will include assessment in an analogue environment to test its efficacy and help identify areas for improvement.

Learning Objectives
1. Traditional medical planning approaches are probabilistic and use past spaceflight experience and terrestrial analogues to generate medical kits to respond to predicted medical issues.
2. Human system failures, how these might occur and the threat posed to life or mission, may be used as a complementary method when generating medical kits for spaceflight.

Thursday, 05/09/2024 ***1:30 PM***
Grand Ballroom A

[S-79]: PANEL: WHERE ARE WE WITH WHITE MATTER AND HYPOBARIA? LATEST RESEARCH AND OUTCOME OF NATO COLLABORATION

Chair: Desmond Connolly
Co-Chairs: Joan Saary, Paul Sherman

PANEL OVERVIEW: *An association between excess subcortical white matter hyperintensities (WMH) and non-hypoxic hypobaria was first reported over a decade ago. NATO Research Technology Group 274 (RTG 274) convened in 2016 to provide a focus for research collaboration and information exchange regarding risks of hypobaric exposure, with emphasis on pathophysiology of WMH. The panel will summarise the latest international research and conclusions of RTG 274 in its recent final report. First, the US research over the last decade will be reviewed, with emphasis on U-2 pilot white matter health, tract integrity (fractional anisotropy) and cognitive performance, and WMH burden in aerospace operational physiologists. A miniature swine model suggests arrest of myelination but possible neuroprotective (anti-oxidant/anti-inflammatory) benefit of atorvastatin. Next, two UK presentations will detail acute human pathophysiological responses to*

severe decompression stress (simulated high altitude parachutist despatch). Besides systemic pro-inflammatory responses, blood biomarkers of brain and lung insult indicate abrupt neuro-inflammatory responses with subsequent neurotrophic changes evident the next day. Acute magnetic resonance imaging (MRI), the day after hypobaric exposure, indicates altered subcortical white matter neurometabolite concentrations indicating loss of neuroprotection, while appearance of lactate and upregulation of white matter blood flow imply preceding microvascular insult. Following on, recent research involving Royal Canadian Air Force fast jet pilots will be presented, encompassing prevalence and volumetric analysis of WMH, blood biomarkers, and neurocognitive evaluation. WMH burden is significantly elevated in fast jet pilots relative to age-matched controls, while regular occupational exposure to non-hypoxic hypobaria may promote ongoing low-grade systemic inflammation with evidence of chronically increased oxidative stress. International evidence supports neuroinflammatory changes in response to hyperoxic decompression, possibly associated with underlying microvascular dysfunction and oxidative stress. Finally, the audience will be updated with the most recent US research into persistent cerebral blood flow responses after hypobaric hypoxia training. Further work will be required to elucidate the neuropathological processes associated with the development of white matter change, appropriate exposure thresholds and effective pharmaceutical interventions.

[466] REVIEW OF THE EFFECTS OF EXTREME HYPOBARIC ENVIRONMENTS UPON THE BRAIN IN AVIATORS AND HIGH-ALTITUDE SPECIAL OPERATORS IN THE PAST DECADE

Paul Sherman

Defense Health Agency/59th Medical Wing, Joint Base San Antonio-Lackland, TX, United States

(Original Research)

INTRODUCTION: NATO HFM ET-138 (2015) followed by HFM RTG-274 (2016-2023) addressed the effects of high altitude upon the brain in pilots and special operators. The last decade of human and swine research of RTG-274 will be reviewed. **METHODS:** Review of the 16 published manuscripts, recently completed research, and the final report of RTG-274, encompassing both human and swine studies. **RESULTS:** There are both transient and permanent changes in the brain secondary to acute and chronic-repetitive hypobaric exposure. U2 pilots demonstrate increased white matter hyperintensities (WMH), global decrease in white matter integrity as measured by magnetic resonance imaing (MRI) fractional anisotropy (FA), and mild neurocognitive deficits (microcognitive testing) compared to age-matched pilot controls. Post cabin altitude reduction effort (CARE) longitudinal MRI evaluation of U2 pilots every three years has shown no significant change in WMHs from initial brain MRI upon entering the U-2 assignment. Single exposure to high altitude (hypobaric chamber training) demonstrates an approximately 5-6% increase in cerebral blood flow (CBF) to whole brain white matter that persists for 72 hours. Repeated high-altitude exposure (6-12 flights) in teenage equivalent swine (Sinclair minipigs, age determined by weight requirements to fit in the MRI coil) results in transient metabolite changes as measured by MR Spectroscopy and an arrest in myelination (global decreased FA) compared to control animals. Subsequent swine high altitude exposure with and without Atorvastatin (a flying waiver approved statin with antioxidant/anti-inflammatory properties) demonstrated significant differential expression of mRNA suggesting potential neuroprotective effects. **CONCLUSION:** The hypobaric exposure environment will remain an essential domain for NATO operations. Unanimous concern for understanding the pathophysiology of hypobaric exposure related brain injury in our aircrew and special operations personnel remains. Further study is required and is underway, with the aim of finding potential mitigators of altitude related "brain stress."

Learning Objectives

1. Understand the current body of research related to transient and permanent brain injury related to hypobaric exposure operations, results of the NATO HFM RTG-274.
2. Understand the current neuropathophysiological hypotheses related to high-altitude brain injury.

[467] BRAIN BIOMARKER RESPONSES TO NON-HYPOXIC HYPOBARIA

Desmond Connolly[1], Leigh Madden[2]

[1]*QinetiQ plc, Farnborough, United Kingdom;* [2]*University of Hull, Hull, United Kingdom*

(Original Research)

INTRODUCTION: Laboratory evaluation of decompression sickness (DCS) risk with repeat exposure to 25,000 ft pressure altitude enabled investigation of brain biomarker responses to non-hypoxic decompression stress. Targets included markers of neuroinflammation, neural injury, repair and degeneration, and blood-brain barrier integrity. **METHODS:** Fifteen healthy men (20 to 50 yrs) undertook consecutive hypobaric chamber ascents to 25,000 ft pressure altitude, breathing 100% oxygen. Venous plasma and serum samples, collected at baseline (T0), following ascent two (T8) and next day (T24), indicated a systemic pro-inflammatory response with levels of glial fibrillary acidic protein (GFAP) increasing by 10% over baseline at T24 ($P = 0.015$). Residual sample material allowed selected follow-on brain and lung biomarker assays using enzyme-linked immunosorbent assay (ELISA) for soluble proteins and flow cytometry for microparticles (MPs). **RESULTS:** Biomarkers of brain injury (neurofilament light; ubiquitin carboxy-terminal hydrolase L1), neurodegeneration (tau protein), oxidative stress (brain creatine kinase) and alveolar injury (CD324 and CD326 MPs) were unremarkable. At T8, monocyte chemoattractant protein-1 (MCP-1) levels rose by 36% ($P = 0.005$) and high mobility group box protein 1 (HMGB1) by 16% ($P = 0.046$), both normalising at T24. Brain-derived neurotrophic factor (BDNF) was elevated by 80% ($P = 0.029$) at T24. Soluble receptor for advanced glycation end products (RAGE) fell by 8% at T8 before normalising ($P = 0.032$). Mean HMGB1/RAGE ratio increased by ~30% at T8 ($P < 0.01$). Post-exposure monocyte counts increased 37% and CD14 (monocyte-derived) MPs were elevated disproportionately ($P = 0.032$). **DISCUSSION:** Post-exposure elevation of MCP-1 and HMGB1 support an acute neuroinflammatory response, with increased GFAP and BDNF indicating trophic responses to glial stress at T24. Increased circulating monocytes, elevated CD14 MPs, and raised MCP suggest a key role for monocytes in mediating the neuroinflammatory response. These data are consistent with subcortical microvascular insult and reports of macrophage accumulation in areas of acutely inflamed white matter microvasculature stressed during decompression. Additionally, monocyte activation and stimulation of the HMGB1-RAGE axis will both generate interleukin-6 and may contribute to the systemic pro-inflammatory response reported previously.

Learning Objectives

1. Understand the acute brain biomarker responses that suggest a neuroinflammatory response to hyperoxic decompression stress.
2. Understand the brain biomarker responses that suggest a neurotrophic (repair) response following hyperoxic hypobaria, implying recovery from glial (white matter) insult.

[468] ACUTE RESPONSES TO NON-HYPOXIC HYPOBARIA ON BRAIN MAGNETIC RESONANCE IMAGING

Desmond Connolly[1], Indran Davagnanam[2]

[1]*QinetiQ plc, Farnborough, United Kingdom;* [2]*University College London, London, United Kingdom*

(Original Research)

INTRODUCTION: Investigation of decompression sickness (DCS) risk with repeated (same-day) exposure allowed evaluation of acute brain magnetic resonance imaging (MRI) indicators of neurological stress in response to non-hypoxic hypobaria. Brain MRI sequences evaluated subcortical white matter (WM) integrity, WM tract diffusivity, cerebral blood flow and neurometabolite concentrations. **METHODS:** Six healthy men (20 to 50 yrs) undertook three ascents, each lasting two hours, to a

maximum 25,000 ft pressure altitude, breathing 100% oxygen throughout. Consecutive ascents followed an hour at ground level breathing air. Brain MRI sequences conducted on the days preceding and following decompression encompassed: diffusion-weighted imaging (DWI) to exclude subcortical micro-infarcts, ischaemia and oedema; diffusion tensor imaging (DTI) for WM tract integrity (fractional anisotropy, FA); arterial spin labelling (ASL) for global grey matter (GM) and WM blood flow; and magnetic resonance spectroscopy for neurometabolite concentrations in parietal subcortical WM, GM (putamen) and cerebellum. **RESULTS:** Post-exposure DWI imagery remained normal, with no subcortical micro-infarcts, ischaemia or oedema. FA was unaffected with near identical pre- and post-exposure profiles in all individuals and the cohort as a whole. In subcortical WM, post-exposure levels of γ-amino butyric acid (GABA) and glutathione fell by 19% ($P = 0.021$) and 27% ($P = 0.049$) respectively, whilst lactate increased in five participants. Neurometabolites in GM and cerebellum were unaffected. Cohort WM blood flow increased and approached the upper limit of MRI estimates, while GM flow was essentially unchanged. **DISCUSSION:** Post-exposure decrements in subcortical GABA and glutathione correlate well ($R^2 = 0.69$, $F(1,4) = 8.82$, $P = 0.041$), suggesting a common origin and loss of neuroprotection. The appearance of lactate implies anaerobic metabolism despite imposition of hyperoxia, possibly from macrophage accumulation in areas of acutely inflamed WM microvasculature stressed during decompression. This is consistent with upregulation of WM flow, which also mitigates and predicts the decrement in glutathione at 24 hours ($R^2 = 0.74$, $F(1,4) = 11.37$, $P = 0.028$). The data provide evidence of acute WM stress following hyperoxic decompression, supporting blood biomarker data, and may help to inform the aetiology of white matter change associated with occupational non-hypoxic hypobaric exposure.

Learning Objectives

1. Understand the influence of hyperoxic decompression stress on subcortical white matter neurometabolite concentrations and how they suggest loss of neuroprotection, oxidative stress and microvascular insult.
2. Understand the cerebral white matter blood flow response to hyperoxic decompression stress and how this influences understanding of microvascular responses to hyperoxia.

[469] FIGHTER PILOTS HAVE ELEVATED WHITE MATTER HYPERINTENSITIES ON MRI – BUT WHY?

Joan Saary[1], Joel Ramirez[2], Christopher Scott[2], Fuqiang Gao[2], Shawn Rhind[3], Oshin Vartanian[3], Gary Gray[4], Shamus Allen[5], Sandra Black[2]

[1]*University of Toronto and Canadian Forces Environmental Medicine Establishment (CFEME), Toronto, ON, Canada;* [2]*Sunnybrook Research Institute, Toronto, ON, Canada;* [3]*Defence Research and Development Canada - Toronto, Toronto, ON, Canada;* [4]*Canadian Forces Environmental Medicine Establishment, Toronto, ON, Canada;* [5]*University of Calgary, Calgary, AB, Canada*

(Original Research)

INTRODUCTION: Contributing to the international research effort to understand the clinical and occupational relevance of white matter hyperintensities (WMH) in aircrew, The Canadian White Matter Hyperintensity study used MRI brain imaging to quantify WMH in Royal Canadian Armed Forces (RCAF) fighter pilots. We previously (2021) presented preliminary results suggesting higher than expected WMH volumes for age. Reanalysis of the now-complete data set supports the hypothesis that fighter pilots have elevated WMH volumes. **METHODS:** After protocol ethical approval by the Research Ethics Boards of Defence Research and Development Canada (DRDC) and Sunnybrook Health Sciences Centre, 42 volunteer pilots with experience flying high performance aircraft and 6 experienced high altitude (non-pilot) parajumpers attended 2 days of testing that included questionnaires on exposure history and known correlates of WMH; physical exam; cognitive testing; blood sampling for peripheral biomarkers; cardiac risk markers; and an agitated saline contrast echo. All underwent brain imaging using a 3 Tesla (T) scanner. Log books provided data on total flight hours and flight hours on specific aircraft types. **RESULTS:** As expected, total WMH volume was significantly correlated with age (r=.48 p<.01). Pilots aged ≤55 had significantly greater WMH volume than age-matched controls (321.9mm^3 vs. 158.6mm^3, p=.005). Jumpers had significantly more WMH burden than pilots (691mm^3 vs. 470mm^3, p=.024), but also had more prior traumatic brain injuries (tbi) (67%) than pilots (40.5%) in whom elevated WMH volume was not tbi-related. In pilots aged ≤55, WMH was elevated occipitally vs controls (122.0 mm^3 vs 37.2mm^3 p=.005) and was correlated with total flight time (r=.411, p<0.05) but not high-performance hours. In the total pilot sample, high-performance time, but not total flight time, was correlated with peri-vascular space volume (r=.352, p< 0.05) but not WMH volume. **DISCUSSION:** Earlier suspicion that WMH burden is elevated in this pilot population is reconfirmed. We continue to examine possible explanatory factors and will discuss our suspicion that a more nuanced examination of flight time on specific aircraft may provide clues to the underlying processes making this population susceptible to increased WMH load. Next steps will also include examining the clinical neurocognitive relevance of these findings.

Learning Objectives

1. The participant will learn about the updated analytics for the Canadian White Matter Hyperintensity Study and the results thereof.
2. The audience will utilize information from the presentation to participate in hypothesis-generating relating to why WMH burden is elevated in fighter pilots.

[470] WARFIGHTER BRAIN HEALTH IN HYPOBARIC ENVIRONMENTS POST NATO HFM RTG-274

Paul Sherman

Defense Health Agency/59th Medical Wing, Joint Base San Antonio-Lackland, TX, United States

(Original Research)

INTRODUCTION: Hypobaric hypoxia (HH) negatively impacts neurocognitive performance. This presentation will address the current human research efforts regarding cerebral blood flow (CBF) changes and swine research efforts to identify drugs and small molecules that can address biomedical impacts of high-altitude flight based on mRNA and miRNA signatures obtained from miniature swine high-altitude models. **METHODS:** A subset of 32 participants from our original study (161 subjects; 96 aircrew trainees, 65 control subjects) and subjected to new analyses. Each subject was exposed to HH at 25,000 ft (7620 m) in altitude chambers by removing their aviator masks for 2-4 minutes. MRI was acquired 24-hr prior to HH and follow-up MRI was conducted 24-hr and 72-hr post-exposure. MRI included pseudo-continuous arterial spin labeling (pcASL) and T1-weighted imaging. Standard space perfusion maps were compared with baseline maps in a VA fashion using paired t-tests. We utilized ARDIS cloud computing for construction and remixing of knowledge graphs (KG) targeted for drug repurposing and application of modern machine learning algorithms to generate a ranked list of relevant small molecules. We utilized a graph machine learning model to predict drug – miRNA interactions and developed a visualization component that displays nodes of interest and their relationships in the KG. **RESULTS:** There were significant increases from baseline CBF at both the 24-hr and 72-hr post-exposure scans in the midline, putamen, and near Sylvian/peripheral arteries. The effect is variable across individuals, with some perfusion changes approaching 10% which persist for 3 days after a single hypoxic exposure. 36 links were predicted between drugs and any of differentially expressed swine genes and human homologs in high-altitude conditions. Classes of the 36 identified drugs included statins, MG-CoA reductase inhibitors, anti-cancer/neoplastic drugs, and anti-infective drugs. **DISCUSSION:** Analysis indicates the increased WM CBF effects specific regions of the brain, demonstrating the importance of both global (ROI) assessments of CBF as well as VA to detect altered CBF following HH, enhancing our understanding of cerebral hemodynamics

associated with HH. The next steps to validate drug predictions will be in vitro/in vivo studies with identified small molecules or retrospective analysis of clinical data sets to confirm therapeutic effects.

Learning Objectives

1. Understand the need for additional research regarding the neuropathophysiology of brain injury related to repeated hypobaric exposure.
2. Understand research lines of effort in progress to mitigate the effects of high altitude exposure upon the brain.

Thursday, 05/09/2024 ***1:30 PM***
Grand Ballroom B

[S-80]: PANEL: ASAMS AEROSPACE MEDICINE 2024 BOARD REVIEW PANEL

Chair: Jeffrey Jones
Co-Chairs: Dwight Holland, Jim Elliott

PANEL OVERVIEW: *To assist American Society of Aeromedical Specialists members in preparing for initial or periodic written examinations for those educated on the topics defined by the American College of Preventive Medicine GME requirements and wishing to become certified or re-certified under the American Board of Preventive Medicine; and to provide education on relevant topics for those interested in Aerospace and Preventive Medicine, the ASAMS education committee assembles topics for review by knowledgeable invited experts in the field. TOPICs: Introduction to the Aerospace Medicine Board Exam Aerospace Physiology Alcohol/Fatigue, Situation Awareness, and Human Factors Analysis and Classification System ('HFACS') Flight Environment Example Test Questions APPLICATION: The knowledge gained in this panel can be applied by the attendee to preparation for the knowledge examination in both the preventive medicine core and the aerospace medicine specialty examination. Others considering potential involvement in clinical Aerospace Medicine or aerospace medicine relevant research may find the review topics interesting and educational. Preventive Medicine Core Content Outline: 25% - I. Clinical Preventive Medicine 25% - II. Public Health/Population Health Medicine Knowledge 20% - III. Epidemiology, Biostatistics, and Informatics Knowledge 15% - IV. Environmental Medicine 15% - V. Strategic Healthcare Leadership Knowledge Aerospace Medicine Content Outline: 40% - The Flight Environment 30% - Clinical Aerospace Medicine 20% - Operational Aerospace Medicine 10% - Management and Administration*

[471] ASAMS AEROSPACE MEDICINE 2024 BOARD REVIEW PANEL

Jeff Jones[1], Thomas Jarnot[2], James Elliot[3], Dwight Holland[4], Joseph Novak[5]
[1]*Baylor College of Medicine, Houston, TX, United States;* [2]*Civilian U.S. Air Force Materiel Command, USAFSAM/FEEG, Dayton, OH, United States;* [3]*FAA, Fort Worth, TX, United States;* [4]*Aerospace Consulting, Roanoke, VA, United States;* [5]*U.S. Air Force, Dayton, OH, United States*

(Education - Tutorial/Review)

INTRODUCTION: To assist American Society of Aeromedical Specialists members in preparing for initial or periodic written examinations for those educated on the topics defined by the American College of Preventive Medicine GME requirements and wishing to become certified or re-certified under the American Board of Preventive Medicine; and to provide education on relevant topics for those interested in Aerospace and Preventive Medicine, the ASAMS education committee assembles topics for review by knowledgeable invited experts in the field. **TOPICs:** Introduction to the Aerospace Medicine Board Exam

Aerospace Physiology

Alcohol/Fatigue, Situation Awareness, and Human Factors Analysis and Classification System ('HFACS')

Flight Environment

Example Test Questions

APPLICATION: The knowledge gained in this panel can be applied by the attendee to preparation for the knowledge examination in both the preventive medicine core and the aerospace medicine specialty examination. Others considering potential involvement in clinical Aerospace Medicine or aerospace medicine relevant research may find the review topics interesting and educational.

Preventive Medicine Core Content Outline:

25% - I. Clinical Preventive Medicine
25% - II. Public Health/Population Health Medicine Knowledge
20% - III. Epidemiology, Biostatistics, and Informatics Knowledge
15% - IV. Environmental Medicine
15% - V. Strategic Healthcare Leadership Knowledge

Aerospace Medicine Content Outline:

40% - The Flight Environment
30% - Clinical Aerospace Medicine
20% - Operational Aerospace Medicine
10% - Management and Administration

RESOURCES: American Board of Preventive Medicine – American Board of Preventive Medicine – The American Board of Preventive Medicine was established to promote the health and safety of the American people through our high standards in the certification and maintenance of certification in the profession of preventive health. (theabpm.org)

American College of Preventive Medicine- American College of Preventive Medicine | ACPM

Learning Objectives

1. To improve the understanding of human factors involved in the operation of aviation and space vehicles, and the key elements of the human-machine interface which can affect both operability and performance, e.g. Alcohol/Fatigue, and Situation Awareness; plus explanation of the Human Factors Analysis and Classification System ('HFACS').
2. To familiarize the audience with an understanding of key principles of aerospace physiology and the impact of the dynamics on the vehicle/aircraft flight crew.
3. To outline the important elements of the flight environment which influence flight dynamics and affect human health and crew performance.

Thursday, 05/09/2024 ***1:30 PM***
Grand Hall J

[S-81]: SLIDES: AEROSPACE MEDICINE RESEARCH

Chair: Joanna Nelms
Co-Chair: Steven Roy

[472] AEROSPACE MEDICINE EDUCATION AT A COMMERCIAL SPACE COMPANY

Isaiah Reeves[1], John Marshall[2]
[1]*UTMB, Galveston, TX, United States;* [2]*Hercules Medical Group, LLC, Houston, TX, United States*

(Education - Program/Process Review)

BACKGROUND: The growing field of commercial human spaceflight includes novel considerations for the aerospace medicine specialist. These include the aeromedical evaluation of individuals from diverse backgrounds and with a wide array of medical conditions, as well as understanding key stakeholders and operational goals of the commercial spaceflight company. With this in mind, aerospace medicine resident education through commercial space companies provide broad benefit to future flight surgeons and aerospace medicine specialists. **OVERVIEW:** University of Texas Medical Branch aerospace medicine residents have

opportunities to rotate at Axiom Space and complete projects under the guidance of an Axiom flight surgeon. One particular experience involved leveraging preventive medicine principles in the evaluation and analysis of current infectious disease and public health threats as part of a developing pre-launch health stabilization program. The experience involved data-gathering and stakeholder analysis including considerations for participation of commercial spaceflight to the International Space Station, as well as considering future implications for end-to-end commercial missions. **DISCUSSION:** This learning opportunity highlighted some of the unique considerations of the conduct of human spaceflight and aerospace medicine as part of a commercial space company. By contributing directly to discussion and development of a knowledge base and program at the commercial company, this experience not only provided real-time benefit to the company but also gave essential exposure to the duties of commercial space flight surgeons and thus increased future competence.

Learning Objectives

1. The participant will understand the expanded and specific learning opportunities possible for aerospace medicine residents at commercial space companies.
2. The participant will understand the importance of integrated aerospace medicine resident education at commercial space companies for future employee competence.
3. The participant will understand the mutual benefits for aerospace medicine resident and commercial space companies when commercial space companies integrate supervised and mentored aerospace medicine education.

[473] OPERATIONALLY-FOCUSED AEROMEDICAL RISK MANAGEMENT FRAMEWORK: A NEW ERA IN RISK MANAGEMENT FOR RAAF.

Adrian Smith, Riannon Quemard
RAAF Institute of Aviation Medicine, Adelaide, Australia

(Education - Program/Process Review)

BACKGROUND: The health of aircrew and controllers is an integral component of aviation safety. The traditional role of the Institute of Aviation Medicine (IAM) was to restrict crewmembers believed to pose an unacceptable risk to aviation safety. However, this was conducted using a framework and language unfamiliar to Commanders. As Defence pivoted towards a balanced Command-acceptance of risk, the traditional model was seen as conservative, risk-averse, and overly-restrictive, and there was a drive for aeromedical risk to align with the management of other risks. **OVERVIEW**: This presentation outlines the process adopted by IAM to assess the likelihood of an aeromedical event occurring during aviation-related duty and result in an adverse outcome, and the controls to eliminate or minimise the aeromedical hazard in a shared model to inform Command-acceptance of risk. **DISCUSSION**: Australian Work Health and Safety (WHS) legislation imposes a duty of care on Chief of Defence Force to ensure the health and safety of workers. Commanders have a responsibility to be informed of the risks and all possible controls associated with any hazards, and if it is not reasonably practicable to eliminate the hazard, to ensure the risks are minimised so far as reasonably practicable. The Australian Defence Force (ADF) has adopted the Seven Step Risk Process (7SRP) as the basis for a harmonised risk management process. IAM has adopted the 7SRP as the basis of the novel Operationally-Focussed Aeromedical Risk Management framework (OFARM) to communicate aeromedical hazards in a manner that complements the approach to other risks potentially impacting aviation safety. The assessment of likelihood and consequences arising from an aeromedical event are shared between the aeromedical advisor, domain experts, and Commanders. Commanders have final authority regarding authorisation of personnel to perform aviation-related duties, with the aeromedical advisor responsible to ensure they have been informed of the hazards and credible adverse outcomes, and that all possible controls have been considered. A Risk Decision Brief documents the basis for this decision process. The OFARM is a significant evolution in aeromedical risk management. By aligning aeromedical risks with other aviation-related risks, aeromedical risks can be communicated in a format Commanders are familiar with, leading to better engagement between aeromedical and operational domains.

Learning Objectives

1. The audience will learn about the novel approach developed by RAAF IAM to assess and manage aeromedical risk in line with the 7 Step Risk Process.
2. The audience will understand the difference between traditional model of aeromedical risk management and contemporary risk-management where risk acceptance is a command responsibility rather than a medical responsibility.

[474] DISCUSSION OF HIV DISCLOSURE PROCESS AND RELATED POLICY

Robert Barbera
USAFSAM, San Antonio, TX, United States

WITHDRAWN

[475] REVIEW OF THE NATURAL HISTORY OF RENAL STONES IN U.S. ASTRONAUTS

Clare McNerlin[1], Sara Mason[2], David Reyes[3]
[1]*Georgetown University, Washington, DC, United States;* [2]*KBR, Houston, TX, United States;* [3]*NASA JSC, Houston, TX, United States*

WITHDRAWN

[476] EVOLUTION OF SPACEFLIGHT RENAL STONE RISKS AND UPDATE TO THE NASA RENAL STONE EVIDENCE REPORT AND INTEGRATED CONCEPT OF OPERATIONS

Emily Stratton[1], David Reyes[2], Richard Cole[1]
[1]*UTMB, Galveston, TX, United States;* [2]*NASA JSC, Houston, TX, United States*

WITHDRAWN

[477] FLIGHT MEDICINE FOR ALL SERVICES - A GUIDE TO ONE OFFS

Michael Yue
U.S. Navy, Patuxent River, MD, United States

(Education - Case Study)

Flight medicine plays a critical role in ensuring the physical fitness and operational readiness of military personnel across various services and nations. The diverse landscape of military services and international collaboration necessitates a wide breadth of understanding of different approaches to flight medicine. This presentation seeks to bridge the gap and provide insights into the unique requirements and considerations when conducting flight physicals and operational medicine for personnel from various military branches and nations. This abstract presents a guide for conducting flight physicals and operational medicine assessments for individuals from different branches of the military, including the US Navy, Army, Air Force, Coast Guard, and Marines. It also explores general guidelines for US military Flight Surgeons when working with patients from other countries. It should also serve as a reference for medical personnel serving in remote locations who will inevitably end up serving aircrew from different services and countries. Through a series of case studies, we highlight the challenges and best practices in providing flight medical services to a diverse military population.

Case Studies:

1. US Navy and US Marine Corps
2. US Army
3. US Air Force
4. US Coast Guard
5. Civilian Aircrew
6. Civilian Passengers
7. Internationals

This guide underscores the significance of tailoring flight medicine to meet the diverse needs of military personnel from various branches and nations. By sharing best practices, and lessons learned through a series of real-life examples, it aims to enhance the effectiveness and efficiency of flight physicals and operational medicine across the military spectrum.

Learning Objectives

1. general familiarity with the different systems used by US military Flight surgeons for aerospace medicine.
2. general familiarity with the different systems used by US Military healthcare providers for readiness tracking.
3. general familiarity with the options for clearing civilians and internationals for flight in US aircraft.

Thursday, 05/09/2024 ***1:30 PM***
Grand Hall K

[S-82]: PANEL: COMMERCIAL SPACEFLIGHT SCOPING REVIEW OF PRIMARY MEDICAL RESOURCES – "CASTOR"

Chair: Tamara Averett-Brauer
Co-Chair: Thomas Hoffman

PANEL OVERVIEW: *As commercial spaceflight (CSF) becomes more available, somewhat more affordable and popular, the greater medical community will be increasingly asked to evaluate the fitness and medical appropriateness of individuals who want to undertake a range of environmental exposures in commercial spaceflights. Currently, the medical screening process is at the discretion of the individual space operators. Notably, there are few publicly available comprehensive standards for screening individuals for short or long-duration flights. This comprehensive and methodologically rigorous CSF Scoping Review (ScR) addresses the emerging topic and research question: What resources or references are available to educate primary healthcare providers about relevant medical considerations to have informed discussions with clients regarding commercial spaceflight travel? Ten teams comprised of international AsMA participants were organized around organ systems to systematically review publicly available literature to identify known, suspected, or potential medical issues and associated risks for CSF and to assess the available literature using Johns Hopkins Levels and Quality of Evidence. Five research databases were queried using the timeframe 2000 to present and using keywords developed by each team. Two panels ("Castor" & "Pollux") will present the findings of the ten teams. The "Castor" panel presents results from five of the ten teams: Neurology/Ophthalmology, Otolaryngology (ENT), Dental, Pulmonary, and Cardiovascular. Each presentation will discuss the methods, results, and discussions related to specific findings of that topical area. The results of this extensive CSF ScR describe the status of the extant literature describing these medical issues and conditions relevant to CSF. Areas of sparse evidence as well as areas for future research are identified. The CSF ScR results provide a resource for primary care medical personnel and build a foundation for recommendations informing future development of medical screening standards.*

[478] DENTAL CONSIDERATIONS IN COMMERCIAL SPACEFLIGHT: A COMPREHENSIVE SCOPING REVIEW

Michael H. Hodapp[1], Victor Lloro[2], Mary Cimrmancic[3]
[1]*Private Practice, Houston, TX, United States;* [2]*Odontology Hospital UB, L'Hospitalet, Barcelona, Spain;* [3]*Marquette University, Milwaukee, WI, United States*

(Original Research)

INTRODUCTION: Astronauts must go through a strict screening process by a series of NASA based flight physicians, psychologists, technicians, nurses, and dentists prior to being accepted into the astronaut corp. The commercial spaceflight (CSF) industry must seek their own professionals to address their health-related concerns of their crewmembers. Few dentists have been exposed to or studied the concepts of spaceflight related oral health. To assist the dentists and physicians that will be called upon for the CSF industry, our team is conducting an extensive scoping review focusing on dental related conditions relevant to CSF. Our objective is to identify resources for primary dental and medical examiners to adequately inform spaceflight participants regarding relevant dental considerations related to spaceflight. **METHODS:** A rigorous approach was used to identify the publicly available peer-reviewed literature that addresses the human aspects of commercial space flight. The study was initiated with an extended list of dental terminology that was used to conduct a comprehensive systematic literature review across five renowned databases. This process was conducted with the aid of an experienced research librarian, and the databases were limited to peer-reviewed publications from PubMed (Ovid Medline access) CINAHL, EMBASE, PsychINFO, and Web of Science (WOS). **PRELIMINARY RESULTS:** Out of the 5190 studies imported for screening, 1516 duplicates were removed, and 3661 studies were screened, out of those screened 3593 were found to be irrelevant. 68 full-text articles were rigorously analyzed to identify sources relevant to spaceflight dentistry and only a few have explored the realm of spaceflight dentistry. **DISCUSSION**: Our extensive analysis revealed that few studies exist relating to oral health preparations for CSF. During the NASA space program there were some oral-health related issues that occurred (one within two weeks of launch) that could have affected mission success had it occurred during critical moments of a mission. The purpose of our study is to give invaluable insight into the currently available CSF related literature to assist the dental and aerospace community in formulating a set of screening standards, treatment recommendations, and informative discussion with CSF participants.

Learning Objectives

1. Review of the literature related to oral health for Commercial Spaceflight.
2. Create a scientific foundation based on extensive research to aid in the development of provider guidelines for the evaluation and preparation for those wishing to travel into space.

[479] CARDIOVASCULAR DISEASES AND CONDITIONS AND THEIR EFFECTS THAT MAY IMPACT THE COMMERCIAL SPACE FLIGHT PARTICIPANTS: A SCOPING REVIEW

Arthur Formanek[1], Cathy DiBiase[2], Peter Lee[3], Zachery Campbell[4], Wendy Collins[5], Tom Diaz[6], Riley Ferguson[7], Taania Girgla[8], Cyril Mani[9], Gwen Owens[10], Ganeev Singh[11]
[1]*Brigham and Women's Hospital, Harvard Medical School, Boston, MA, United States;* [2]*Inomedic Health Applications for NASA, Kennedy Space Center, FL, United States;* [3]*Brown University, Providence, RI, United States;* [4]*Wright State University, Dayton, OH, United States;* [5]*Ross University School of Medicine, Bridgetown, Barbados;* [6]*University of North Carolina at Chapel Hill Eshelman School of Pharmacy, Chapel Hill, NC, United States;* [7]*University of Cincinnati, Cincinnati, OH, United States;* [8]*Brigham and Women's Hospital, Boston, MA, United States;* [9]*McGill University Health Beyond Initiative, Canadian Space Agency, Montreal, QC, Canada;* [10]*Boston Children's Hospital,*

Harvard Medical School, Boston, MA, United States; [11]*University of Massachusetts Chan Medical School, UMass Memorial Medical Center, Worcester, MA, United States*

(Original Research)

INTRODUCTION: We are in a new era of spaceflight where the non-governmental and non-professional citizens can become passengers on suborbital or orbital commercial spaceflight. As cost decreases and number of companies offering these services increases, more people will pursue this opportunity. Spaceflight should be encouraged but a medical screening process to inform and address undue medical risks to the spaceflight participants (SFP) should be considered. Many cardiac and vascular conditions can compromise a potential SFP's ability to perform even simple activities of daily living, which in space, may lead to greater compromise or intensity. Because primary care physicians without aerospace medical expertise may be called upon to determine a SFP's fitness for commercial space travel, we have reviewed the available literature for cardiovascular conditions that may be relevant to this population and report on the current state of the peer-reviewed literature and offer suggestions for future research. **METHODS:** A professional research librarian conducted a search of English language peer-reviewed literature in five databases (PubMed, EMBASE, CINAHL, PSYCINFO, and Web of Science) using a list of search terms developed by consensus within the Cardiovascular Commercial Spaceflight Ad Hoc Committee. Title/abstract screening and full text reviews were facilitated using Covidence software to complete a scoping review. Each article was screened and reviewed for inclusion and exclusion by a minimum of two members of the team with third party arbitration, if needed, by senior team members. **RESULTS:** The final CV list included 99 search terms. The database searches yielded 3293 results. Title and abstract screening were performed before full-text review. The majority of the non-professional astronaut literature focused on analogs (bedrest, centrifuge testing, and parabolic flights). Studies on SFP that have achieved suborbital or orbital flight could not be found in the current peer-reviewed literature. **DISCUSSION:** Cardiovascular conditions searched in this scoping review focused on cardiovascular conditions, and included cardiac masses, dysrhythmias, and congenital disorders. There were many studies that were related to professional astronauts. These included vascular conditions, dyslipidemia, and orthostatic hypotension in returning astronauts. Further research into SFP and their medical conditions and changes in spaceflight need to be explored.

Learning Objectives

1. The participant will be able to identify potential cardiovascular concerns relevant to commercial spaceflight.
2. The participant will understand the implications of existing cardiovascular pathology on the commercial spaceflight participant.

[480] PULMONARY MEDICAL ISSUES AND CONDITIONS RELEVANT TO COMMERCIAL SPACEFLIGHT – A SCOPING REVIEW

Dara Regn[1], Anishka Bandara[2], Nate Barott[3], Lauren Church[4], Phillip Gary[3], Saahil Golia[5], Takuma Ishibashi[6], Christopher Rock[7], Yoshika Saito[8], Matthew William[9], Britt Wiseman[10]

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(Original Research)

INTRODUCTION: With the rapid expansion of the commercial space flight (CSF) market there has been a growing demand for space tourism. To provide information to primary care providers that may perform medical risk assessment of CSF passengers with pulmonary comorbidities, a scoping review (ScR) was conducted to assess available literature regarding pulmonary physiology and to highlight gaps in knowledge and evidence. **METHODS:** A ScR was conducted of peer-reviewed literature published in English from 2000 to present (2023). Search terms were developed by the CSF Pulmonary team using the framework of the Fundamentals of Critical Care causes of respiratory failure and the top respiratory diagnoses in the Global Disease Burden estimates by the World Health Organization. A professional research librarian conducted a search of five databases (PubMed, EMBASE, CINAHL, PSYCINFO, Web of Science). Title/abstract screening and full text review were facilitated using Covidence software. Each article was screened and reviewed for inclusion by a minimum of two members of the team with third party arbitration by senior team members. **RESULTS:** The final pulmonary search term list included (78 number) of terms. The database searches yielded 11,647 results. After the title and abstract screening, full texts were reviewed. The final data set of articles were analyzed, and CSF-relevant pulmonary physiology and comorbidities were identified. There was a paucity of literature specific to CSF participants. What was identified was predominantly level V evidence (reviews, case reports and expert opinion). Literature about professional career astronauts was excluded, however those data are quite informative regarding potential ramifications for CSF passengers. For example, a study looking at microgravity and sleep disordered breathing demonstrated 55% reduction in apnea hypopnea index (AHI) and virtual elimination of snoring. **DISCUSSION:** This methodologically rigorous scoping review provides primary care providers insight into published evidence about pulmonary diseases in CSF. The pulmonary results highlight important considerations for passengers with pulmonary comorbidities and discuss the relevant pulmonary physiology in the context of the known hazards of spaceflight. These results support the aerospace medicine community in informing CSF medical screening standards, outlining a framework for CSF safety regulations, and focusing future CSF research priorities.

Learning Objectives

1. The audience will identify known, suspected, or potential pulmonary medical issues and associated risks with Commercial Spaceflight.
2. The audience will be able to describe one interesting finding in the Scoping Review – a study looking at microgravity and sleep disordered breathing demonstrated 55% reduction in apnea hypopnea index (AHI) and virtual elimination of snoring.

[481] ENT CONSIDERATIONS FOR POTENTIAL COMMERCIAL SPACE FLIGHT PASSENGERS: A SCOPING REVIEW

David B. Wexler[1], Thomas S. Hoffman[2], Heather Panic[3], Brooke Stephanian[4], Sophie Hutton[5], José Pedro Correia[6], Matthew T. Kuntzman[7], Dora Babocs[8], Marian B. Sides[9]

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(Original Research)

INTRODUCTION: The rapidly developing era of commercial spaceflight (CSF) brings a growing interest in spaceflight experiences from potential passengers that lack professional astronaut qualifications. Such individuals across the spectrum of age and health may present initially to primary care providers for medical risk assessment pertinent to CSF. We are conducting an extensive scoping review to assess the available literature on otolaryngological (ear, nose and throat; ENT) medical conditions, with the intent to provide guidance and actionable advice to primary

care physicians. **METHODS:** A professional research librarian conducted a search of English language peer-reviewed literature in five databases (PubMed, EMBASE, CINAHL, PSYCINFO, and Web of Science) using a list of search terms developed by consensus within the CSF ENT working group. Title/abstract screening and full text review were facilitated using Covidence software. Each article was screened and reviewed for inclusion by a minimum of two members of the team with third party arbitration by senior team members. **RESULTS:** The final ENT list included 115 search terms. The database searches yielded 1889 citations. After title/abstract screening, about 15% of the articles were found to be suitable for full-text review. The great majority of the non-professional astronaut literature focused on mechanisms and mitigation of vestibular-related dysfunction, including space motion sickness and spatial disorientation. These articles were often highly technical in nature. There was a distinct paucity of articles pertinent to hearing loss, Eustachian tube dysfunction, sino-nasal disorders in space, and upper aerodigestive tract problems. **DISCUSSION:** This scoping review of ENT conditions pertinent to CSF uncovered a fairly large set of studies on vestibular-related disorders and mechanisms. However, there was highly incomplete coverage of other key ENT management areas, such as pre-existing hearing loss and chronic sino-nasal disorders. The aeromedical/CSF communities should begin exploring how to adapt medical standards and recommendations from traditional sources (e.g., military aviation protocols and the professional astronaut literature) to the medically diverse upcoming populations of CSF spacefarers.

Learning Objectives

1. The audience will understand the methodical search strategy underlying this scoping review (ScR).
2. Participants will recognize that medical research relating to commercial spaceflight (CSF) is an emerging field necessitating the need to adapt current medical standards and recommendations from traditional sources to the medically diverse upcoming populations of CSF.
3. Participants will be able to identify gaps in the Otolaryngological (Ear, Nose and Throat-ENT) literature supporting Commercial Spaceflight, thus suggesting future topics for research.

[482] NEURO-OPHTHALMOLOGY IN COMMERCIAL SPACE FLIGHT: A COMPREHENSIVE SCOPING REVIEW

Lydia Johnson Kolaparambil Varghese[1], Schuyler Link[2], Rachael Filzen[3], Emma Hartness[4], Rafael Tiza Fernandes[5], Tejal Gala[3], Martin G. McCandless[6], Alexander W. Suh[7], Roya Ghafoury[8], Max Tenenbaum[9], Jason-Flor V. Sisante[10]

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(Original Research)

INTRODUCTION: The advent of commercial space flight (CSF) has necessitated the evaluation of medical risks for non-astronauts interested in space travel. Primary care providers play a vital role in evaluating the potential health risks associated with CSF. To assist physicians in this endeavor, we conducted an extensive scoping review focusing on neuro-ophthalmological conditions relevant to CSF. By critically analyzing the available scientific literature, our objective is to provide evidence-based guidance and practical recommendations in assessing and managing neuro-ophthalmological risks in prospective CSF passengers across various demographic profiles. METHODS: A comprehensive systematic literature search was conducted by an experienced research librarian across five renowned databases, namely PubMed, EMBASE, CINAHL, PSYCINFO, and Web of Science. To guide the search, the CSF neuro-ophthalmology working group developed an Excel sheet with search terms organized alphabetically by the etiology of neurological diseases and compartmentally by anatomical considerations for ophthalmological conditions. The Covidence software facilitated efficient screening of titles/abstracts, and thorough evaluation of full-text articles. Inclusion criteria were meticulously assessed by at least two team members, with expert oversight from senior team members to resolve any conflicts. This rigorous process ensures the credibility and integrity of the reviewed literature. **PRELIMINARY RESULTS:** The systematic literature search across five renowned databases yielded 16,369 results, which were then narrowed down to 11,258 articles after removing duplicates. Through title/abstract screening, we further reduced the selection to 653 full-text articles. Rigorous analysis of the included data led to the identification of relevant neuro-ophthalmological pathologies and countermeasures specific to CSF. **DISCUSSION:** Our research furnishes primary care providers invaluable insights into the existing body of published evidence. By shedding light on the physiological facets and coexisting medical conditions relevant to neuro-ophthalmological risks, this study assists the aerospace medicine community in formulating robust medical screening standards for prospective CSF passengers. Furthermore, it establishes a structured framework for the development of safety regulations and serves as a guiding beacon for future research endeavors in the ever-evolving sphere of commercial space flight.

Learning Objectives

1. Review the state-of-the-art literature related to the neurologic and ophthalmological pathology challenges faced during the Commercial Spaceflight era.
2. Based on this scientific background create the basis to develop medical standards and guidelines to apply to individuals that want to access to Space.

Thursday, 05/09/2024 ***1:30 PM***
Grand Hall GH

[S-83]: SLIDES: FATIGUE AND PERFORMANCE

Chair: Ian Mollan
Co-Chair: Merrill Rice

[483] THE DIGITAL PILOT – CONTINUOUS MONITORING OF VITAL SIGNS FOR THE EARLY DETECTION OF HAZARDOUS CONDITIONS

Simon Annaheim[1], Denis Bron[2], Frederik Bauer[1], René M. Rossi[1]

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(Original Research)

INTRODUCTION: The tasks of pilots on duty require high cognitive performance while exposed to the most diverse stressors. To detect conditions that might affect cognitive performance potentially resulting in hazardous situations, we aim to develop a textile-based physiological multi-parameter monitoring tool able to continuously record vital signs, including heart rate (HR) and heart rate variability (HRV), breathing frequency (BF) and breathing variability (BFV) as well as body temperature and heat flux. The goal is to integrate the tool into the pilot suit in a later stage of development. We hypothesize that the system is able to detect changes during exposure to hypoxia. **METHODS:** The monitoring tool consisted of 1) two knitted ECG Electrodes integrated into the textile system, 2) a conductive stretch-sensitive textile sensor to measure respiration by monitoring chest expansion, and 3) a foil heat-flux and temperature sensor. Ten male military pilots (22.4 ± 2.1 years of age) in training were monitored during the occasion of a low-pressure exposition training session

including breathing without oxygen mask at 7500m and 9000m of altitude. Therefore, no ethical approval was needed. Nevertheless, measurements were conducted according to the principles described in the Declaration of Helsinki and written informed consent was obtained from each participant. **RESULTS:** Data was recorded at high quality (95% of ECG data usable for further analysis; 19dB signal-to-noise ratio for respiration data). An immediate drop in HRV was observed (-22%) after removing the mask at high altitude, which was further reduced at the end of hypoxia exposure (-64%). This drop in HRV was accompanied by an increase in HR (+26%). In parallel, an increase in BF and BFV was observed (+21% and 42%, respectively), while the breathing amplitude was reduced (-20%). **DISCUSSION:** We confirmed the feasibility of conducting continuous measurements of vital signs during the training program of military pilots. Furthermore, we were able to detect changes in physiological variables related to hazardous conditions. Additional measurements will be conducted during exposure to other stressors (G forces, training flight sessions) followed by a more in-depth evaluation of the data to detect specific patterns being indicative of psychophysiological conditions of reduced performance.

Learning Objectives

1. Hypoxia exposure immediately affects physiological responses after removing the oxygen mask at an altitude of 7500m potentially affecting psychophysiological conditions and working performance.
2. A continuous monitoring of vital signs on duty bears the potential to early detect changes in psychophysiological conditions and impaired working performance relevant to increase safety in highly demanding situations.

[484] FATIGUE AND ITS ASSOCIATION WITH DEPRESSION AND ANXIETY IN PILOTS OF A MEXICAN CARGO AIRLINE

Alejandro Vieyra-González, Vicente Lozada-Balderrama, Ana Laura Luna-Torres, Armando Rodríguez-López
Instituto Politécnico Nacional, Mexico City, Mexico

(Original Research)

INTRODUCTION: The aviation industry is facing an increasing demand for services; hence, companies attempting to meet this demand seek to make the most of their aircraft by requesting their pilots to work longer hours, rotating, or night shifts. These arduous conditions have been associated with the development of psychopathologies such as fatigue, depression, and anxiety in several studies. The main objective of this research was to evaluate the association of operational fatigue with depression and anxiety in a sample of pilots working for a Mexican carrier. **METHODS:** This investigation consisted of a quantitative, cross-sectional, descriptive, and correlational study on a 54-pilot sample from an airline dedicated to cargo transportation based in Mexico City. An assessment tool that included a informed consent form, a sociodemographic and employment questionnaire, the Sustained Operations Assessment Profile (SOAP) scale to evaluate operational fatigue, the 9-item Patient Health Questionnaire (PHQ-9) to assess depression, and the 7-item Generalized Anxiety Disorder scale (GAD-7) to assess anxiety was applied online. Then, a descriptive and inferential statistical analysis was performed. This study was carried out in accordance with the ethical guidelines applicable in the place of its execution. **RESULTS:** 54 instruments were successfully completed, 96% belonging to male pilots (n=52) and 4% to female pilots (n=2). Fatigue levels were found to have a correlation with the number of hours flown during the last fortnight (r=0.30, p=0.03) as well as with the compliance to the schedule sent to the pilots at the beginning of each month (r=-0.31, p=0.02). The number of hours flown during the last fortnight (r=0.274, p=0.05), as well as the number of overnight layovers during the last fortnight (r=0.33, p=0.02), were correlated to the development of depression. The percentage of compliance to the schedule assigned was inversely associated with the presence of anxiety (r=-0.42, p=<0.01). **DISCUSSION:** Prevalence of depression was 0.36 percentage points higher than the prevalence reported for pilots globally in 2015. Anxiety prevalence was 3 percentage points lower than the last prevalence reported for Mexican population. No previous study with similar criteria in pilots was found to compare the obtained anxiety prevalence. A high and significant correlation of fatigue with depression and anxiety exists among assessed pilots.

Learning Objectives

1. The assistants will be able to identify the working conditions correlated with the presence of fatigue, depression, and anxiety in the sample.
2. The audience will learn about and be aware of the development of other psychopathologies that may be present in fatigued pilots.

[485] PRELIMINARY FATIGUE LEVELS BASED ON PERFORMANCE AND BEHAVIORAL MEASURES

Katharine Woodruff[1], Guliz Tokadli[2], Peggy Wu[3], Cheyenne Matthews[4], Tom Ferris[5]
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(Original Research)

INTRODUCTION: As aircraft capabilities advance, operation durations and complexities increase which place higher demands on the pilot which can affect their fatigue, attention, and/or stress levels. These potential risks could be lessened with the help of pilot monitoring solutions. This work aims to investigate and define fatigue levels based on performance and behavioral measures. Previous fatigue studies compared fatigue and no-fatigue conditions. This study investigates how performance and behaviors change as participants get more fatigued. **METHODS:** Participants refrained from sleep, caffeine, tobacco, and alcohol 18 hours prior to data collection to ensure sufficient fatigue. To mimic operational conditions, two lighting conditions were administered. Condition 1 consisted of constant daytime lighting while condition 2 consisted of varied lighting to augment daylight to nightfall transition. Participants performed short flight tasks under each condition until 3 microsleeps occurred. After each task, participants completed the Karolinska Sleepiness Scale (KSS) question, and Psychomotor Vigilance Task (PVT) for response time. Researchers annotated observed behaviors (e.g., blink, eyes closed, yawning, head nod, and fidgeting) during experiments. To assess each participant's fatigue state changes, the data of the first, middle and last intervals of condition 1, and the first and last intervals of condition 2 were used. The PVT and the KSS scores were analyzed using multivariate ANOVA and two-sample t-tests, respectively. **RESULTS:** Between the first and middle intervals of condition 1, there was a significant difference in both the PVT $F(1)=52.3$, $p=6.2e-13$ and KSS scores $t(28.5)=-3.2$, $p=0.002$. Between the middle and last intervals of condition 1, there was a significant difference in PVT $F(1)=5.72$, $p=0.017$. Observed facial behaviors showed similar trend with the PVT scores. **DISCUSSION:** PVT scores provided higher granularity in significantly different scores across data collection compared to KSS as a subjective survey. The significant differences in PVT are used to derive the preliminary fatigue levels as follows: Level 1: <480ms, Level 2: 481ms-680ms, Level 3: 680ms-740ms, and Level 4: >740ms.

Learning Objectives

1. The audience will learn how fatigue self-reports, response times, and behaviors change as humans get more and more fatigued.
2. This study helps derive four preliminary fatigue levels based on performance measures with the support of fatigue behaviors.

[486] MONOCYTE CHEMOATTRACTANT PROTEIN-1 IS INCREASED IN SWISS MILITARY AVIATORS WITH BACK AND NECK PAIN

Kenneth Kincel Jr.[1], Elizabeth Damato[1], Michael Decker[1], Sibylle Grad[2], Andres Kunz[3], Denis Bron[3]
[1]*Case Western Reserve University, Cleveland, OH, United States;* [2]*AO Research Institute, Davos, Switzerland;* [3]*Fliegerärztliches Institut (Aviation Medical Center), Dübendorf, Switzerland*

(Original Research)

INTRODUCTION: Back and neck pain are prevalent among military aviators. Objective biomarkers concurring with the presence of pain, along with accompanying musculoskeletal inflammation are lacking. We sought to determine whether such biomarkers exist. Our heuristic model/hypothesis predicted that proinflammatory serum biomarkers would be elevated in military aviators reporting back or neck pain. **METHODS:** The Swiss Air Force human subjects ethics panel approved this project in which 45 male participants were studied. Each person was categorized according to their frequency of back or neck pain during the prior year. Serum derived from venous blood samples were analyzed for 37 candidate biomarkers using electrochemiluminescent technology. One-way ANOVA was used to determine differences between groups. **RESULTS:** Four groups emerged based on self-reported back and neck pain frequency. Group 1 reported no pain within the past year. Group 2 reported 1-7 days of pain. Group 3 reported 8-30 days of pain. Group 4 reported more than 30 days of pain. Group 1 Monocyte Chemoattractant Protein-1 (MCP-1) levels were 14.68 pg/mL ± 1.63. Significantly higher levels of MCP-1 were found in both Group 2 (17.40 pg/mL ± 1.63, p = .015) and Group 3 (17.58 pg/mL ± 1.91, p = .008). MCP-1 serum levels were also elevated in Group 3 aviators who reported 8-30 days of neck pain (18.44 pg/mL ± 1.93, p = .013) in comparison to Group 1 aviators who reported no neck pain (15.56 pg/mL ± 1.90). **DISCUSSION:** Findings from this prospective cross-sectional study suggest a relationship between presence and severity of self-reported back and neck pain and blood serum levels of the proinflammatory chemokine MCP-1. Confirmation of that relationship will require an experimental paradigm designed to elicit cause and effect. Establishing that neck and back pain are associated with increased blood serum levels of MCP-1 would provide scientific rationale to then determine the cause of that pain. Those findings could support the use of blood serum levels of inflammation as objective markers of neck and back pain/injury as well as to assess efficacy of strategies aimed at reducing such pain and/or injury.

Learning Objectives

1. The participant will understand the prevalence of back and neck pain in Swiss Air Force aviators.
2. The participant will learn that MCP-1 may be an objective biomarker of back and neck pain in military aviators.

[487] THE IMPACT OF CONTROLLED REST ON SELF-REPORTED SLEEPINESS AT TOP-OF-DESCENT

Cassie Hilditch[1], Lucia Arsintescu[1], Sean Pradhan[2], Kevin Gregory[3], Erin Flynn-Evans[3]

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(Original Research)

INTRODUCTION: Long and irregular working hours can lead to fatigue in aviation operations. In some regions, a short nap taken on the flight deck (known as *controlled rest*) can be used as a countermeasure to unexpected in-flight sleepiness. We aimed to investigate the impact of taking controlled rest on self-reported sleepiness at top-of-descent. **METHODS:** Data from 120 long-haul (>6 h flight duration), unaugmented flights were analyzed (n = 31 pilots). Pilots wore actigraphs and completed sleep logs before and during trips. At pre-flight and top-of-descent, pilots completed a Karolinska Sleepiness Scale (KSS). A mixed-effects model was used to assess the impact of controlled rest on KSS at top-of-descent. Sleep duration in the 48 hours prior to departure, timing of the flight (day vs. night), and pre-flight KSS scores were included as covariates. **RESULTS:** Due to missing data, complete data from 83 flights (n = 29 participants) were available in the analyses of the KSS. There were no differences by controlled rest status for KSS scores at top-of-descent (estimated marginal means ± SEM with controlled rest: 5.10 ± 0.22, without controlled rest: 5.37 ± 0.29; p = .45, η^2_p = 0.01). **DISCUSSION:** Our results suggest that there is no difference in self-reported sleepiness at top-of-descent on flights in which controlled rest was taken compared to flights without controlled rest. Further research is necessary to determine the impact of controlled rest on objective measures of performance at top-of-descent.

Learning Objectives

1. Understand how controlled rest may impact self-reported sleepiness at a critical phase of flight.
2. Appreciate the need for further research on controlled rest to understand how the policy is implemented in practice and its impact on objective performance measures.

[488] THE JOINT HELICOPTER COMMAND FATIGUE RESEARCH PROJECT: A CROSS-SECTIONAL STUDY OF FATIGUE IN MILITARY ROTARY WING PILOTS.

Andrew Pelham

Army Air Corps, British Army, Stockbridge, United Kingdom

(Original Research)

BACKGROUND: A study of fatigue in British military rotary wing pilots was undertaken in order to calculate the likely utility of actigraphy-driven fatigue modelling in the military rotary wing environment. **METHODS:** After four UK-based rotary wing squadrons were visited, a total of 48 study participants were recruited across the three services. Objective fatigue was predicted using wearable actigraphy and the Sleep Activity Fatigue Task Effectiveness (SAFTE) fatigue model. Subjective data were collected from daily questionnaires completed by the study participants, including an assessment of their own fatigue, using the Samn-Perelli Scale (SPS). The relationship between these two data sets was then assessed with correlation and linear regression modelling. **RESULTS:** SAFTE scores – the objective measure of fatigue – were shown to decline for night flying, especially if landing >0200hrs (correlation -0.737, $p < 0.001$, R^2 0.55). With increasing subjective levels of fatigue, the relationship between objective SAFTE scores and subjective Samn-Perelli scores in study participants weakened. Pilots had increased levels of objective ($p < 0.05$) and subjective ($p < 0.05$) fatigue when deployed on exercise, compared with non-deployed pilots, and if they lived with children aged under one year ($p < 0.05$) – compared with those with older children. **CONCLUSION:** Actigraphy-driven biomathematical fatigue modelling has a clear role in aspects of military rotary wing aviation. Consideration should be given to its use for night-flying, pilots deployed on exercise and operations, and for those with young children at home. Due to the apparent cognitive burden of rotary wing flying, research into iterative, in-flight objective fatigue measurement in military rotary wing pilots should be strongly considered.

Learning Objectives

1. To understand the likely components of fatigue which military rotary wing pilots are most susceptible to.
2. To understand the circumstances in which bio-mathematical modelling and actigraphy can be used to estimate fatigue in military rotary wing pilots.
3. To understand the likely future avenues for research into fatigue in military rotary wing pilots; this includes, but is not limited to, wearable devices able to offer objective iterative measurement of a pilot's fatigue.

Thursday, 05/09/2024 ***1:30 PM***
Grand Ballroom AB

[S-84]: PANEL: SYSTEM LEVERS WITHIN IMPACT

Sponsored by ExMC

Chair: Jon Steller
Co-Chair: Kris Lehnhardt

PANEL OVERVIEW: *BACKGROUND: Informing Mission Planning via Analysis of Complex Tradespaces (IMPACT) is a computational tool created to assess medical outcome risk for the treated and untreated disease states for*

a growing evidence library that currently includes 119 included conditions. It can also optimize the risk buydown within design reference mission mass and volume constraints and develop requirements for the medical system based on this optimization. Risks are defined by mission parameters (duration, number of crew, # of EVAs, etc.), the incidence of medical conditions, the proportion of pre-defined "best case scenarios" versus "worst case scenarios" definitions, and the three associated outcomes of loss of crew life (LOCL), need for medical evacuation (MED-EVAC), and crew task time affected (TTA). OVERVIEW: The outputs from IMPACT help medical and engineering teams with mission planning, medical system creation, and with crew medical training. A legion of levers is at the disposal of mission planners to help understand mission risk and design solutions. Input levers exist where we may adjust mission parameters or even the mass and volume of the medical system to see how it may affect mission outcomes. Output levers exist as well where mission planners can set thresholds for acceptable LOCL, MED EVAC, or TTA, or even adjust the prioritization of these parameters and see how these affect mission inputs like mass, volume, power, or even medical system resourcing. DISCUSSION: This panel introduces IMPACT, discusses preliminary validation against real world systems, then determines how adjusting levers such as DRM duration, medical system size, or outcome prioritization will affect medical resourcing and mission outcomes for a long-duration Lunar mission.

[489] IMPACT OVERVIEW FOR EXPLORATION SPACEFLIGHT—RISK PREDICTION AND MITIGATION

Arian Anderson[1], Jon G. Steller[2], Ariana M. Nelson[2], Dana Levin[2], Prashan J. Parmar[2], Lynn A. Boley[3], David C. Hilmers[4]
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(Education - Program/Process Review)

BACKGROUND: Probabilistic Risk Analysis (PRA) is a method for estimating risk in complex engineering systems. The Informing Mission Planning via Analysis of Complex Tradespaces (IMPACT) tool uses PRA as a customizable predictive analytics tool for quantifying medical risk based on mission profile. IMPACT enables the Exploration Medical Capability (ExMC) element to assess these risks, identify resources necessary to mitigate this risk, and assess the combination of resources that enables the lowest risk within the design constraints of the vehicle. **OVERVIEW**: IMPACT's evidence library (Ev Lib) is a living database that currently contains 119 medical conditions. Each condition is defined with a "best case" (BC) and "worst case" (WC) scenario representing a mild and more severe condition scenario for each medical condition. These scenarios are each associated with outcomes for a treated state (T) and an untreated state (U) yielding a total of 4 possible outcomes for each condition (BC/T, BC/U, WC/T, and WC/U). Each condition's incidence, probability of BC vs. WC, probability of loss of crew life, and the risk of evacuation for each of the four outcome states was determined via literature review. A third metric, task time affected, was obtained via a Delphi style analysis of mission tasks. SMEs then determined the capabilities and resources required to manage each condition within the constraints of exploration class missions. User inputs such as mission duration, medical system size constraints in mass and volume, number of crew, pre-existing conditions, and mission activities allow IMPACT to quantify mission risk, resource allocation, and the achievable risk reduction for a wide variety of potential mission profiles. Quantitative analysis of mission medical risk can then be used by mission planners to optimize and inform medical system design. **DISCUSSION**: This presentation describes the technical aspects of our approach to build the evidence library supporting predictive analytics for medical risks in spaceflight.

Learning Objectives

1. Learn about how IMPACT models system risk for human spaceflight.
2. About how to quantify human health and performance for human spaceflight.

[490] IMPACT REAL WORLD SYSTEM VALIDATION

Prashant Parmar[1], Eric Kerstman[2], Lynn Boley[3], Millennia Young[4], John Arellano[5], Jon G. Steller[1], Dana Levin[1], Ariana M. Nelson[1], Arian Anderson[6], David C. Hilmers[4]
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(Education - Program/Process Review)

BACKGROUND: IMPACT estimates the frequency and consequences of medical conditions that may arise during long-duration exploration missions (LDEMs). A validation analysis of IMPACT was performed with International Space Station (ISS) and Shuttle Transportation System real world system (STS RWS) referent data due to the limited referent data available from exploration missions. **OVERVIEW**: Observed mission and crew characteristics from STS and ISS missions were used as model inputs within MEDPRAT (Medical Extensible Dynamic Probabilistic Risk Assessment Tool). For each mission, 200,000 simulations were generated. Mission model outputs included occurrence counts for each medical condition, total medical events (TME), and the probability of loss of crew life (LOCL). These simulated model outputs were compared to the RWS referent data. The predicted number of total medical events exceeded the total RWS medical events for ISS missions and combined ISS and STS missions. They fell within the 90% confidence interval (CI) for STS missions. For the 32 ISS missions simulated by IMPACT, the number of total medical events was overpredicted for 19 and fell within the 90% CI for 13. For the 21 STS missions, the total number of medical events was overpredicted for 1, in range for 18, and was underpredicted for 2. Combined, 31 missions were in range, 20 were overpredicted, and 2 were underpredicted. LOCL was within the 90% CI. The validation analysis included condition-by-condition analysis. For ISS missions, 49 conditions were in range, 49 were statistically underpowered, 16 were overpredicted, and 5 were underpredicted. Overall, 30% (21/70) of conditions were out of range. For STS missions, results were 40, 59, 10, and 10, respectively. Overall, 30% (20/60) of conditions were out of range. For combined ISS and STS missions, results were 47, 47, 17, and 8, respectively. Overall, 35% (25/72) of conditions were out of range. **DISCUSSION:** The results of this validation analysis are unsurprising given the evidence library driving IMPACT is built for LDEMs and are being validated against short-duration ISS and Shuttle missions. This validation analysis can be used to assess IMPACT outcomes in terms of consistencies and inconsistencies with RWS referent data.

Learning Objectives

1. The audience will learn how IMPACT was validated against real-world system referent data.
2. The audience will learn how variations between predicted and observed conditions can be a function of IMPACT's design and biases.
3. The audience will learn the benefits and limitations of comparison to real-world referent data when there is no current "gold-standard" comparison.

[492] THE EFFECT OF MISSION DURATION ON PREDICTED MEDICAL RISK AND MEDICAL SYSTEM DESIGN CONSIDERATIONS FOR AN EXTENDED DURATION LUNAR MISSION

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(Education - Program/Process Review)

BACKGROUND: NASA's Informing Mission Planning through Analysis of Complex Tradespaces (IMPACT) tool suite is designed to predict mission risks from medical events and use combinational optimization techniques to estimate the optimal medical system requirements for

long-duration exploration missions (LDEMs). With a healthy population such as NASA's astronaut corps, a principal driver of medical risk in space is—time. The longer a mission is, the greater the chance of a medical event occurring. This study sought to determine the effect of changing mission duration on mission outcomes and medical system design recommended by the IMPACT tool. **OVERVIEW:** Three IMPACT simulations were run for a design reference mission of 4 crew members with a mission to land on the Lunar surface. The mass and volume constraints were kept the same for all 3 simulations, but the duration was changed from 3 months to 9 months, and to 24 months. The surface duration and number of surface EVAs was also increased corresponding to the increased mission time. Each duration generated different medical system elements with shorter missions carrying lower overall risk and requiring a less complex system when compared to longer missions. Longer durations increased the diversity of medical events that could occur and increased the risk of a medical morbidity affecting clinical outcomes such as loss of crew life (LOCL), need for medical evacuation (MED-EVAC), and of affecting crew task time (TTA). **DISCUSSION:** In each case, the medical system was sufficient to reduce the risks substantially from an untreated baseline illustrating that IMPACT appears to function as designed and likely represents an effective tool for predicting and helping to mitigate medical risk in space for a diverse array of long-duration exploration design reference missions.

Learning Objectives

1. The duration of a mission has substantial effects on health related risks.
2. Predictive analytics tools can help inform medical system design for deep space missions.

[491] THE EFFECT OF MEDICAL SYSTEM SIZE ON PREDICTED MEDICAL RISK AND MEDICAL SYSTEM DESIGN CONSIDERATIONS FOR AN EXTENDED DURATION LUNAR MISSION

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(Education - Program/Process Review)

BACKGROUND: Crew health is impacted by intrinsic human factors, the spaceflight environment, and mission activities. On board medical systems can mitigate mission relevant adverse outcomes such as loss of crew life (LOCL), medical evacuation (MED-EVAC), and crew task time affected (TTA). However, given limited fuel and habitable volume, long-duration exploration missions (LDEMs) require prioritizing the most critical diagnostics and therapeutics. NASA's Informing Mission Planning via Analysis of Complex Tradespaces (IMPACT) tool applies Probabilistic Risk Assessment (PRA) methodology to statistically select the medical capabilities most likely to improve mission success within planner defined mass and volume constraints. This study sought to determine the effect on mission outcomes of changing the mass and volume of the medical system from 20kg/50L, to 50kg/150L, to unlimited. **OVERVIEW:** Three IMPACT simulations were run for a design reference mission of four crew members with a mission to land on the Lunar surface with a 20kg/50L, 50kg/150L, and unlimited size medical system respectively. The size of the medical system significantly affected all mission outcomes (LOCL, MED-EVAC, and TTA) with smaller allocations associated with higher mission risks. **DISCUSSION:** The outputs from IMPACT provide an evidence-based medical system design that can be utilized by SMEs to inform and optimize medical systems for LDEMs and design pre-flight crew training. As the tool is iterative, the database can be updated when new data emerges or with data targeting specific environments (i.e., Lunar vs. Martian) to help continue medical risk mitigation into the future. Here we review the ability of IMPACT to predict the most important clinical resourcing to optimize crew health based on varying vehicular constraints during an extended duration Lunar mission.

Learning Objectives

1. List the key crew health and performance metrics that are used to assess the utility of a given medical system in the IMPACT tool suite.
2. Compare and contrast the relative risk reduction if a larger physical medical system is selected for crewed space missions.

[493] MEDICAL CAPABILITIES THAT INFLUENCE LOSS OF CREW LIFE, MEDICAL EVACUATION, AND TASK TIME AFFECTED FOR AN EXTENDED DURATION LUNAR MISSION

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(Education - Program/Process Review)

BACKGROUND: As we prepare for long-duration exploration missions (LDEMs), mass, volume, and power will limit the resources and capabilities built into the medical system. Thus, the resourcing chosen for the medical system will also be critical for mitigation of loss of crew life (LOCL), medical evacuation (MED-EVAC), and crew task time affected (TTA). Informing Mission Planning via Analysis of Complex Tradespaces (IMPACT) is NASA's newest Probabilistic Risk Assessment (PRA) tool created to assist in selection of the medical capabilities and resources that are most likely to reduce these risks. Furthermore, the tool suite can be used to selectively prioritize reduction of one of these outcomes over the others. We sought to determine how medical system resourcing recommendations may change by independently prioritizing LOCL vs. MED-EVAC vs. TTA. **OVERVIEW**: The levers of IMPACT allow investigators to equally prioritize all three of these mission outcome metrics or to prioritize one outcome over the other. We found that the need for evacuation or LOCL from a medical morbidity is typically driven by rare and serious condition states, whereas the conditions affecting crew task time are often exceedingly more common and benign. Building a medical system with the diagnostics and treatments for conditions leading to TTA is significantly different than a medical system created for decreasing the risk of LOCL and MED-EVAC. **DISCUSSION**: Changing the priority of mission outcomes is just one lever that mission planners may use to buy down medical risk for LDEMs. The outputs from IMPACT help empower SMEs when creating and optimizing medical systems catered to the risk profile desired.

Learning Objectives

1. The audience will learn how prioritizing loss of crew life as a lever within IMPACT can affect suggested medical resourcing and outcomes for a long-duration Lunar mission.
2. The audience will learn how prioritizing the need for medical evacuation as a lever within IMPACT can affect suggested medical resourcing and outcomes for a long-duration Lunar mission.
3. The audience will learn how prioritizing crew task time affected as a lever within IMPACT can affect suggested medical resourcing and outcomes for a long-duration Lunar mission.

Thursday, 05/09/2024 ***3:30 PM***
Grand Ballroom A

[S-85]: PANEL: USING HUMAN BODY MODELING TO PREVENT INJURIES TO AIRCREW

Chair: Micah Kinney
Co-Chair: Lindley Bark

PANEL OVERVIEW: *Since the beginning of human flight, crash protection has evolved to continuously strive for improved survivability and return to duty. With advances in digital human modeling, not only can acute injury be better understood within the context of the aviation environment, but*

chronic injury (e.g., neck, back, and knee pain) prevention can be sought after in developing optimized next generation aircraft. This panel will discuss how the use of finite element digital human modeling is being used at the Naval Air Warfare Center Aircraft Division, in partnership with the Office of Naval Research, academia, and industry, to inform aircrew restraint equipment, seat, and airframe designs. The first topic will highlight how chronic and acute injuries, related to the aviation environment, plague military aircrew readiness and return to flight operations. Second, a discussion on the use of human body modeling to identify head and neck injury causes in mishap recreation. Next, a presentation on how human body modeling can be used to understand injuries to abdominal organs under mishap equivalent forces. Fourth, a brief will be given on lower extremity injury, such as femur and tibia fracture, and how digital modeling is being used to better understand the biodynamics in these crash events. Finally, a wrap up discussion on how digital human modeling supports naval aviation acquisition of improved technology to prevent injury to aircrew.

[494] WHY DO WE NEED MODELING AND WHAT DOES MODELING NEED?

Bethany Shivers[1], Phillip Whitley[2]
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(Education - Tutorial/Review)

INTRODUCTION: Military aircrew neck pain and chronic injury are consistently ranked as a top 10 Aeromedical Issue among all U.S. military branches of service and with our international partner nations. Chronic neck pain and injury diminish operational performance, quality of life, and often lead to early medical retirement. Research methodologies used to investigate causes and mitigation strategies include surveys, post-mortem human subject research, and human volunteer research. Each of these approaches are effective, but also inherently limited in their ability to adequately scope the problem and develop solutions. Modeling provides an avenue to fill in the gap between these research approaches, by taking the results of each approach and connecting the dots. **TOPIC:** While injury prediction models are a critical tool for connecting the dots, they are only as good as the research data available to develop and validate them. Surveys are one of the most common and most easily deployed research tools used to characterize the nature and extent of a problem; however, there are several inherent limitations. As surveys are one of the easiest research tools to use, Warfighters are often inundated with requests to complete them or "participate" in the research. As time is a premium for Aircrew. Like all military occupational specialties, surveys are often either ignored or given little attention or effort. Surveys often lack the specificity needed to capture accurate and meaningful data. A Naval Air Warfare Center Aircraft Division sponsored effort has developed the Operational Neck Pain Index (ONPI), a digital survey that incorporates the core questions identified by the North Atlantic Treaty Organization (NATO) Human Factors Program (HFM) 252 Panel on Aircrew Neck Pain. These questions were developed by panel members to provide the level of specificity necessary to accurately determine the nature and location of pain. **APPLICATION:** The ONPI provides invaluable quality data for modelers looking to characterize the cause or contributing factors to neck pain whether it be focused on longitudinal effects representative of a career's worth of flight exposure, or predicting the effects of various equipment variations or proposed solutions such as helmet and helmet-mounted systems that are under consideration for acquisition efforts.

Learning Objectives

1. The participant will learn about the different research approaches used to investigate the contributing factors and potential mitigation strategies associated with military aircrew neck pain.
2. The participant will learn about the role modeling plays in linking the results from the various research approaches, associated limitations, and data requirements to develop a validated model.

[495] IDENTIFICATION OF INJURIES FOR HEAD AND NECK USING HUMAN BODY MODELS

Nathaniel Owens
Naval Air Warfare Center Aircraft Division, Patuxent River, MD, United States

(Education - Tutorial/Review)

INTRODUCTION: The safety community has put an emphasis on the protecting the head and neck from injury. Because of this, there are currently multiple injury criteria developed for ATD testing. As human body models (HBM) become used more for injury prediction, the application of these injury criteria needs to be adapted or further developed. Many of these criteria were developed with the use of specific accelerometers in mind and not the continuous data available from HBMs. **TOPIC**: Human body models (HBM) are currently being used by NAWCAD Modeling and Simulation (M & S) lab. These HBMs are being used to examine injury potential of the head and neck for many different crashworthy systems that can help protect from high dynamic loading such as seating systems, helmets and harnesses. More time and research is needed to investigate how we can better protect the warfighter from different injury types with the additional information that HBMs provide. **APPLICATION:** NAWCAD is utilizing acute injury human body models from the automotive sector and collaborating with the Office of Naval Research in the development of I-Predict Human model for the fulfillment of Navy's need with a long-term vision of mitigating acute and chronic injuries. The emphasis is on mishap investigations and targeting specific human injuries where effects of posture for chronic injury probability can be evaluated. This information is used for developing guidelines for the warfighters. The applications also include the development/refinement of human tolerance in terms of G force and injury criteria for various anthropometric sizes. NAWCAD is also in the process of collaboration with the medical community to seek interpretation of the results obtained through these models.

Learning Objectives

1. The audience will learn that there are several injury criteria for acute injury in the head and neck.
2. The audience will learn the added capability that human body models provide can be used to better inform crashworthy protective equipment design.

[496] IDENTIFICATION OF VARIOUS TORSO INJURIES USING HUMAN BODY MODELS

Nicholas Harris
Naval Air Warfare Center Aircraft Division, Patuxent River, MD, United States

(Education - Tutorial/Review)

INTRODUCTION: Current methods of predicting human injury from a crash safety prospective rely heavily on anthropomorphic testing devices (ATDs). While these have allowed great advances in crash safety, they are limited to predicting injury at discrete locations in specific conditions. In an attempt to improve injury predicting capabilities, the use of a human body model (HBM) has been implemented. These models have the potential to allow the prediction of a larger variety of injury, lethal and non-lethal, at a larger variety of points on the human body. These HBMs have proved very capable of predicting previously unobservable injuries and give a more complete picture of what happens in a crash. However, the specific criteria that should be used to predict injury is still up for discussion. **TOPIC**: Human body models are currently being used by NAWCAD Modeling and Simulation (M&S) lab to examine injuries that are not being predicted by ATDs. These HBM injury predictions are being used to help influence the design of various crashworthy seating, fall protection, and mobile aircrew restraint systems. The models are evaluating lethal and non-lethal injury to get a more robust and accurate picture of the crash environment. Through this work, it has become clear that identification of injury criteria is needed for several areas of interest. These areas include, but are not limited to, rib cartilage separation, vital organ damage, intestine load, major blood

arteries/vessels loading. **APPLICATION:** NAWCAD is utilizing acute injury human body models from the automotive sector and collaborating with the Office of Naval Research in the development of the Incapacitation Prediction for Readiness in Expeditionary Domains: an Integrated Computational Tool (I-PREDICT) Human model for the fulfillment of Navy's need with a long-term vision of mitigating acute and chronic injuries. The emphasis is on mishap investigations and targeting specific human injuries where effects of posture for chronic injury probability can be evaluated. This information is used for developing guidelines for aircrew protection. The applications also include the development/refinement of human tolerance in terms of G forces and injury criteria for various anthropometric sizes. NAWCAD is also in the process of collaboration with the medical community to seek interpretation of the results obtained through these digital human models.

Learning Objectives

1. The audience will learn about the capability difference between ATD testing and Human Body Model simulation.
2. The audience will learn about the current and future planned uses of human body models for injury prediction.

[497] IDENTIFICATION OF INJURIES FOR LOWER EXTREMITY USING HUMAN BODY MODELS

Aamir Jafri
Naval Air Warfare Center Aircraft Division, Patuxent River, MD, United States

(Original Research)

The aviation safety community has emphasized a need to mitigate lethal injuries pertaining to the head and upper torso. Most aircrew protective systems are designed for protecting the upper extremity, i.e., the head and torso. There is criterion where some discrete location on crash dummies can measure femur load and tibia indexes to record severity of impact, but not much attention is given to those types of injuries in the automotive and commercial aircraft sector. Though these injuries are non-lethal, they have a potential of becoming lethal in the event of a mishap or can disable a warfighter temporarily or permanently which can lead to early retirement. It can also impact the decision-making capability of warfighters during critical task assignments. Hence, there is a need for additional focus on these types of injuries, and how to prevent them, in naval aviation. Human body modeling is currently being used by NAWCAD Modeling and Simulation lab to examine the lower extremity responses for a typical crashworthy seating system that experiences a highly dynamic vertical load during a mishap. Injuries are evaluated accordingly by comparing the model with field data that naval personnel experience during aviation mishap events. The research conducted through these models is not limited to acute harm that is lethal but non-lethal that can be expensive or life-changing. Therefore, more time is devoted to understanding these injuries and the mechanical cause.NAWCAD is utilizing acute injury human body models from the automotive sector and collaborating with the Office of Naval Research in the development of I-Predict Human model for the fulfillment of the U.S. Navy's need with a long-term vision of mitigating acute and chronic injuries. The emphasis is on mishap investigations and targeting specific human injuries where effects of posture or chronic injury probability can be evaluated. Since the acute human models from the automotive sector are developed with necessary details from the perspective of modeling and anthropometry, the effects of occupant preposition on lower extremity injury probability or severity are being evaluated with an aviation context. This information is used for developing guidelines for aircrew protection. NAWCAD is also in the process of collaboration with the medical community to seek additional interpretation of the results obtained through these digital human models.

Learning Objectives

1. Human body models are used to detect injuries that cannot be detected by Crash Dummies. Hence, an accurate understanding of injuries can be researched. Lethal and non-lethal injuries can be evaluated through these models. These models provide a sanity check before finalizing a design.
2. Human body models are being used in the U.S. Navy to develop new injury criteria and refinement of existing injury criteria. The U.S. Navy is using these models to understand aviation mishaps and compare the results of these models with field data.

[498] USING HUMAN BODY MODELS TO SUPPORT ACQUISITION OF INJURY-MITIGATING HARDWARE

Lindley Bark
Missouri University of Science and Technology, Rolla, MO, United States

(Education - Tutorial/Review)

INTRODUCTION: Current employed methods of qualifying crash-protective hardware against crash conditions rely heavily on anthropomorphic testing devices (ATDs). Standardized families of these test devices, when used in controlled testing processes, provide for repeatable and replicable results. As the crash-protective community moves toward future incremental advances in injury mitigation, there is a desire to become more specific with respect to injuries. The majority of these advances will rely on predictive human body models (HBMs). The use of HBMs in the certification/qualification processes is not straightforward. **TOPIC:** In the research environment, HBMs have shown great promise in predicting injuries in ways that previously were not possible. HBMs indicate specific injury mechanisms that are generally not identifiable with physical ATD testing. Further, HBMs are being developed and employed to predict chronic injury in addition to acute injury. The primary issue in bringing HBMs to the acquisition of aviation hardware is the lack of standardization in test methods. One must bring HBM-produced data into the qualification process. Lack of standardization, as exists with ATDs, makes this challenging. However, with aircrew endurance issues, chronic injury issues, and remaining acute injury that is mitigatable, there is strong value in using HBMs. The importance is magnified when we consider that mission durations are significantly increasing. **APPLICATION:** NAWCAD is pursuing HBM analysis to identify means to mitigate injury. Presently, the research in this area is strong and producing promising results. Applying HBMs to the acquisition of hardware will require new means of assessing compliance and even specifying what the compliance criteria may be. Ironically, it may be that the HBMs will provide the vision to get started in developing compliance procedures. This will require collaboration between at least regulatory, medical, engineering, physiology, and acquisition personnel, all focused on achieving reduction in aircrew injury and increasing fleet readiness.

Learning Objectives

1. The participant will gain an understanding of how medical, engineering, and other professionals interact to find elusive solutions to injury mitigation gaps.
2. The audience will gain an understanding of how ATD's and HBMs differ in predicting injury.

Thursday, 05/09/2024 ***3:30 PM***
Grand Ballroom B

[S-86]: PANEL: AEROMEDICAL ETHICS PANEL: SPONSORED BY ASAMS

Chair: David O'Brien
Co-Chair: Karen Heupel

PANEL OVERVIEW: *Aerospace medicine may present an array of potential ethical dilemmas to aviation medicine physicians and other aeromedical professionals that may arise out of conflicts between the interests, rights, and responsibilities of those within our profession, individual patients/aircrew, private employers, and governmental certifying agencies. Case studies will be presented for open audience discussion that address a variety of relevant ethical and/or legal value conflicts in the current practice of aerospace medicine.*

[499] AEROMEDICAL ETHICS PANEL: SPONSORED BY THE AMERICAN SOCIETY OF AEROSPACE MEDICINE SPECIALISTS

Mark Mavity
The American Society of Aerospace Medicine Specialists, McLean, VA, United States

(Education - Case Study)

Aerospace medicine may present an array of potential ethical dilemmas to aviation medicine physicians and other aeromedical professionals that may arise out of conflicts between the interests, rights, and responsibilities of those within our profession, individual patients/aircrew, private employers, and governmental certifying agencies. Case studies will be presented for open audience discussion that address a variety of relevant ethical and/or legal value conflicts in the current practice of aerospace medicine.

Learning Objectives

1. The audience will explore the process of ethical decision-making and its impact upon the practice of aerospace medicine.
2. The audience will learn about the current foundational resources which form the framework of current medical ethical guidance, particularly the ASAMS Ethical Guidelines as they relate specifically to the practice of aerospace medicine.
3. The audience will be encouraged to provide thought and attention to the ethical issues impacting the practice of aerospace medicine.

Thursday, 05/09/2024 ***3:30 PM***
Grand Hall J

[S-87]: PANEL: WHY SHOULD I BE DECLARED UNFIT TO FLY OR TO CONTROL IN 2024?

Sponsored by SOFRAMAS (Francophone Society of Aerospace Medicine)

Chair: Olivier Manen

PANEL OVERVIEW: *Care medicine has been moving all the time, concerning the diagnostic and therapeutic approach, including new medications, protocols, and technologies that are more and more used to improve the prognosis of patients but also their well-being. Medical progress has been taken into account in the official aeromedical regulations such as the EASA rules, that's why a regular updated version of these norms is required, all the more as the philosophy of expertise and of the risk evaluation has changed in time as well, sometimes in a strange way (ARA.MED.330). Accordingly, the aeromedical examiners gradually have been encouraged to push the fitness limits far away. One could summarize by saying that the questioning "Should this pilot or air traffic controller fly or work again?" has moved to "When and in which conditions should he/she fly or work again?" considering particularly one or several operational limitations to be used. In that context, we should question the circumstances that lead to the impossibility to continue the flying/working duties and therefore to a permanent decision of unfitness. If the characteristics of a disease are a key element, many other elements may play an important role such as the status of the aircrew, the specialty and technical role, the working conditions but also the acceptable risk level, the motivation and search for secondary profits… all of them will be discussed through four presentations by military aeromedical experts and one by an occupational practitioner of an airline company.*

[500] WHAT MAKES A FRENCH ATCO UNFIT NOWADAYS?

Sebastien Bisconte[1], Philippe Furtwengler[2], Jonathan Monin[1], Gaetan Guiu[1], Caroline Brescon[1], Mustapha Khezami[1], Laetitia Marion[1], Olivier Manen[1]
[1]*French Health Service, Clamart, France;* [2]*DGAC, Issy les Moulineaux, France*

(Original Research)

INTRODUCTION: Air Traffic Controllers (ATCOs) are subjected to periodical medical examinations during which the aeromedical examiner screens for diseases that could impact the flight safety. The evolution of medical knowledge improves the diagnosis and prognosis of many diseases facilitating the rehabilitation of ATCO. What makes a French ATCO unfit nowadays? The aim of this presentation is to describe the medical causes of ATCOs unfitness by the licensing authority. **METHODS:** All the data from the referral files to the French ATCO licensing authority were collected and analyzed retrospectively. **RESULTS:** From 01/01/2017 to 05/25/2023, 1000 files were analyzed by the licencing authority for 550 different ATCOs [70.3% male, mean age: 44.7 yr +/- 11.2 yr, range 19-70 yr, 12.4% military ATCO] were included. In total, 14.7% of cases resulted in unfitness The first cause is psychiatric with 27 ATCOs declared unfit (33.3%), more than half of them for an anxio-depressive syndrome and a quarter for addictive behaviors. The second reason is ophthalmological with 25 ATCOs declared unfit (30.8%) mainly for dyschromatopsia (33%), stereoscopic vision disorder (18%), keratoconus (11%) or diplopia (11%). Neurology represents the third reason with 11 ATCOs declared unfit (13.6%). Half of them are linked to an epileptic pathology or electroencephalography abnormalities. It should be noted that the cardiology represents only 9 unfit ATCOs (11.1%) mainly linked to coronary artery disease. Finally, oncology represents only 4% of unfitness, mainly for detectable cancers. Pulmonary (sleep apnea), urological (renal colic), ENT or endocrinological (diabetes) pathologies are the cause of almost no unfitness. **DISCUSSION:** This is the first study about this specific population. Psychiatric, ophthalmological, and neurological pathologies are the most likely causes of unfitness among ATCOs. Compared to French aircrew population, there are significantly more causes for ophthalmological unfitness (p=0.005) and fewer causes for neurological unfitness (p=0.02), no significant difference for psychiatric causes. On the contrary, sleep apnea, cancer and urolithiasis most often allow aptitude. This development reflects the evolution of screening techniques and the improvement of medical care.

Learning Objectives

1. Know the reasons for unfitness for air traffic control in France.
2. Highlight the evolution of reasons for unfitness for air traffic control.
3. Discuss the critical medical elements for air traffic control fitness in 2023.

[501] ANALYSIS OF THE PERMANENT INCAPACITY OF AIRCREWMEMBERS OVER THE LAST PAST TEN YEARS (2012-2022), BY THE AIR FRANCE OCCUPATIONAL HEALTH SERVICE

Catherine Cardines, Marie Christine Bouton
Air France, Roissy, France

(Original Research)

In France, civil aircrew members have a double medical follow-up by aeronautical physicians (AME) and by occupational physicians like all French employees. This survey is carried out at Air France's occupational medicine department. The Air France collective agreements specify the terms and conditions of exercise in the event of loss of license (definitive unfitness). Therefore, loss of license must be requested by the aircrew members. The aeromedical expert prepares the file with the various medical elements and then transmits the request to the Civil Aeronautics Medical Council (CMAC). After analyzing the medical file, the CMAC issues the notice of permanent or temporary loss of the medical license. Our study was carried out using computer data identified and entered within the occupational health medical service. This concerns the characterization of the loss of licenses of the Air France air crewmembers, pilots and cabincrews, over the last past ten years: identification according to their function and gender, and the medical causes of the loss of license. We have identified, around 300 loss of license, from 2013 to 2022: Cabincrew (0.42 ‰ to 3.94 ‰) and Pilots (0.27 ‰ to 4 ‰) per year. We will present and discuss about the physical and psychological reasons observed. We

will also discuss the professional future within the company of those who have chosen the option of a retraining offered in the company according to their medico-professional skills, and the support offered for a retraining outside the company.

Learning Objectives

1. This concerns the characterization of the loss of licenses of Air France air crewmembers, technical (pilot) and commercial (cabin crew).
2. Identification according to their function and gender, and the medical causes of the loss of license.

[502] IS A BRAIN LESION ALWAYS DISQUALIFYING IN MILITARY AIRCREWS?

Jonathan Monin[1], Gaëtan Guiu[1], Laëtitia Marion[2], Sébastien Bisconte[1], Caroline Brescon[1], Mustapha Khezami[1], Eric Perrier[1], Olivier Manen[1]

[1]*Aeromedical Center, Percy Military Hospital, Clamart, France;* [2]*Medical Service of Clinical Psychology Applied to Aeronautics, Percy Military Hospital, Clamart, France*

(Original Research)

INTRODUCTION: Brain lesions could be due to numerous causes including head trauma, stroke but also intracranial tumors and infections. They represent a major issue in aviation medicine due to their potential consequences on flight safety such as epileptic seizures or cognitive and motor sequelae. Thus, we decided to perform a study to describe the population of aircrew members with a brain lesion, and to assess the arguments leading to a decision of unfitness in the aeromedical evaluation. **METHODS:** This is a retrospective study including all the military aircrew members with a history of brain lesion, whose medical file had been referred to the military aeromedical commission between 2014 and 2023. Numerous data were collected including flight duty, brain lesion cause, sequelae evaluation, and fitness assessment. **RESULTS:** Among the 1,073 medical files referred to the military aeromedical commission, 41 (3.8%) were of aircrews with brain lesions, mostly males (95%), pilots (51%) with a mean age of 40.2 ± 9.4 yr. 20 airmen (49%) had suffered a stroke, 11 (27%) a head trauma, 8 (20%) a cerebral tumor and 2 (5%) a cerebral infection. An at-risk cortical lesion was found in 66% of cases (n = 27), an EEG was performed for each of them with abnormalities in 6 cases. 24 aircrews (59%) had sequelae: 11 cognitive, 9 motor, 6 ophthalmologic, 4 with seizures. 29 aircrews (71%) were declared unfit, mostly because of an elevated epileptic risk (34%) and cognitive disorders (28%). Being a jet fighter pilot was a risk factor for unfitness ($p = 0.03$) as was the presence of sequelae ($p = 0.01$). **DISCUSSION:** The study reminds us that brain injuries are not such a rare phenomenon in military aircrews. It also underlines the logical link between the presence of sequelae like cognitive disorders or a high epileptic risk with a decision of unfitness. An exhaustive evaluation seems mandatory in this context including MRI, neurocognitive evaluation, and EEG in case of at-risk cortical lesion on the MRI. This evaluation could help aircrews, if no important sequelae is found, to get a waiver.

Learning Objectives

1. To know the main causes of brain lesions in military aircrews.
2. To understand the arguments leading to a decision of unfitness in military aircrews with a brain lesion.

[503] WHICH PSYCHIATRIC CONDITION WILL MAKE YOU UNFIT IN 2024?

Laëtitia Marion, Louis Chevalier, Sébastien Bisconte, Jonathan Monin, Olivier Manen

Aeromedical Center, Percy Military Hospital, Clamart, France

(Original Research)

INTRODUCTION: Military aircrews are a population that has been strictly medically selected. Psychological aspects are assessed from the beginning to the end of their career, due to the exceptional constraints to which they are exposed and to maintain flight safety at its highest level. Despite this assessment, some of them are no longer able to fly due to medical issues. In this study, we focused on the psychiatric causes of unfitness in military aircrews. **METHODS:** This is a retrospective study of the aircrew cases submitted for psychiatric reasons to the military aeromedical commission between January 2017 and September 2023. We were interested in the diagnoses adopted by the aeronautical psychiatrist and the fitness decisions taken by the medical commission: fit, fit with restrictions, temporarily or permanently unfit. **RESULTS:** Among the 759 files submitted to the aeromedical commission between January 2017 and September 2023, 101 (13.4%) were psychiatric files. The average age was 38.8 ± 7.9 yr, 75% were men, and 48% were pilots. The diagnoses were anxiety disorders and depressive disorders for 49% of them, adjustment disorders for 22%, addictive disorders and personality disorders for 17%, PTSD for 12% and psychoses for 4%. 45% were declared fit by the commission, generally with limitations. In terms of diagnosis, psychotic disorders, personality disorders ($p < 0.01$), adjustment disorders ($p = 0.03$) and depression ($p = 0.05$) appear to be risk factors for crew members to be unfit for flight. Flight incidents also correlate with more unfit decisions ($p = 0.02$). **DISCUSSION:** Despite some limitations linked to the retrospective nature of this study, it underlines the high proportion of psychiatric cases among those referred to the aeromedical commission. In addition, this study highlights the differences in terms of fitness prognosis depending on the diagnosis. Except in the case of severe psychiatric disorders, a case-by-case assessment is carried out, taking into account the pilot's experience and background, in order to discuss the possibility of a waiver.

Learning Objectives

1. To highlight the importance of mental health in terms of aeronautical fitness.
2. To better understand the fitness prognosis depending on the psychiatric diagnosis.

[504] BEYOND THE DISEASE, CAN BEING AT RISK MAKE YOU BECOME UNFIT TO FLY?

Nicolas Huiban[1], Mélanie Gehant[1], François-Xavier Brocq[1], Sébastien Bisconte[2], Laetitia Marion[2], Jonathan Monin[2], Catherine Cardines[3], Olivier Manen[2], Marc Monteil[1]

[1]*French Military Health Service, Toulon, France;* [2]*French Military Health Service, Clamart, France;* [3]*Air France, Roissy Aéroport CDG, France*

(Education - Program/Process Review)

BACKGROUND: In his daily practice, the expert may be confronted with a wide range of pathologies, the repercussions of which degrade flight performance. The potentially serious operational consequences can then naturally justify a decision of unfitness. But beyond the simple assessment of the compatibility between a morbid condition, expected performance levels and flight conditions, can a broader reflection on flight safety and the risk of in-flight incapacitation be reasonably concluded by a decision of unfitness? **OVERVIEW:** This question needs to be considered against a backdrop of increasing progress (medical and technological), and a regulatory framework authorizing operational limitations designed to "control" this risk by reducing it to a level deemed "acceptable". But could this approach be relevant in a military environment? In commercial civil aviation, it could make a lot of sense, since the simple addition of a second pilot could statistically reduce the risk of an accident caused by a pilot becoming incapacitated in flight by a factor of 1000. In other words, it would be virtually possible to "eliminate" this risk for air transport operations… But what would happen to a student pilot planning to become an airline pilot, but not yet holding a professional license at the time of the medical examination? Or a Class 2 private pilot? While this approach cannot be directly transposed outside commercial aviation, it appears that the level of safety required is generally lower in private than in commercial aviation. Some authors therefore recommend tolerating a higher risk of incapacitation for private pilots. So, apart from disabling pathologies, could the « simple »

risk legitimately constrain the fitness decision? **DISCUSSION:** In the end, in our current practice, could a decision on unfitness for flight be reasonably motivated by risk factors alone, or by a morbid condition that would be transient or even chronic, but without functional damage or sequelae? We will attempt to develop this question in the light of recent experience at the Toulon AEMC, by using clinical illustrations of military and civilian aircrews, received as part of initial and renewal medical visits.

Learning Objectives

1. To understand strategies for managing the risk of in-flight incapacitation.
2. To know the main causes of unfitness to fly decisions.

Thursday, 05/09/2024 ***3:30 PM***
Grand Hall K

[S-88]: PANEL: MEDICAL EDUCATION IN AEROSPACE MEDICINE: THE ROLE OF CERTIFICATION

Chair: Jennifer Fogarty

PANEL OVERVIEW: *This panel brings together aerospace medicine professionals involved in medical education activities related to the practice of aerospace medicine. Panelists represent different health professions, affiliated specialties, and varying stakeholder views. The first panelist will discuss the role of aerospace certification from the perspective of a Naval O-6 with respect to operational readiness and resource allocation. The second panelist will present the perspective of a civilian aerospace medicine fellowship program that accepts applicants with varied clinical backgrounds including family medicine, internal medicine, and emergency medicine. The third panelist will define aerospace nursing certification and describe a pathway for development. An approach to competency-based medical education models as it relates to aerospace medicine strategies and certification is presented by the fourth panelist. The concluding contribution will detail the viewpoint of a chief medical officer of a private company building a medical team capable of supporting private and government-sponsored astronauts aboard the NASA International Space Station and eventually the first commercial space station.*

[505] AEROSPACE NURSING CERTIFICATION – WHAT IS IT AND WHY DO WE NEED IT?

Cathy DiBiase
NEMCON Aerospace Medicine Group, Cape Canaveral, FL, United States

(Education - Tutorial/Review)

INTRODUCTION: Certification for any profession elevates the individual and the profession as a whole. There are many board certifications in nursing, but none are specific to aerospace nursing. **TOPIC:** Aerospace Nursing is a profession practiced by various groups of nurses both in civilian and military arenas across the world. Nurses practicing nursing within Space Medicine consist of a smaller subset of nurses. A general certification specific to Aerospace Medicine does not currently exist. Though there have been discussions within nursing arenas to promote a certification. other efforts have taken precedence. The urgency of work toward a certification should be promoted and pursued as we enter an era of greater frequency of commercial spaceflight where certification will validate the profession. **APPLICATION:** The goal of this presentation is to present the obstacles toward nursing certification and the education that would accompany this effort.

Learning Objectives

1. The participant will be able to discuss the pertinent benefits of aerospace nursing certification.
2. The participant will be able to describe the obstacles to establishment of a certification.

[506] THE IMPORTANCE OF AEROMEDICAL BOARD CERTIFICATION IN COMMERCIAL SPACE

Michael Harrison[1], Duncan Hughes[2]
[1]*Axiom Space Inc & Hercules Medical Group, Houston, TX, United States;*
[2]*Virgin Galactic, Truth or Consequences, NM, United States*

(Education - Program/Process Review)

BACKGROUND: Board certification in aviation (and later aerospace) medicine was first approved through the American Board of Preventive Medicine (ABPM) in 1953 and has provided specialists to support all manner of flight programs. The aeromedical events and the associated lessons learned from human spaceflight are occasionally high profile but, more frequently and in keeping with the basis in preventive medicine, occur discretely and without widespread awareness. The practice of high-quality preventive medicine has resulted in a stellar track record of mission support wherein primary medical events have very rarely resulted in mission impact. As commercial space opportunities increase and a wider range of health conditions become compatible with spaceflight, the training and certification provided by aerospace medicine training programs accredited by ABPM becomes increasingly important. **OVERVIEW:** No mandate for medical standards currently exists for certifying commercial astronauts for spaceflight. This freedom places significant responsibility on the individual spaceflight providers and their medical departments to practice in the best interest of their crewmembers, mission, company, and overall industry. A solid base as a clinician in a primary specialty and the augmented clinical capabilities provided by accredited training in aerospace medicine is a proven method to produce high quality operational flight surgeons capable of supporting all aeromedical aspects of commercial spaceflight. As commercial operations grow to include more international partners, the pathway to ABPM board certification or recognition of international equivalency becomes less of an obstacle to employment as compared to obtaining US licensure to practice. **DISCUSSION:** As human spaceflight grows to include more commercial operations, the current state of legislation and lack of binding medical standards makes aerospace board certification more important to the safe process of certifying crewmembers for commercial spaceflight and providing guidance on vehicle and mission design/support. It is unreasonable to assume the current training curriculums perfectly meet the needs of the industry but, as has been demonstrated over the past 70 years, the accredited training programs that produce board-certified flight surgeons are capable of adapting to meet the needs of the patient.

Learning Objectives

1. The audience will learn about the practice of aerospace medicine and the value of board certification to commercial space companies.
2. The audience will learn about the history and evolution of accredited aerospace medical training over the past 70 years.

[507] THE IMPORTANCE OF BOARD-CERTIFIED AEROSPACE MEDICINE SPECIALISTS IN THE NAVY

Robert Krause
U.S. Navy, Virginia Beach, VA, United States

(Education - Program/Process Review)

BACKGROUND: The origins of Naval Aerospace Medicine date back to 1912 when the Navy Bureau of Medicine and Surgery issued the first physical standards for Naval Aviation Candidates. Since that time the specialty has grown into a formal residency which was recognized by the American Board of Preventive Medicine (ABPM) in 1953. Aerospace Medicine Specialists have used the foundations of preventive medicine and safety to provide safe aviation and spaceflight operations within the Department of Defense, NASA, the FAA, and other private and government entities. Physical requirements, safety requirements, and cultural competency all play a role in Aerospace medicine and creating the pilot-physician bond which is unique from most other areas of medicine. As aviation and commercial spaceflight expand to a greater population, the training and certification accredited by the ABPM is increasingly important to keep

flying safe. **OVERVIEW:** With increasing demands on military medical providers, the benefit of board certified aerospace medicine specialists has previously been brought into question. The recent experience with COVID often placed an aerospace medicine trained physician at the forefront of prevention and reason for the operational forces that do not have the time to stop their mission. It also highlighted the potential pitfalls that can occur when a provider lacks a preventive medicine background and cannot communicate population health to a community. Additionally, the importance of obtaining cultural competency within Naval Aviation cannot be understated when working with this population. **DISCUSSION:** As the potential for conflict arises with near-peer competitors many medical leaders will be at the tip of the spear working as an advisor and caretaker to the aviators within their purview. Establishing care for this community will be unique and the pilot-physician relationship will be increasingly important. The need for military aerospace medicine physicians may increase as they will need to lead and mentor the less experienced flight surgeons in the practice of preventive medicine which may be foreign to someone with a hospital-centric experience. Understanding safety, risk mitigation, and the clinical aspects unique to the aerospace population cannot be learned overnight and training and working within that environment is critical to obtaining the competencies to succeed within the community and gain pilot trust which ultimately leads to safer missions.

Learning Objectives

1. The participant will understand the importance of cultural competency and the pilot-physician relationship which is unique in Aerospace Medicine.
2. The participant will understand the unique role of aerospace medicine providers within the Navy and why board certification is critical to the Navy's medical mission and success.

[508] CIVILIAN AEROSPACE MEDICINE RESIDENCY: MORE THAN 30 YEARS OF EDUCATING PROVIDERS FROM SHUTTLE TO ISS TO COMMERCIAL SPACE

Serena Auñón-Chancellor
UTMB, Galveston, TX, United States

(Education - Program/Process Review)

INTRODUCTION: With more than 30 years as an established American College of Graduate Medical Education (ACGME) accredited two year Post Graduate Medical Education (PGME) provider in aerospace medicine, this civilian based program has a significant footprint in aerospace medical education. Graduates have supported different eras of spaceflight from Shuttle, to International Space Station, and commercial crew missions. Enriched by a faculty with diverse clinical, physiologic, and disciplinary backgrounds, residents are educated through varied activities. **TOPIC:** A unique asset of the program lies in the four streams: (1) aerospace medicine residency; (2) principles of aviation and space medicine; (3) human health and performance; and (4) aerospace medical school concentration. The aerospace medicine residency program leads medical doctors to board certification. The remaining streams provide an inclusive opportunity, accepting learners at all levels and from different clinical backgrounds. They provide structured formal education, allowing those learners to contribute to other aspects of human space flight. In turn, this may serve to inform and enrich the PGME program. **APPLICATION:** The focus of this discussion will be on the value of aerospace medical education activities targeted at preparing for board certification and those that provided structured exposure without immediately leading to certification. Similar to off service placements in undergraduate medical education (UME) and PGME, there is significant value to accessible aerospace medical education at different levels of learner expertise.

Learning Objectives

1. List three levels of learner that may engage in formalized aerospace medicine education activities.
2. Describe the requirements for board certification in Aerospace Medicine by the American Board of Preventative Medicine (ABPM).
3. Describe the difference between a UME and PGME educational interventions.

[509] COMPETENCY BASED MEDICAL EDUCATION AS A FRAMEWORK FOR THE DEVELOPMENT OF AEROSPACE MEDICINE EXPERTISE

Kathleen Samoil
Simon Fraser University, Burnaby, BC, Canada

(Education - Program/Process Review)

INTRODUCTION: As space mission frequency increases and the number of individuals requiring aerospace medicine expertise to inform and provide clinical care there is value in examining the role of competencies as to inform education and evaluation strategies. These concepts can be carried forward to inform the certification process. **TOPIC:** Competency based medical education (CBME) is the current framework of the Accreditation Council for Graduate Medical Education (ACGME). Milestones, competencies, evaluation, and their relation to clinical outcomes at both the program and individual learner level require a strong framework (Nasca, Philibert, Brigham, & Flynn, 2012). This continues the competency structure for undergraduate medical education outlined by the Association of American Medical Colleges (2023). This work is built of the CanMEDS framework of the Royal College of Physicians and Surgeons of Canada (Frank, Snell, & Sherbino, 2015). This model outlines a model for the development of medical expertise through foundational medical knowledge, clinical skills, and professional values (Frank, Snell, & Sherbino, 2015). A key component of CMBE is the role of external and objective evaluation as it relates to the roles of (1) Communicator, (2) Collaborator, (3) Leader, (4) Health Advocate, (5) Scholar, and (6) Professional. **APPLICATION:** With the move to CMBE for each of undergraduate, post graduate, and continuing medical education activities there are some core tenets that can be used to inform certification of different health professions including medical doctors, registered nurses, physiotherapists, paramedics and beyond within aerospace medicine. These tenets include the role of the external evaluator as opposed to self-assessed expertise. Cross monitoring, and a system of checks and balances as they relate to up to date, ethical, resourceful, and collaborative clinical care.

Learning Objectives

1. Describe two distinct concepts of a competency based medical education framework.
2. List the six unique roles of the medical expert as first described in CanMEDS.

FRIDAY, MAY 10, 2024

Friday, 05/10/2024 ***8:00 AM***
Grand Ballroom ABCD

[S-89]: WORKSHOP: SPACE MISSION ANALOGS: MEDICAL CARE IN REMOTE MARITIME OPERATIONS

Chair: Brian Pinkston

Workshop OVERVIEW: *In the early days of the U.S. Space program, hard lessons were learned through the trials of courageous scientists, engineers, astronauts, and other explorers. One of the most challenging human components of the mission was the safe recovery of astronauts in the hostile environment of the ocean. Pioneers such as NASA flight surgeon, Dr. Bill Carpentier, risked their lives in operational trials to ensure the safety of crew members in maritime operations. Decades of space shuttle missions followed by Soyuz support to the international space station shifted focus from the ocean. However, commercial space operations have returned to the practice of ocean-based recoveries. This has required reinvigoration and retraining in this area as much of the team members with this knowledge have retired. This workshop is intended*

to be an introductory, hands-on workshop focused on medical care and safe operations in remote maritime missions. It will cover the following: 1) recovery of crew members in the water including proper techniques to reduce the risk of circumrescue collapse and afterdrop. 2) hypothermia, drowning, and their treatment in the field 3) maritime communications in an emergency and an introduction to rescue systems around the world 4) statistical analysis of common injuries and illnesses aboard ocean-bound vessels as well as their treatments 5) considerations for an appropriate maritime medical kit 6) roles and responsibilities of a vessel's medical officer 7) patient packaging for transport This workshop will be conducted with demonstrations and activities in a classroom, aboard sailboats, and in a controlled water environment.

[510] SPACE MISSION ANALOGS: MEDICAL CARE IN REMOTE MARITIME OPERATIONS

Brian Pinkston[1], Cheryl Lowry[1], Jim Fike[2], Bonnie Posselt[3]
[1]*Kinetic Medical Consultants, St. Petersburg, FL, United States;* [2]*Fike Global Health, Alexandria, VA, United States;* [3]*RAF, London, United Kingdom*

(Education - Tutorial/Review)

In the early days of the U.S. Space program, hard lessons were learned through the trials of courageous scientists, engineers, astronauts, and other explorers. One of the most challenging human components of the mission was the safe recovery of astronauts in the hostile environment of the ocean. Pioneers such as NASA flight surgeon, Dr. Bill Carpentier, risked their lives in operational trials to ensure the safety of crew members in maritime operations. Decades of space shuttle missions followed by Soyuz support to the international space station had shifted focus from the ocean. However, commercial space operations have returned to the practice of ocean-based recoveries. This has required reinvigoration and retraining in this area as much of the team members with this knowledge have retired. This workshop is intended to be an introductory, hands-on workshop focused on medical care and safe operations in remote maritime missions. It will cover the following:

1. recovery of crew members in the water including proper techniques to reduce the risk of circumrescue collapse and afterdrop;
2. hypothermia and drowning and their field treatment;
3. maritime communications in an emergency and introduction to rescue systems around the world;
4. statistics for common injuries and illness aboard ocean-bound vessels and treatments;
5. considerations for an appropriate maritime medical kit;
6. roles and responsibilities of a ship's medical officer;
7. patient packaging for transport.

This workshop will be conducted with demonstrations and activities in a classroom, aboard sailboats, and in a controlled water environment.

Learning Objectives

1. By the end of the session, participants will be able to properly call a "mayday" and package a patient for transport in a maritime operation.
2. By the end of the session, the attendees will be able to name the top three injuries that commonly occur aboard a maritime vessel.
3. By the end of the session, each participant will understand the key steps to safely recover an overboard crew member while minimizing the risks of a fatal dysrhythmia or cardiovascular collapse.

[511] SPACE MISSION ANALOGS: MEDICAL CARE IN REMOTE MARITIME OPERATIONS

Brian Pinkston[1], Cheryl Lowry[1], Bonnie Posselt[2]
[1]*Kinetic Medical Consultants, St. Petersburg, FL, United States;* [2]*RAF, London, United Kingdom*

(Education - Tutorial/Review)

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4. statistics for common injuries and illness aboard ocean-bound vessels and treatments;
5. considerations for an appropriate maritime medical kit;
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Index of Abstract Authors (with abstract numbers) and Session Chairs (with session numbers designated by S-01 through S-89)

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Hernando "Joe" Ortega, Jr., M.D., MPH

American Osteopathic Association Delegate
Warren Silberman, D.O.

+Members of Executive Committee
*Ex Officio member without a vote

2024 Annual Meeting Chairs & Committees

Eilis Boudreau
Scientific Program

Amanda Lippert
Deputy Scientific Program

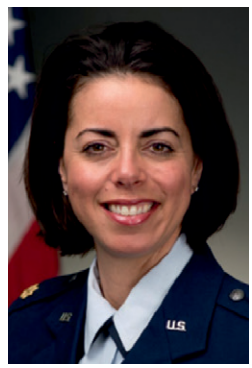
Samir Alvi
Panels

Douglas Boyd
Slides

Katie Samoil
Posters

Adam Sirek
Remote Review

Ken Egerstrom
Deputy Remote Review



Jaime Harvey
Members-at-Large Chair

Scientific Program
Eilis Boudreau—Chair
Amanda Lippert—Deputy Chair
Samir Alvi—Panels
Douglas Boyd—Slides
Katie Samoil—Posters
Adam Sirek—Remote Review
Ken Egerstrom—Deputy Remote Review
Jamie Harvey—Members-at-Large Chair
John Barson—Member-at-Large
Roy Allen Hoffman—Member-at-Large
Thomas Hoffman—Member-at-Large

Remote Reviewers
Mark Adams
Samir Alvi
Mina Arsanious
Tamara Averett-Brauer
Jeremy Berger
Dacia Boyce
Lisa Brown
Paul Cervenko
Bob Cheung
Rowena Christiansen
Brennan Cox
Sarita Dara
Jason David
Charles DeJohn
Kevin Divers
William Dodson
Jessica D'Urbano
Chris Edge
Elizabeth Eekhoff
Carlos Enamorado
Richard Folga
Estrella Forster
Juan García Vite
Steven Gaydos
John Harrell
Nils Holmedahl
Joseph Hudson
Nora Johnson
Jeffrey Kinard
Samantha King
J. Klingenberger
Joseph LaVan
George Lopez
Khanh Mai
Geoffrey McCarthy
Kristian Mears
Ian Mollan
Dirk Neefs
Eleanor O'Rangers
Forest Pavel
Denise Pierre
Brian Pinkston
Carol Ramsey
Brandi Ring
Kathleen Samoil
Sanjiv Sharma
Ganeev Singh
Thomas Smith
Annette Sobel
Timothy Sprott
Lloyd Tripp
Jeffrey Tsang
Anthony Tvaryanas
Stephen VanderArk
Marion Venus
Frank Villamaria
Rich Whittle
Alex Wolbrink
Jesse York
Inne Yuliawati

Onsite Reviewers
Christopher Armstrong
Denise Baisden
Jennifer Benincasa
Frederick Bonato
Jeff Chancellor
James DeVoll
Benjamin Easter
Edmond Feeks
Justin Flatt
Kathryn Hughes
William Klein
Andrew Lam
Benisse Lester
Harriet Lester
Peter Mapes
Matthew Melin
Kenneth Myers
Paul Newbold
Robert Orford
Ryan Peirson
Casey Pruett

See "SPC members", p. 634

Aerospace Medical Association Staff

Jeffrey Sventek
Executive Director

Gisselle Vargas
Deputy Executive Director

Sheryl Kildall
Membership Services

Rachel Trigg
Managing Editor & Subscriptions Manager

Stella Sanchez
Assistant Managing Editor

David Newman
Editor

Sandy Kawano
Assistant to the Editor

The Wing of AsMA Executive Board, 2024–2025

Elected Officers

President	Jackie Bohnker
Vice President	Lisa Veronneau
Secretary	Jeanette Egerstrom
Treasurer	Brenda Clinton
Deputy Treasurer	Terry Crane

Board Members-at-Large

Liz Fox; Julia Elliot; Debra Anzalone

Special

Past President	Fran Laue
2nd Past President	Sandy Vanderploeg
Liaison to AsMA	Peggy Trumbo
Nominating Chair	Fran Laue

Appointed Officers

Parliamentarian	Carrie Davis

Communications

Electronic Communications	Fran Laue
Newsletter	Yalonda Silberman
Website	Deb Sventek

Standing Committee Chairs

Membership	Yalonda Silberman
Registration/Advanced Registration	Abby Elliott
Arrangements	Michelle Garber

Scientific Program & Registration Committee Members *("SPC Members", Continued from p. 633)*

David Schroeder
Nereyda Sevilla
Bethany Shivers
Warren Silberman
Raunak Singh
Rahul Suresh
Debra Sventek
Jeffrey Sventek
Anthony Wagstaff
Sarah Wright
Tami Averett-Brauer
Christopher Backus
Edmond Feeks
Jason Cromer
William Dodson
Jeremy Garlick
Sonya Heidt
Thomas Hoffman
Gordon Landsman
Jeff Lawson
Charles Shurlow
Sherry Sandoval
Allan Ward
Paul Young

Registration

Nora Johnson—Chair
Winton P. Laslie—Co-Chair
Carolyn Jarrett—Co-Chair

Abridged Minutes of the 93rd Annual Business Meeting

Tuesday, May 23, 2023, Sheraton New Orleans Hotel, New Orleans, LA, United States

Northrup

Sventek

Call to Order (Susan Northup): A quorum of more than 100 members in attendance was met and the meeting started at 12:00 pm CDT on Tuesday May 24, 2023.

In Memoriam (Susan Northrup): Attendees paused to reflect and remember those members of AsMA who passed away since the last AsMA conference in 2022.

Recognition Of Past Presidents (Susan Northrup) : Past presidents were asked to rise and be acknowledged.

President's Report (Susan Northrup): It has been an amazing year. It has been a challenging year. You will hear the reports from all of the vice presidents and the treasurer that indicate we are back and financially sound. We are being asked our opinions – our opinions matter. Some organizations claimed to know what we were going to do before we did it and used our name [AsMA] in various missives. I would see that in my civilian position and would remark "I didn't approve of that!" As an organization we carry weight. Please see my full report to the AsMA Council on 21 May.

Report of the Executive Director (Jeff Sventek): Madame President, Officers and Members of the Association, it is my pleasure to report that this year was extremely active and very successful. I especially want to recognize all the volunteers that helped move our Association forward. Thank you for your continued strong support for the Aeromedical Association. I would also like to recognize our headquarters office staff and our journal independent contractors. They work hard every day to provide a high quality Scientific Journal as well as outstanding customer service and administrative support to our members.

Pam Day retired from our association in early 2023 after serving AsMA for over 42 years. Dr. Fred Bonato, AsMA Journal Editor-in-Chief and I selected Rachel Trigg, Pam's long-time assistant, as the new Managing Editor of our Journal. Rachel's selection generated a need to hire a new assistant to the managing editor and we posted the advertisement through the Indeed website, receiving twelve applications. Six were selected for interviews. From those interviews we selected Stella Sanchez to serve as our Assistant Managing Editor, who we are pleased accepted our offer to come work with us. All the staff stood to be recognized.

AsMA finished 2022 in good financial shape. We were able to meet all 2022 obligations without pulling money from the AsMA investments. The Joint Annual Scientific Meeting with the UHMS in Reno was very well attended and excess revenue from that meeting was $591,570. The UHMS 'share of the excess revenue was $95,595 based upon their percentage of attendees. That left AsMA with excess revenue from Reno of $495,975.

AsMA also collaborated with the International Academy of Aviation and Space Medicine (Academy), the European Society of Aerospace Medicine (ESAM), and the Francophone Society of Aerospace Medicine (SOFRAMAS) in hosting the 1st International Congress in Aerospace Medicine (ICAM), that was conducted September 22-24, 2022 in Paris, France. AsMA was responsible for the registration processes and we shared any excess revenue from the event. The ICAM was designed for a break-even goal of 400 registrants. The final registration total was 845. The ICAM finished with net excess revenue of €245301,10 or $260,019.17. This net excess revenue was distributed to each of the four organizations responsible for the ICAM in the following amounts: SOFRAMAS: € 63681,33 ($67,502.21); IAASM: € 59581,95 ($63,156.87); ESAM: € 56578,91 ($59,973.68); AsMA: € 65458,91 ($69,386.44). The differences in the amounts distributed included organization-specific liabilities incurred during the ICAM. All organizations agreed to the amounts distributed. The ICAM 2022 was a big educational and financial success!

AsMA, the International Academy of Aviation and Space Medicine (IAASM), the European Society of Aerospace Medicine (ESAM), and the Portuguese Society of Aerospace Medicine (SMAPor) have started meeting to prepare for the 2024 International Congress in Aerospace Medicine (ICAM 2024) in Lisbon, Portugal. I would encourage you to put that on your calendars.

AsMA recently completed the annual financial audit for 2022. The published audit report provides the auditors' opinion.

"We have audited the accompanying financial statements of Aerospace Medical Association [(the Association) (a nonprofit organization)], which comprise the statements of financial position as of December 31, 2022 and 2021, the related statements of activities, functional expenses and cash flows for the years then ended, and the related notes to the financial statements. In our opinion, the financial statements referred to above present fairly, in all material respects, the financial position of Aerospace Medical Association as of December 31, 2022 and 2021, and the changes in its net assets and its cash flows for the years then ended in accordance with accounting principles generally accepted in the United States of America."

AsMA membership: AsMA membership has stabilized between 2,000 and 2,100 paid up members. As of today, the AsMA membership is 2,104. The AsMA Council voted to approve the Allied Membership as a permanent membership category for our association at the Sunday, 2023 AsMA Council Meeting. We will be updating the By Laws and all the membership literature to reflect that in the future. This Allied Membership is designed to expand the AsMA membership to residents of countries with developing economies and low incomes.

For the 93rd Annual Scientific Meeting Scientific meeting in New Orleans, as of this morning, the total registration is 1,612 registrants. This represents an increase of 125 attendees or 8.4% increase from the registration at the same time in Reno last year. Revenues from these meetings represent a very large portion of our annual operating budget and we thank all of you for participating in our onsite face-to-face meetings.

Finally, last July 2022 was the first month where the electronic version of the *Aerospace Medicine and Human Performance* (AMHP) Journal became the default member benefit. This change was approved by the AsMA Council in November 2021. All AsMA members now have access to the electronic journal via the AsMA Members Only section of the AsMA website as part of their membership. If they wish to receive the AMHP Journal in print, they must now purchase a subscription to the print journal. A 1-year subscription to the print AMHP Journal for an AsMA member is currently set at $100.

The July invoice for the printing and mailing of the AMHP journal was $1,599.84. The average cost to print and mail the January, February, April, and May issues of the AMHP journal was $6,028.60/month. Moving to the electronic journal as the default member benefit appears to save AsMA about $5,000/month or $60,000/year.

A comparison of 2021 vs. 2022 costs for journal Print/Mail/Handling shows a cost of $127,021.14 in 2021 vs. a cost of $87,185.80 in 2022. This is an overall savings of $39,835.34 year to year. However, this savings was realized in only the last 6 months of 2022. That is an average monthly savings of $6,639.22 and suggests an annual savings of approximately $75,000 in Print/Mail/Handling expenses for 2023 and beyond.

Report of the AsMA Foundation Chair (Kim Broadwell): Dr. Broadwell thanked the members of AsMA, noting that it is 'your AsMA Foundation' and the work of the Foundation could not continue without the members' support. He expressed the hope that AsMA members who had donated, had received their purple donor ribbons. "You should put it on and wear it. It will make you look more important." He pointed out the AsMA Foundation funds are doing very well, and have weathered the crisis in the stock market. The Foundation has been able to meet all of the award and scheduled scholarship commitments. The endowments, thanks to the conservative management, have recovered from the stock market crater of last year.

The Foundation has done good things for 16 years, but the Board of Directors would like to do more, to take it to the next level. Dr. Broadwell presented the exciting new Foundation Initiative to empower the next generation of aerospace medicine [specialists] to solve the 'Challenge of Deep Space Exploration.' There will be two major foci of the campaign, first to increase what is available for post-graduate education of aerospace medicine specialists. Second, to provide seed money for young investigators to take their experiments to commercial spaceflight companies or to NASA and ask them to 'fly' their projects. 'The Need for Speed' – to go farther, faster, together with an endowment goal of $5 million by the AsMA Centennial in 2029.

GOVERNANCE (Joe Dervay)

Bylaws Committee: There were no new Bylaws or Policy and Procedures changes reviewed at council.

Scientific Program Committee: An excellent report was given yesterday at the opening ceremony by Dr. Ian Mollan. We appreciate Dr. Mollan's report.

Nominating Committee Report (Chuck DeJohn): The Nominating Committee meets several times per year and does a tremendous job. Members of the Nominating Committee stood and were acknowledged. The President-Elect is Robert Orford; Vice Presidents: Susan Fondy (2-Yr Term), Anthony Wagstaff (2-Yr Term), and Rowena Christiansen (1-yr term to replace Dr. Orford); Secretary: J. Karen Klingenberger (2-Yr Term); Members-at Large: Kathy Hughes, Dan Van Syoc, Denise Baisden, Diego Garcia, Winton Laslie, (2-yr term to replace Anthony Wagstaff), Wendell Becton (1-yr term to replace Rowena Christiansen). No nominations were received outside of this process.

AsMA Treasurer's report (Casey Pruett): For 2022, net income stands at −$14,708 (compared to budgeted $41,968). AsMA recorded the highest ever total revenue to date, $1,919,259 and the highest unrealized loss on its investments to date, −$122,305! Convention revenue was $52K less than budgeted, with the expenses $83K over budget. However, the convention still yielded a positive result of $370,000. The journal did well at $14K above budget with increases in royalties while the membership hit $21K below budget despite the lower individual and corporate membership, and five new life members. Journal expenses were $42K less than anticipated coincidentally at the same level under budget for AsMA management expenses due to insurance and travel savings. Overall, an amazing job to have a result of −$14K, given a −$99K in investment value. Otherwise, we would have wound up $85K, compared to a budgeted expectation of $41K.

ICAM Paris 2022 generated a net income of $260K that was shared across the four supporting organizations, resulting in approximately an additional $69K net income for AsMA. Membership remains the second largest contributor to AsMA revenues at $68K ($119K expenses) thus far. There were more life memberships (5) compared to 1 budgeted, resulting in additional revenue of $25K vs. $5K. Corporate membership dues were slightly less than budgeted by $2K. The journal slightly over performed in revenue, including open access and classified advertising that were better than expected. Printing costs dropped substantially from an estimated $130K down to $87K. Staff salaries and printing and mailing were within budget. The financial result for 2022 is very close to being on target compared to budgetary expectations. This is despite uncertain markets, "unmasking" COVID for the first full AsMA, additional revenue from ICAM, stopping the print journal, changing membership (more lifetime, more students, less corporate), and management cost savings in travel and insurance costs. The goal remains to have $1M in the Investment Portfolio to be used for down years and unanticipated expenses.

For 2023, preliminary data for January-February shows a net income loss driven by $85K revenue from membership and journal compared to $167k expenses from management and journal. To date, slightly higher royalties and archive fees contributed to the expected subscription income for journal revenue, while printing costs and salaries comprised the highest portion of journal expenses.

Recommendations: Reassess AsMA financial position after New Orleans and perhaps start replenishing the investment portfolio to regain our $1M posture (2-4 years?). Use the lessons learned from 2020-2022 and increase revenue with a potential virtual convention, meetings, and workshops, membership incentives, fund raisers. We will also continue to leverage the cost saving efforts from the membership and journal committees.

EDUCATION AND RESEARCH (Warren Silberman)

Science & Technology (S&T) Committee: The Chair is Ryan Mayes. The S&T committee is being reinvigorated and will be producing articles about different technologies. The S&T Committee presented a panel. A planetary protection monograph was developed by students with Jeff Myers' mentorship. There was a meeting on Space Medicine Fellowship as it relates to Aerospace Medicine Residency.

INTERNATIONAL SERVICES (Bob Orford)
Allied Membership in AsMA is offered to International Members from low and middle income countries (total of 90 countries as determined by the United Nations) for an annual fee of $50.00 with free registration to the Annual Scientific Meeting. There was a concern, at the initiation of the program, that the number of Allied Members would incur increased costs to AsMA. As a result, an initial limit or goal was set at 90 and later adjusted to 50 Allied Members. The Allied Members Program was discussed at both the Executive Committee Meeting in March and the AsMA Council, last Sunday. Ultimately it was decided that in view of the relatively small costs involved, it would be reasonable to extend this program indefinitely. The actual numbers during the COVID pandemic were 23 last year and 29 this year.

The International Congress on Aviation and Space Medicine (ICASM) will meet in Abu Dhabi this fall. ICASM sponsored by the International Academy of Aviation and Space Medicine (IAASM) will alternate every other year with the International Conference in Aerospace Medicine (ICAM). ICAM will be held in Lisbon Portugal from the 3-5th of October in 2024.

REPRESENTATION AND ADVOCACY (Susan Northrup for Barry Shender)
Resolution 2022–01: Titled 'Importance of Accredited Training and Board Certification in Aerospace Medicine for the growing Commercial Space Industry', this resolution was approved by the AsMA Council for posting.

Thank you for donating to the Foundation.

The Communications Committee should be acknowledged for elevating our presence in the online world.

Unfinished Business: none.

New Business: none.

Motion made and seconded to adjourn the meeting at 12:53 CDT.

Respectfully submitted,
Jeffrey Sventek, MS, FAsMA, CAsP, Executive Director
J. Karen Klingenberger, M.D., MPH, MS, Secretary

Abridged Minutes of the 94th Annual Business Meeting

Tuesday, May 7, 2024, Hyatt Regency Chicago Hotel, Chicago, IL, United States


Dervay


Sventek

Call to Order (Joe Dervay): A quorum of more than 100 members in attendance was met and the meeting started at 12:00 pm CDT on Tuesday May 7, 2024.

In Memoriam (Jeff Sventek): Attendees of the Annual Business Meeting paused to reflect and remember those members of AsMA who passed away since the last AsMA conference in 2023.

Recognition Of Past Presidents (Jeff Sventek): Past presidents were asked to rise and be acknowledged. Introduction of John Peters, Executive Director and Owen O'Neil, president elect of UHMS.

President's Remarks (Joe Dervay): I would like to thank the AsMA Council for the excellent, substantive meeting on Sunday. Also, thanks to the Scientific Program Committee for the tremendous Scientific Program this week. It has been an amazing year. The Reinartz Lecture was excellent and we would have liked to have 45 more minutes for the presentation. The Thursday morning Council Meeting will now be at 6:00 p.m. on Wednesday to encourage a greater attendance. Please consider donating Honor's Night tickets to AMSRO members to help them attend Honors Night.

Report of the Executive Director (Jeff Sventek): Mr. President, officers, and members of the Aerospace Medical Association, it is my pleasure to report that this past year was extremely active and very successful. There are many within the Association responsible for this success, including elected officers, AsMA Committees, Constituent Organization leaders, Affiliated Organization leaders, and all who volunteered this past year to help move the Association forward. Thank you for your continued strong support of the Aerospace Medical Association. I'd also like to recognize the Headquarters Office Staff and our journal independent contractors. Please stand as I introduce you so our members can put a face to the name. The AsMA Deputy Executive Director is Gisselle Vargas, who has been employed by AsMA for 18 years. Our Membership Director is Sheryl Kildall, a 23-year employee of AsMA. Managing Editor for the journal is Rachel Trigg, who has been with AsMA for nearly 21 years. Stella Sanchez has been with AsMA since January 2023 and serves as our Assistant Managing Editor for the journal. We also have two outstanding contract employees. Dr. David Newman serves as the Editor-in-Chief for our AsMA journal and Sandy Kawano works as the Assistant to the Editor-in-Chief. All of our employees and independent contractors work hard every day to provide a high-quality scientific journal as well as outstanding customer service and administrative support to our members. Thank you all for your outstanding work.

Speaking of our AsMA Journal, Dr. Fred Bonato stepped down as the AsMA journal Editor-in-Chief on 31 December 2023. The AsMA Council selected Dr. David Newman to replace Dr. Bonato. Dr. Newman assumed the role as Editor-in-Chief of the *Aerospace Medicine and Human Performance* journal on 1 January 2024. He, along with Sandy Kawano, Rachel Trigg, and Stella Sanchez have not missed a beat in ensuring the AsMA journal remains as a high-quality scientific publication.

The AsMA journal staff have also initiated two additional changes to the AsMA journal this year. You likely noticed we did not provide you a print program for the 2024 AsMA Annual Scientific Meeting as we have done for many years. Rather, we provided you a printed Meeting Activities Brochure with your registration packet and directed you to the digital meeting

app for meeting details. The decision to stop using the March or April issue of the journal for a print program was based upon several problems we experienced on an annual basis with the print program. First, all materials for a March journal publication must be to the publisher by 15 January and all materials for an April journal publication must be to the publisher by 15 February. As you might imagine, many changes are made to the Annual Scientific Meeting schedule after 15 January or 15 February and those are not captured in the printed program issue. Second, all accepted scientific abstracts are submitted to the publisher on the referenced dates. Numerous events impact our presenters and several presenters each year must make the decision to withdraw their approved presentations. Many of the withdrawal notifications to AsMA arrive after materials are sent to the publisher so abstracts are published in the print program journal issue that are not presented during the Annual Scientific Meeting. As a result, the AsMA journal team decided to use one of the summer issues following the annual scientific meeting to publish a proceedings issue that will publish only those presentations that were actually made during the meeting.

The second AsMA journal initiative is related to the AsMA archived journals (1930–2002) hosted by Mira and the current online journals (2003–Present) hosted by Ingenta Connect. Members and subscribers must move between these two hosting services to access the desired journal issue and articles. Each hosting service offers different user interfaces and search capabilities, making it a bit frustrating when searching for specific topics. The AsMA Council approved a proposal from our publisher, Sheridan, to migrate all issues of the AsMA journal (1930–Present) from the two current hosting services to the Sheridan PubFactory service. That migration process is nearly complete and we anticipate having all AsMA journal issues in one place soon. PubFactory will offer our members and subscribers a modern and sophisticated user interface. It will also offer all issues of the AsMA journal in one location to facilitate easier access to journal issues and articles as well as one-stop shopping for searching the journal. You will be notified when the migration process is complete and the new PubFactory website is open for business. By the way, you will continue to access the PubFactory website in the same way you have accessed the Mira and Ingenta Connect websites. You will log into the Members Section of the AsMA website and select the PubFactory website to gain access to all years and issue of the AsMA journal.

AsMA finished 2023 in good financial shape. We were able to meet all 2023 obligations without withdrawing money from the AsMA reserves. The 2023 Annual Scientific Meeting in New Orleans was very well attended and excess revenue from that meeting was $539,284. AsMA finished 2023 with net excess revenue of $112,070. Following this year's Annual Scientific Meeting, the AsMA Treasurer and I will recommend an amount to the Executive Committee to move from the AsMA bank account into the AsMA investments as we continue to move our AsMA investments toward the $1 million goal.

AsMA recently completed the annual financial audit for 2023. The published audit report provides the auditors' opinion.

"We have audited the accompanying financial statements of Aerospace Medical Association (the Association) (a nonprofit organization), which comprise the statements of financial position as of December 31, 2023, and 2022, the related statements of activities, functional expenses and cash flows for the years then ended, and the related notes to the financial statements. In our opinion, the financial statements referred to above present fairly, in all material respects, the financial position of Aerospace Medical Association as of December 31, 2023, and 2022, and the changes in its net assets and its cash flows for the years then ended in accordance with accounting principles generally accepted in the United States of America."

AsMA membership is experiencing a slow growth. As of this report, AsMA membership totals 2,158. That represents a 2.5% increase from the same time last year. As a result of the increase in membership, AsMA finished 2023 with membership revenues of $405,000 vs. the budgeted amount of $357,000.

AsMA is collaborating with the International Academy of Aviation and Space Medicine (Academy), the European Society of Aerospace Medicine (ESAM), and the Portuguese Society of Aerospace Medicine (SMAPor) in hosting the 2nd International Congress in Aerospace Medicine (ICAM) scheduled for October 3–5, 2024, at the Aula Magna in Lisbon, Portugal. A Memorandum of Understanding between the four organizations has been signed and is very similar to the agreement used for the ICAM 2022 in Paris, France. Registration for the 2nd ICAM is open with very reasonable registration fees. As of this meeting, there are 123 registered for the 3-day Congress. There are also currently six 1-day registrants and seven accompanying persons. The 2nd ICAM is offering four Technical Visits with two occurring prior to the start of the Congress, 1 occurring in conjunction with the Congress, and 1 occurring after the Congress. The Congress is also offering two workshops. The scientific program is being developed by a joint group from all four organizations and currently has approved 70 presentations for the Congress. The deadline for submitting an abstract for consideration is 19 May.

As of this morning, total registration for [the 2024] meeting is 1,752, compared to 1,612 at the same time for the 2023 meeting. Of that total, 1,675 were registered in advance of the meeting and 77 attendees registered here on site. This represents an increase of 140 attendees or 8.7% above the 2023 meeting in New Orleans. Revenue from our Annual Scientific Meetings represents a large portion of our annual operating budget and we thank all participants.

Report of the AsMA Foundation Chair (Kim Broadwell): Dr. Broadwell is the outgoing chair. The new chair will be Mark Campbell. A new position on the AsMA Foundation Board will be an AMSRO member on the board. The Foundation has great ambitions that are focused on the next generation. "The Need for Speed"—to go farther, faster, together with an endowment goal of $5 million by the AsMA Centennial in 2029. Dr. James Vanderploeg donated a $25,000 matching contribution to "The Need for Speed" campaign. You can donate in many ways, including during registration for the AsMA Scientific Meeting. Dr. Broadwell reminded members, if you have donated to the AsMA Foundation, you can wear a ribbon on your badge.

GOVERNANCE (Robert Orford)

The theme for the next year will be Innovation: Journey to the Future. Dr. Orford presented the current status of the collaboration with UHMS and plan for John Peters to become Executive Director of both AsMA and UHMS in June 2025. The background is that AsMA was established in 1929, UHMS was established in 1967 and became an AsMA constituent organization in 1974. The organization merged with Hyperbarics in 1990. A working group designated during the Executive Committee developed an MOU with the following concepts and steps: keep

the identity and culture of AsMA and UHMS; single executive director of both AsMA and UHMS; CME will be continued to be managed by UHMS; larger role to senior staff within AsMA and UHMS, Giselle Vargas will be the Deputy Executive Director; MOU collaboration committee build guidelines for a more collaborative relationship with the AsMA and UHMS staffs; June 30, 2025, Jeff Sventek will retire and Jeff Peters will be Executive Director of both UHMS and AsMA; pre-hire John Peters in July of 2024 through December 2024 at no cost to AsMA organization; Consulting payment to John Peters from Jan to June 2024; proposal outlined in MOU accepted by the AsMA council.

Bylaws Committee: There were no new Bylaw or Policy and Procedures changes reviewed at the AsMA Council Meeting.

Scientific Program Committee: An excellent report was given yesterday at the opening ceremony by Dr. Ian Mollan. We appreciate Dr. Boudreau's report.

Scientific Program Committee Report (Eilis Boudreau): 696 abstracts were submitted and reviewed. There was an 80% acceptance rate and 20% decline rate. That is the sign of a really healthy scientific organization. I served with an incredible Scientific Program Committee Leadership. Please stand to be acknowledged. Additionally, we did expand the poster sessions to seven, allowing us to accept 555 abstracts as poster presentations. They are in video format. There are poster tours, as an experiment this year. We presented the changes for the next year regarding the Scientific Program Committee to the Executive Committee and the AsMA Council. The Scientific Program Committee will have more work to continue making it a straightforward process. We will not be splitting panels and will be providing examples. We are aware that emails from Open Water are not making it through to the author's email box.

Nominating Committee Report (Jim DeVoll/Joe Dervay): Jim DeVoll thanked the nominating Committee and outlined the AsMA nominating process. The Nominating Committee meets several times per year and does a tremendous job. He asked the members of the Nominating Committee please stand and be acknowledged. The slate of Officers is: President-Elect: Warren Silberman; Vice Presidents: Fred Bonato, Rowena Christiansen; Treasurer: Casey Pruett; Members-at Large: Roy Allen Hoffman, Thomas Hoffman, Bonnie Posselt, and Annette Sobel. No nominations were received outside of the process.

AsMA Treasurer's report (Casey Pruett): We have a very good view of the final 2023 AsMA results (pending audit confirmation). With the higher-than-expected New Orleans meeting attendance yielding a boost to revenues, along with positive membership and investment account contributions. Our overall expenses are in line with budget projections; thus we expect an overall positive net operating income for 2023. New Orleans 2023 has edged out Las Vegas 2019 as the largest revenue generator AsMA annual meeting to date, with its higher attendance than expected. It seems there is a strong appetite to travel and meet in person for events like AsMA's annual meeting. The location also certainly helped. The net positive result of $539,000 for New Orleans is the best outcome to date, edging out Las Vegas in 2019. In addition, the improving investment accounts contribute to a prediction for a 2023 final result ($200K NOI) much better than budgeted ($11k). We continue to recognize cost savings from meetings, printing/mailing the journal, and management activities. There is a concern about declining membership and its associated benefits, which requires more attention.

The UBS Investment Portfolio shows growth (added $122K year-over-year for the end of 2023, $108K current YOY), even if it is slower than previous recoveries. Keeping the long-term horizon in mind is always important and rebalance when necessary, as shown in the recent reallocation from Delaware to PIMCO Income Institutional Fund. After 2023 is finally accounted for, we may have the opportunity to replenish funds into the AsMA investment account. By the way, PIMCO continues to show positive growth and emphasizing it was a good decision to change. The 2023 Financial Audit review has completed with zero findings!

Recommendations: Reassess ASMA financial position after 2023 accounting finalized and perhaps replenish the investment portfolio to regain our $1M posture. Increasing Membership is a topic to consider, as well as virtual meetings, incentives, and joining with UHMS. We will also continue to leverage the cost-saving efforts from the membership and journal committees.

REPRESENTATION AND ADVOCACY(Anthony Wagstaff)

Resolutions Committee: Have recently brought forth three resolutions that are available in the committee's report.

Communications Committee: Is working actively with headquarters to improve our presence in social media. Please look up our social media sites and follow them.

Air Transport Medicine Committee: Held their meeting today. It was well attended and is working on several issues on air transport medicine

EDUCATION, TRAINING, AND RESEARCH (Warren Silberman)

Education and Training**:** Report regarding Education and Training and their contribution to Resolution to 2022-1, concerning the importance of accredited training and board certification in aerospace medicine. There will be a meeting regarding this topic after the Business Meeting.

MEMBERSHIP (Susan Fondy)

Awards Committee: The Bauer Award was presented to Dr. Chancellor yesterday because she will not be here Thursday night. The rest of the awards will be presented at Honors Night. Membership Committee**:** Is working hard to expand their services. One of their initiatives is to have local Health Profession Students attend this Scientific Program for one day. There are plans to expand that program for future meetings in Atlanta and Denver to bring in students to give them a vision and dream. Please engage with these students. We are developing a mentorship program with the membership committee and the Associate Fellows Group. If you are an Associate Fellow and think it would be interesting to mold the next generation, please see members of the Membership Committee or the Associate Fellow Group.

Corporate and Sustaining Membership Committee: Please come see Susan Fondy, as we need a new leader.

Unfinished Business: none

New Business: none

Motion made and seconded to adjourn the meeting at 12:53 CDT.

Respectfully submitted,
Jeffrey Sventek, MS, CAsP, Executive Director
J. Karen Klingenberger, MD, MS, MPH, Secretary

Bylaws of the Aerospace Medical Association
(Revised May 24, 2022)

ARTICLE I. NAME
The name of this association shall be the Aerospace Medical Association.

ARTICLE II. VISION, MISSION, AND GOALS
A. Vision: The international leader in aerospace medicine and human performance.
B. Mission: Apply and advance scientific knowledge to promote and enhance health, safety, and performance of those involved in aerospace and related activities.
C. Definition: As used in this document, Aerospace Medicine is the multi-disciplinary application of professional and scientific knowledge, training, and research to promote and maintain the health, well-being, safety, and performance of those involved in aerospace activities.
D. Goals:
(1) Provide opportunities for education and promote research.
(2) Provide members opportunities for professional growth and development.
(3) Represent the discipline of Aerospace Medicine to professional, commercial and governmental organizations and advocate policies and standards.
Governance of the Association is necessary to maintain a sound financial structure and ensure continuity of the Association in service to its goals.

ARTICLE III. MEMBERSHIP
SECTION 1. Categories, Qualifications, and Election for Membership.
A. Categories: There shall be the following categories of membership: (1) Member, (2) Life Member, (3) Emeritus Member, (4) Honorary Member, (5) Corporate and Sustaining Member, (6) Technician Member, (7) Student Member, and (8) Resident Member.
B. Qualifications: An applicant for membership shall have one or more of the following minimum qualifications:
(1) Be a duly licensed physician or nurse in the country of residence; or
(2) Hold a designation as an aviation medical examiner, a flight medical officer, an aviation medical director, a flight nurse, or a submarine or diving medical officer, or have held such rating in federal or national government services and normally shall be actively engaged in related capacities; or
(3) Be a graduate of a college or commissioned in the
armed services with equivalent qualifications, working in or contributing to the field of aerospace medicine, aeronautics, astronautics, undersea medicine, or environmental health; or
(4) Be a scientist or engineer concerned with the life sciences in the field of, or related to, aerospace medicine, aeronautics, astronautics, undersea medicine, or environmental health; or
(5) Be engaged in teaching, research, or the applications of such research in the field of, or related to, aerospace medicine, aeronautics, astronautics, undersea medicine, or environmental health.
C. Election for Membership
(1) Application for membership shall be accompanied by the full amount of the annual membership dues. The Executive Director shall review the application. If it meets all requirements for qualification without question, the applicant shall be notified that the application has been approved in the appropriate category. If there is a question as to the qualification or category of the applicant, the application shall be referred to the Executive Committee. The Executive Committee shall review the application and shall take such action as its findings warrant. The Executive Committee may refer the application to the Council, which shall then determine whether the applicant meets requirements and in which category. Any applicant refused membership for any reason will be informed of the refusal and the reason for the refusal in writing from the Executive Director and shall be informed of their right to appeal the refusal to the appropriate level.
(2) Members shall have the rights to attend all meetings of the Association, shall be entitled to vote at the business meeting and hold office and to receive the official journal.
(3) Those on the list of active members shall continue as active members as long as they retain their membership in good standing to include payment of dues appropriate to their membership category as established by the Council.
D. Life Member: The Executive Director shall have the authority to grant Life Membership in this Association as consistent with the conditions and appropriate fee for Life Membership as established by the Council. These Life Members shall be entitled to vote and hold office and to receive the official journal.
E. Emeritus Member: The Executive Director shall have the authority to grant Emeritus Membership in this Association as consistent with the conditions and appropriate fee for Emeritus Membership as established by the Council. At age 65, those individuals who have been members for a minimum of 25 years are eligible to apply. Such Emeritus Members shall be entitled to vote and hold office and shall retain all rights and privileges of regular members in good standing. Membership entitles Emeritus Members to the electronic version of the official journal of the Association via the Aerospace Medical Association website. The print version of the official journal of the Association shall be available to Emeritus Members via a subscription at a rate to be determined by the Executive Committee.
F. Honorary Member:
(1) Honorary Members shall be elected from among those individuals who have made outstanding contributions to the advancement of aerospace medicine, aeronautics, astronautics, undersea medicine or environmental health activities. Honorary Members shall not receive the official journal of the Association except by personal subscription.
(2) The Council shall have the power to select not more than four Honorary Members in any one year. The President of the Association, with the concurrence of the Executive Committee, shall propose nominees to the Council for approval. However, any member of this Association may submit such nominations in writing to the Executive Director for transmittal via the Executive Committee to the Council.
G. Corporate and Sustaining Member:
(1) The Executive Committee shall admit as Corporate and Sustaining Members those companies, associations, foundations, groups, or individuals contributing minimum annual dues and who meet other eligibility requirements as established by the Executive Committee.
(2) Upon their approval and acceptance by the Executive Committee, Corporate and Sustaining Members shall receive such other services as the Executive Committee may deem appropriate.
(3) Corporate and Sustaining Members shall have the privilege of attending all meetings of the Association. However, they shall not be eligible to vote or hold office.
H. Technician Member:
(1) An applicant for Technician Membership must be a technician in the field of, or related to, aerospace medicine, aeronautics, astronautics, undersea medicine, or environmental health.
(2) Technician Members shall make application in the prescribed ways indicated in Section 1, C of this Article.
(3) Technician Members shall pay prescribed dues, receive the official journal of the Association, and may participate in all activities of the Association including the Annual Business Meeting, holding office and voting.
I. Student Member:
(1) An applicant for Student Membership must be enrolled full-time in an accredited college or university and have an express interest in aerospace medicine or allied sciences.
(2) Student Members shall make application in the prescribed ways as indicated in Section 1, C of this Article. Members seeking Student status beyond five years shall submit evidence of full-time student status at the time of application.
(3) Student Members shall pay prescribed dues and are entitled to the electronic version of the official journal of the Association via the Aerospace Medical Association website. Student Members are entitled to participate in all activities of the Association including the Annual Business Meeting, holding office and voting.
J. Resident Member:
(1) An applicant for Resident Membership must be enrolled full-time in an accredited residency or equivalent training program and have an express interest in aerospace medicine or allied sciences.
(2) Resident Members shall make application in the prescribed ways as indicated in Section 1, C of this Article. Members seeking resident status beyond five years shall submit evidence of full-time resident status at the time of application.
(3) Resident Members shall pay prescribed dues, receive the official journal of the Association, and may participate in all activities of the Association including the Annual Business Meeting, holding office and voting.
SECTION 2. Review of Ethical Concerns
A. The Ethics Policy of the Association, as defined in the Policies and Procedures Manual, shall apply to all categories of Association members.
B. Ethical Concerns:
(1) An ethical concern should be resolved at lowest level possible within the Association.
(2) Should the ethical concern not be resolved at lower levels, the concern may be elevated to the Executive Committee using the process delineated below.

(3) Ethical concerns addressed through this process shall be limited in scope to conduct deemed contrary to the best interests of the Association, to include the business and governance of the Association, the annual scientific meeting, and the Association's official journal. The Executive Committee shall determine if the concern is within the scope of this process.

(4) Any member may raise an ethical concern regarding another member who is believed to have violated the Ethics Policy of the Association, to include the business and governance of the Association, the annual scientific meeting, and the Association's official journal. The Executive Shall determine if the concern is within the scope of this process.

(5) The Executive Committee shall initially review the written ethical concern to determine the validity of the concern and whether a formal investigation is warranted. The Executive Committee may dismiss the concern if it is deemed not valid or outside the scope of this process.

(6) If the Executive Committee determines the ethical concern has validity and is within the scope of the process, the concern will be referred to the Ethics Body for investigation as described in the Policies and Procedures Manual.

(7) The respondent shall be advised in writing of any ethical concern regarding him or her and be provided an opportunity to respond to the Ethics Body and the Executive Committee.

(8) Once the investigation is complete, the Ethics Body shall provide a summary report of the investigation to the Executive Committee.

(9) For any ethical concern regarding a member of the Executive Committee, the Council will assume the role of the Executive Committee in this process.

C. Administrative Action:

(1) Upon receipt of the report from the Ethics Body, the Executive Committee shall determine the appropriate administrative action.

(2) The Executive Committee shall have, but not be limited to, the following powers: dismissal of the ethical concern, censure, probation for a period not to exceed two years, suspension for a period not to exceed three years, or expulsion of a member, as the findings warrant.

(3) A two-thirds vote of the full membership of the Executive Committee is required for any ruling.

D. Appeal Process:

(1) Proposed administrative actions may be appealed to the full Council and shall be submitted in writing to the Executive Director.

(2) Should an appeal be requested, no administrative action shall proceed until the appeal process is complete.

(3) A two-thirds vote of the full membership of Council is required to modify or reverse the action of the Executive Committee. Failing to achieve modification or reversal from the Council, the action of the Executive Committee is confirmed. Action of the Council is final.

ARTICLE IV. Corporate Forum

SECTION 1. Titles, Structure, Representation, and Relationship to AsMA Committee

A. Titles: The Corporate Members shall constitute the Corporate Forum.

B. Structure: The Corporate Forum may have an internal governance structure of its choosing, with officers and procedures appropriate to its activities.

C. Representation: The Corporate Forum shall choose one of its members to represent the Forum at Council meetings. The representative shall serve as a liaison between the Council and the Forum. The Corporate Forum is aligned under the Vice President of Member Services.

D. Relationship to Corporate and Sustaining Membership Committee: The Corporate Forum will work in coordination with the Corporate and Sustaining Membership Committee as described in Article XII of these Bylaws.

SECTION 2. Membership

All members of the Corporate Forum shall be Corporate Members as determined in Article III of these Bylaws.

SECTION 3. Activities

A. Forum Events: The Corporate Forum will plan and conduct an annual Advisory event, in coordination with Council. The purpose of the Advisory will be an exchange of information and goals between the Association leadership and the Forum to facilitate good relations and advances in the field of Aerospace Medicine and Human Performance. The Forum may also sponsor a speaker or other similar event(s) for the general Association membership.

B. Forum Budget: The Association budget will consider and plan for reasonable expenses in connection with Forum events.

ARTICLE V. FELLOWSHIPS

A. There shall be the following categories of Fellows: (1) Fellow, (2) Associate Fellow, and (3) Honorary Fellow.

B. Fellow:

(1) Fellows of the Aerospace Medical Association will be selected from among the active members who have made outstanding contributions to aerospace medicine, aeronautics, astronautics, undersea medicine, or environmental health, in the practical usage of research, or by precept and example.

(2) All those now holding the grade of Fellow, or who may be hereafter elected to such, shall constitute the group of Fellows. The group shall meet and shall elect annually, its chair, who shall hold office until a successor is elected.

(3) Nominations for Fellows shall be made by the Fellows who are active members.

(4) Fellows shall be elected annually through a published process developed by the Fellows and approved by Council.

C. Honorary Fellow:

(1) Honorary Fellows shall be elected by the Fellows from among persons who have rendered outstanding service or made outstanding achievements in aerospace medicine, aeronautics, astronautics, undersea medicine or environmental health activities. Honorary Fellows shall not normally be elected from members in good standing. Honorary Fellows shall be nominated and voted upon as prescribed for the election of Fellows. However, a two-thirds majority of votes cast shall be required for election. If required for any reason, additional voting may be conducted at the time of the annual meeting of the group of Fellows.

(2) Honorary Fellows shall not be entitled to vote or hold office. They shall pay no dues and shall not receive the official journal of the Association except by personal subscription.

(3) The election of Honorary Fellows is limited to no more than two in any one year.

D. Associate Fellow:

(1) Selection as an Associate Fellow shall honor members of the Aerospace Medical Association who have contributed to the Association in a positive manner.

(2) All those holding the grade of Associate Fellow, or who may hereafter be elected to such, shall constitute the group of Associate Fellows. The group shall meet annually during which the election of officers will be announced.

(3) A candidate for Associate Fellow shall have been a member for at least five years.

(4) Applications for Associate Fellowship shall be reviewed by the Associate Fellows and submitted to the Executive Committee for approval.

ARTICLE VI. OFFICERS

SECTION 1. Elected Officers

The elected officers of this Association shall be a President, President-Elect, four Vice Presidents, Secretary, and Treasurer. The President-Elect shall be elected annually to serve one year or until a successor is elected and assumes office at the close of the Annual Business Meeting of the Association. The Vice Presidents, Secretary, and Treasurer shall serve for two years or until their successors are elected and assume office at the close of the Annual Business Meeting of the Association. The President-Elect shall automatically succeed to the office of President at the close of the Annual Scientific Meeting.

SECTION 2. President.

The President shall chair all meetings of the Council of the Association and the Executive Committee. The President shall appoint chairs of Association committees unless provided otherwise in these Bylaws. The President has the authority and obligation to provide specific tasking to committees and other functionaries doing work for the Association. The President is an *ex officio* member of all Standing Committees except the Nominating Committee. In the event an officer or elective member resigns, is incapacitated, or is otherwise unable to act, the President may appoint, with approval of the Executive Committee, an acting officer or elective member to perform those duties until the next Annual Business Meeting or for the period of the incapacity.

SECTION 3. President-Elect.

The President-Elect shall become familiar with the duties of the President and shall perform such other functions as the President may designate. In the event that the President is incapacitated or otherwise unable to act, the President-Elect shall perform the functions of and act as President for the period of such incapacity.

SECTION 4. Vice Presidents.

The four Vice Presidents shall perform such duties as designated by the President.

SECTION 5. Secretary.

The Secretary shall be responsible for reviewing the minutes of the Council and Executive Committee meetings and shall perform those duties as directed by the President. The Secretary shall have other duties usually performed by a Secretary which are not accomplished by the home office staff.

SECTION 6. Treasurer

The Treasurer shall have duties usually performed by a Treasurer and shall perform those duties as directed by the President, Council, or Executive Committee. The Treasurer shall be the chair of the Finance Committee and custodian of

all monies and securities and hold same subject to the direction and disposition of the Executive Committee under the direction of the Council. The Treasurer shall perform the duties in cooperation with the Executive Director.

SECTION 7. Unbudgeted Expenditure of Funds.

No Officer may make or authorize any unbudgeted expenditure without approval of the Executive Committee or the Executive Director. The Executive Director shall not make or authorize any unbudgeted expenditure exceeding the amount stipulated by the Policy and Procedures Manual without approval of the Executive Committee.

ARTICLE VII. EXECUTIVE DIRECTOR.

SECTION 1. Appointment

The Executive Director shall be appointed by the Council, and shall not hold an elective office.

SECTION 2. Duties.

A. The Executive Director shall be the chief operating officer of the Association and shall keep its records, and a file of its publications. The Executive Director shall notify all members of the time and place of meetings, notify Council members of the time and place of Council meetings, and shall prepare the programs of the meetings under the direction of the Council.

B. The Executive Director shall cooperate with the chairmen of various groups and committees of the Association in the execution of the policies of the Association as outlined by the Council, shall coordinate the work performed by the various committees of the Association, shall perform such duties as are assigned by the Council, and shall act under instruction of the Executive Committee.

C. The Executive Director is authorized to provide such assistance as is necessary for the proper conduct of the Association headquarters office, subject to the directives of the Executive Committee and the Council. The Executive Director shall employ and supervise the staff, authorize purchase of supplies and equipment, arrange for office and other facilities for operating purposes, within the budget and as approved by the Executive Committee, and is empowered to sign contracts and enter into agreements on behalf of the Association and within the policies established by the Council and the Executive Committee.

D. The Executive Director shall, with the Treasurer, prepare a budget covering estimated annual expenses, to be submitted to the Council for adoption.

E. The Executive Director shall serve as the general coordinator and organizer for the Annual Scientific Meeting and shall direct the chairmen of the committees appointed for the planning, preparation, and operation of the Annual Scientific Meeting of the Association subject to the supervisory authority of the Executive Committee.

F. The Executive Director may retain legal and professional services as may be required with the prior approval of the Executive Committee.

G. The Executive Director shall prepare for the Annual Business Meeting a concise and summarized report on the activities of the Association for the year, its membership, and other matters of importance to the Association.

H. The Executive Director shall report in writing the total membership of the Association as of January 1 each year to the chair of the group of Fellows prior to the annual meeting of the Fellows.

I. The Executive Director shall be insured in an amount approved by the Executive Committee.

ARTICLE VIII. COUNCIL OF THE AEROSPACE MEDICAL ASSOCIATION AND EXECUTIVE COMMITTEE

SECTION 1. The Council of the Aerospace Medical Association.

The governing body of this Association shall be the Council of the Aerospace Medical Association, hereinafter referred to as the Council. Council members shall conform their conduct and perform their duties in a manner consistent with a published Ethics Policy adopted by the Council.

SECTION 2. Membership of the Council.

Membership of the Council shall consist of the President, President-Elect, the immediate Past President, the four Vice Presidents, the Secretary, the Treasurer, 12 elective members, one member selected by each of the Constituent Organizations, one member selected by the Fellows group, one member selected by the Associate Fellows Group, the Aerospace Medical Association Delegate to the American Medical Association, the Aerospace Medical Association Delegate to the American Osteopathic Association, a student or resident representative selected by the Aerospace Medicine Student Resident Organization, the Editor-in-Chief of the Association's official journal (*ex officio* member without vote; appointed by the President and approved by Council), a representative from the Corporate Forum (*ex officio* member without vote), and the Parliamentarian (*ex officio* member without vote; appointed by the President and approved by Council). The Executive Director shall be an *ex officio* member without vote. Of the 12 elective members, 4 shall be elected to the Council each year for three-year terms. No such elected member shall be eligible for more than two successive terms as an elective member. In the event an elected member of the Council resigns or is otherwise unable to complete a term on the Council, the Nominating Committee shall propose a nominee or nominees for election to fill the remaining year or years in that term. In the event a non-elected member resigns, is incapacitated, or is otherwise unable to attend a Council meeting, the appointing entity may designate an alternate by notifying the Executive Director or Secretary. All voting members of the Council must be members of the Association.

SECTION 3. Powers of the Council.

A. The Council establishes policy for the Association. The Council shall be vested with the management of the funds, properties, and the affairs of the Association and shall act in the capacity of a board of directors. The Council shall adopt such regulations as may be appropriate for governing the Association including an Ethics Policy for its members. It shall have the power to approve proposed budgets, authorize expenditures, seek and accept contributions, authorize contracts in the name of the Association, define and promote the activities of the Association, approve applications for constituency or affiliation with the Association, determine special classifications of membership and the eligibility of applicants for membership, authorize employment of auditors, and provide for issuance and distribution of the official educational scientific publications of the Association, including the official journal of the Association. The Council shall have the power to approve the appointment of an Executive Director and the Editor-in-Chief of the official journal of the Association, or any educational or scientific journal or other publication, on recommendation of the Executive Committee.

B. The Council shall provide for the business and conduct of the annual special meetings, and through its Executive Committee shall be responsible for the program of the annual scientific sessions and shall approve and grant any award given by the Association.

C. The Council shall establish such rules and regulations for the election of Associate Fellows as it deems advisable and which are not in conflict with the provisions of the Bylaws

D. The Council may delegate powers and duties to officers and employees of the Association.

E. The Council may assign responsibility to the Executive Committee for the management of the Association's finances and the investment of the Association's funds.

F. The Council may establish standards and procedures for certification of the professional competence of individuals within the special disciplines of the Association. Certification shall be made by action of the Council.

G. The Council may, at any time, on its own initiative, propose resolutions.

H. The Council shall perform such other duties as provided by the Bylaws.

SECTION 4. Meetings of the Council.

A. Regular Meetings: The Council shall have at least three regular meetings a year at the time and place called by the President as follows:

(1) Not more than 30 days before the Annual Business Meeting of the Association.

(2) Not more than two days after the Annual Business Meeting of the Association. If such a meeting is called before the close of the Annual Scientific Meeting, the President for the succeeding year shall be installed as Chair of the Council by the then President. The new Chair, the succeeding President, shall preside during the reorganization of the Council and consider any new business or items directed to the Council by the membership at the Annual Business Meeting.

(3) Not more than eight months nor less than four months after the Annual Business Meeting.

B. Special Meetings: Special meetings of the Council shall be held at the time and place called by the President, or the Executive Director may call a meeting upon written request of any 12 members of the Council.

C. Attendance and Quorum:

(1) Attendance at any regular or special meeting of the Council may be in person or in any manner consistent with procedures published in the Policies and Procedures Manual.

(2) Forty percent of the Council shall constitute a quorum at any duly called meeting of the Council.

SECTION 5. Executive Committee.

A. The Executive Committee shall consist of the President, the President-Elect, the four Vice Presidents, Secretary, Treasurer, Executive Director (*ex officio* without vote), and three members of the Council nominated by the President for the succeeding year, who shall be elected by a majority vote of the Council at its first meeting following the annual election of officers and councilors.

B. Except as otherwise provided in these Bylaws, the Executive Committee shall have the power to exercise all the functions of the Council between Association meetings and when the Council is not in session. The Council may delegate to such Executive Committee any or all of the powers granted to the

Council by law or by these Bylaws, and not specifically delegated to any other committee or reserved to the Council by law.

C. The Executive Committee shall act as a Committee on Credentials.

D. The Executive Committee shall be responsible to the Council for the program of scientific meetings. The Executive Committee shall follow the guidelines in the Policy and Procedures Manual for review and acceptance of proposed exhibits for the Annual Scientific Meeting.

E. The Executive Committee shall be in charge of the finances of the Association and the investment of funds of the Association under the direction of the Council. It shall regulate and approve the budgets of all other committees.

F. The Executive Committee shall have the power to appoint the Editor of the official journal of the association, or any educational scientific journal or other publication, with the approval of the Council, and may recommend the members of the Editorial Board to the Council after consulting with the Editor.

G. The Executive Committee shall have the power to appoint a Managing Editor and such Assistant Editors as it deems necessary.

H. The Executive Committee shall approve changes to the Aerospace Medical Association Policies and Procedures Manual as necessary to be consistent with the Bylaws and Council direction.

I. The Executive Committee shall select the time, place, and format of the Annual Scientific Meeting.

J. Meetings: Attendance at any meeting may be in person or in any other manner consistent with procedures published in the Policies and Procedures Manual. A majority of the Executive Committee shall constitute a quorum at any duly called meeting of the Committee. The President shall call such meetings of the Executive Committee as the business of the Association may require, or a meeting shall be called by the Executive Director upon written request of a majority of the Executive Committee.

ARTICLE IX. ORGANIZATIONS.

SECTION 1. Constituent and Affiliated Organizations.

A. Qualifications:

(1) All Constituent and Affiliated Organizations shall have a similar mission and goals to those of the Aerospace Medical Association as outlined in Article II; have the objective of furthering the goals of this Association through local meetings, acquaintanceship, and discussion by the members, embraced within the group, of matters relating to aviation, space, or undersea medicine, or their allied sciences; increasing the value of this Association to its members, and helping maintain and increase its membership. The mission, goals, limitations, and activities of such group shall not be inconsistent with those of the Aerospace Medical Association. The Bylaws or other instruments of organization of such group shall be in conformance with the general provisions of the Bylaws of this Association and shall be approved by the Council of the Aerospace Medical Association.

(2) Constituent and Affiliated Organizations shall make formal written application through its responsible officers to the Association through the Council of the Aerospace Medical Association. Such application shall indicate the name of the group and the proposed area of its jurisdiction.

(3) A copy of the Constitution, Bylaws or other instruments of organization and amendments thereto of such group shall accompany its application. The application shall be presented to the Council of the Aerospace Medical Association. When the Council has approved the application by a two-thirds vote, a formal notification recognizing the Constituent or Affiliated Organization shall be issued to the group by the Council and such notification shall include a statement of the mission and goals of the Aerospace Medical Association as set forth in Article II.

B. Discontinuance of Constituency or Affiliation: Discontinuance of an existing organization shall be referred to the Executive Committee for study, whereupon the Executive Committee shall make a recommendation to the Council for appropriate action.

C. Constituent Organizations:

(1) Constituent Organizations must have a minimum membership equivalent to 2% of the active membership of the Aerospace Medical Association as determined and communicated in accordance with the Policies and Procedures Manual. With its application for constituency, each Constituent Organization shall furnish the Executive Director a current roster of its members in good standing, giving name, residence, and connection with aerospace medicine or its allied sciences. All members of the Constituent Organization shall be members of the Aerospace Medical Association. A Constituent Organization may have sustaining partners, however, that are not active members of the Aerospace Medical Association. These sustaining partners are not members and do not count toward the 2% criterion for Constituency status. By January 1 of each calendar year, each Constituent shall furnish the Executive Director a current roster of its members.

(2) Each Constituent Organization shall be represented on the Council by an individual who is a member of the Association designated by the Constituent Organization. Each such organization shall present the name of its designated primary representative to the Executive Director during the Annual Scientific Meeting. In the event the primary representative cannot attend a Council Meeting, the name of an alternative representative shall be presented to the Executive Director or Secretary.

D. Affiliated Organizations:

(1) Each Affiliated Organization shall furnish the Executive Director with a current demographic description of its membership with its application for Affiliated status.

(2) Each Affiliated Organization shall communicate with the Association at least once per year to indicate its desire to remain an Affiliated Organization of the Association.

SECTION 2. Regional Subdivisions and Chapters.

It is the policy of the Association to encourage and recognize the establishment of local chapters and subdivisions of its members. The Council shall have the authority to control the establishment, guidance, and termination of regional chapters and subdivisions and may establish regulations for this purpose upon such terms and conditions as it may deem appropriate in order to further the mission and goals of the Association. The provisions of the certificate of incorporation and of these Bylaws shall be equally binding upon the Association and all its regional sections, subdivisions, or chapters.

ARTICLE X. CERTIFICATION BOARDS.

SECTION 1. Certification Boards.

A. Titles: The Association may sponsor Certification Boards.

B. Qualifications: All Certification Boards shall have a similar mission and goals to those of the Aerospace Medical Association as outlined in Article II; have the objective of furthering the goals of this Association through evaluation and examination of individuals seeking certification by the Association on matters relating to aviation, space, undersea medicine, or their allied sciences; increasing the value of this Association to its members, and helping maintain and increase its membership.

SECTION 2. Membership.

All members of a Certification Board must be members of the Association and be approved by Council. The Council shall select one of its members to represent each Certification Board at Council meetings. The representative should be certified in an appropriate field and will serve as a liaison between the Certification Board and the Council.

SECTION 3. Discontinuance of a Certification Board.

Discontinuance of an existing Certification Board shall be referred to the Executive Committee for study, whereupon the Executive Committee shall make a recommendation to the Council for appropriate action.

ARTICLE XI. ELECTIONS.

Elections shall be held at the Annual Business Meeting of the Association. Only active members in good standing shall be entitled to vote in the election of officers and members of the Council. These shall be elected by a majority vote of those voting members present at the Annual Business Meeting. If there is more than one nominee for an office, the nominees shall be excused and the vote shall be by show of hands.

ARTICLE XII. COMMITTEES

SECTION1. Standing Committees.

A. There shall be the following standing committees:

(1) Aerospace Human Performance, (2) Aerospace Safety, (3) Air Transport Medicine, (4) Arrangements, (5) Awards, (6) Bylaws, (7) Communications, (8) Corporate and Sustaining Membership, (9) Education and Training, (10) Finance, (11) Global Liaison and Outreach, (12) History and Archives, (13) Membership, (14) Nominating, (15) Registration, (16) Resolutions, (17) Science and Technology, and (18) Scientific Program.

B. Other committees of the Association may be established as provided in the Bylaws or determined by the Council.

SECTION 2. Appointment and Duties.

A. The President, in consultation with the President-Elect and with the concurrence of the Executive Committee, shall appoint all chairs of standing committees except as otherwise provided in the Bylaws.

B. The chair of each committee may be directed by the President of the Association to accomplish specific tasks and reports relative to the area of expertise of that committee. Committee Chairs shall identify at least one Deputy Chair. Committees may have such subcommittees as the President and the committee may deem necessary to carry out their purposes. The Policies and Procedures Manual describes the committees' reporting responsibilities and details of their activities and function.

SECTION 3. Standing Committees Functions.

A. Aerospace Human Performance Committee: This committee shall be responsible for establishing an integrating function and forum sponsoring panels and seminars, preparing reports, resolutions, and recommendations concerned with personnel selection, human performance, and human factors input in the concept, design, development, test and evaluation, and operational deployment of aerospace programs and systems. The committee will seek to promote research and application of human performance knowledge in every phase of systems development and deployment. Human performance and systems integration require a multidisciplinary approach involving decision-making, behavioral, biomedical, psychosocial, physiological, and engineering factors. The goal of the committee is to produce recommendations for improving aerospace systems performance.

B. Aerospace Safety Committee: The goal of this committee shall be to improve the safety of aviation and space activities. The committee shall direct its efforts to identifying specific, important aviation and space safety issues, national or international in scope that represents a significant threat to the health and safety of people involved in aviation and space activities, either as crew members or passengers. The objective of the committee shall be the resolution of aviation and space safety issues through either educational or regulatory processes. The committee may, with approval of the Council or Executive Committee, recommend research projects, prepare reports and scientific papers, sponsor panels and seminars, or formulate recommendations and resolutions to accomplish this objective.

C. Air Transport Medicine Committee: This committee shall be responsible for performing studies and preparing reports, resolutions, and recommendations on biomedical aspects of air transport operations. This committee shall concentrate its efforts on the promotion of international health, safety, and care through the mechanism of collecting information, analyzing data, and recommending solutions leading to improving health and safety in air transport operations.

D. Arrangements Committee: The Arrangements Committee works with the Association Headquarters Staff to make logistical arrangements for the Annual Scientific Meeting.

E. Awards Committee: The Awards Committee shall obtain and review all nominations for the various awards and honorary citations presented by the Association and make recommendations to the Council in such manner as the Council may prescribe.

F. Bylaws Committee: This committee shall be a fact-finding committee on matters pertaining to the Bylaws. The committee shall study proposed amendments to the Bylaws referred by the Council, and make its recommendations to the Association through the Council. If deemed necessary, this committee shall revise or develop new Bylaws for submission or approval in turn by the Council and the Association subject to proper publication, notification, and approval by a two-thirds vote of members attending the Annual Business Meeting as set forth in Article XVI.

G. Communications Committee: This committee shall oversee the communications program of the Association including brochures, books, and electronic media. The Communications Committee, at the request of the President or Council, prepares, reviews, and publishes publications sponsored by the Association other than the journal. The Committee may propose other projects related to communications that must be approved by Council.

H. Corporate and Sustaining Membership Committee: This committee shall be responsible for initiating programs and activities whose purposes and objectives are to increase and represent the interests of the corporate and sustaining members. This committee shall assist the Executive Director and the Executive Committee in reviewing the applications for corporate and sustaining membership referred to it, secure all available information concerning such applicants, and submit its recommendations to the Executive Committee through the Executive Director.

I. Education and Training Committee: This committee shall promote international aerospace medicine and allied disciplines through excellence in education and training conducted or cosponsored by the Association and consistent with the Association's objectives. It shall establish procedures to ensure the dissemination of educational and training related information and materials to the membership; coordinate the Association's education and training needs with the Scientific Program Committee; and coordinate the Association's Continuing Medical Education (CME) role.

J. Finance Committee: this committee shall update and review the Association's financial balance sheets on an ongoing basis, provide an overview of the Association's financial position to the Council at its regular meetings, and bring forward or review potential new courses of financial action. The committee is comprised of a Chair and four regular members. The Chair will appoint the regular members of the committee. The President-Elect of the Association is an *ex officio* member of the Finance Committee.

K. Global Liaison and Outreach Committee: This committee shall be responsible for initiation, coordination, and promotion of the Association's global perspectives, namely: 1) to promote coordination, cooperation, and harmonization of efforts associated with global aerospace medicine and human performance challenges, 2) to promote the importance of and opportunities in aerospace medicine and human performance in each country or region, 3) to identify and promote global best practices in aerospace medicine and human performance research and applications, and 4) to strengthen the connection between AsMA and its global membership, its global constituents and affiliated organizations.

L. History and Archives Committee: This committee shall be responsible for acquiring, preserving, and maintaining those items of historical significance that represent and depict the achievements of the Association and its members. This responsibility shall be exercised through historical research, commemorative presentations, and fostering the preservation of library, archival, and museum collections.

M. Membership Committee: This committee shall be responsible for initiating programs and activities whose purposes and objectives are to increase membership in the Association and to promote public relations. This committee shall act in an advisory capacity to the Executive Committee and the Council in matters relating to the establishment of eligibility requirements for all classes of membership.

N. Nominating Committee: Elected officers and the elective members of the Council shall be nominated by a Nominating Committee made up of the five most recent living Past Presidents of the Association and a representative selected from each Constituent Organization of the Aerospace Medical Association. The immediate Past President shall serve as a member of the Nominating Committee for a one-year term, and shall become Chairperson of that committee in the subsequent year. A Chairperson or any Past President who is unable or unwilling to discharge their associated responsibilities shall be replaced by the President with another Past President. The Nominating Committee shall conduct its activities by electronic communication. Each individual nominated shall have been approved by at least a simple majority vote of the Nominating Committee members. The report of the Nominating Committee shall be made as stipulated in the Policies and Procedures Manual and orally at the opening ceremony of the Annual Scientific Meeting. Any member may offer additional nominations, including name of nominee and office for which nominated, from the floor at the Annual Business Meeting; however, the Executive Director must be provided written notice of the nomination no less than twenty-four hours before the Annual Business Meeting. Such nominations must be accompanied by a petition of at least 2% of the active members of the Association and must be accepted by a two-thirds majority vote of members attending the Annual Business Meeting, before the nominee can be a candidate in a vote for a named position.

O. Registration Committee: The Registration Committee assists with registration activities associated with the Annual Scientific Meeting. This includes distribution of registration materials and coordination of tickets for events.

P. Resolutions Committee: Resolutions may be proposed to the Resolutions Committee by individual members, standing and special committees, Constituent Organizations, the Executive Committee, and the Council. Proposed resolutions that have been reviewed and coordinated by the Resolutions Committee shall be submitted to Council. If disapproved by Council, the resolution will be returned to the Resolutions Committee for further review and coordination. If approved by Council, the resolution will be presented to the Association membership. Proposed resolutions will be published on the Association's website for a period of at least 60 days to offer members the opportunity for review and comment. Members of the Association will be notified by electronic means when resolutions are posted on the website for review and when posted for a vote. Members may submit comments to the Resolutions Committee within the 60-day comment period. Comments received from members may be incorporated into the proposed resolution by the Resolutions Committee, after which the revised resolution shall be resubmitted to Council. After final review and approval by Council, the draft resolution will be posted on the Association's website for a vote by the membership. Association membership shall have final approval of resolutions. Voting on resolutions by the Association members can be performed remotely by electronic means or in person during Annual Business Meetings of the Association. Electronic voting on proposed resolutions will be open for a period of at least 30 days. A quorum of 100 Association members is necessary for a vote, and a majority of those voting members is required for final approval of a proposed resolution. Voting will not be terminated prematurely when a quorum is achieved but will remain available for the entire 30-day period. If a quorum is not met at the end of the 30-day period, the voting period may be extended up to an additional 30 days.

Q. Science and Technology Committee: This committee is responsible for informing and educating the Association regarding interdisciplinary problems in the areas of systems analysis and technology utilization, as well as aeromedical, biomedical, and human factor requirements.

R. Scientific Program Committee: The Scientific Program Committee is responsible for the development and execution of the scientific program for each year's Annual Scientific Meeting. The Chair, with the help of committee members, arranges for abstract submission and review, scheduling of scientific sessions, and presentation of the scientific program.

SECTION 4. Special Committees.

The Council or the President may create special committees as may be deemed necessary with such membership and for such a period of time as may be considered appropriate. The Council or the President shall establish and define the functions of such committees.

ARTICLE XIII. MEETINGS

SECTION 1. Required Meetings.

Required meetings may be conducted in one of the following formats (1) in-person only, (2) combined in-person and virtually, or (3) virtual only.

A. The Association shall conduct at least one Annual Business Meeting which shall be open to the general membership and devoted to the reception of annual reports, the nomination and election of officers, consideration of amendments to the Bylaws, consideration of resolutions, and any other such business as decided by the Council.

B. The Association shall conduct at least one scientific meeting each year.

SECTION 2. Time and Place of Meetings.

The Annual Scientific Meeting shall be conducted at a time and place, and in a format selected by the Executive Committee. Meetings shall be held as provided for in these Bylaws. In cases of emergency, the Council shall have the authority to cancel, postpone, or change the site or format of an annual meeting, or a special Association meeting may be authorized or called by the Council.

SECTION 3. Quorum.

The Annual Business Meeting shall require a minimum of one hundred (100) active members to constitute a quorum.

SECTION 4. Parliamentary Authority.

The current edition of Robert's Rules of Order Newly Revised shall cover the procedure at all meetings unless otherwise provided by these Bylaws. Unless provided otherwise by Robert's Rules of Order Newly Revised or by these Bylaws, all elections and questions shall be decided by a majority of votes cast.

SECTION 5. Parliamentarian.

The duties of the Parliamentarian will be as specified in the Parliamentary Authority, with the intent to help ensure the orderly progress of meetings and the fair and equitable treatment of all participants.

ARTICLE XIV. DUES AND SUBSCRIPTIONS

SECTION 1. Annual Dues.

A. Annual dues for all classes of membership shall be set by the Council with the proposed change becoming effective no sooner than 60 days following advance notice published in the journal of the Association, during which time members may register their comments with the Executive Director of the Association and such comments shall be given due consideration by the Council.

B. Membership dues are payable on the last day of the month in which the applicant is selected for membership and annually thereafter.

C. Annual dues shall include subscriptions to the official scientific journal of the Association and to such other records, reports, proceedings, and publications as authorized by the Council except where otherwise provided.

D. The Executive Committee may authorize suspension of dues or subscriptions on the part of any member.

SECTION 2. Exemption from Dues.

A. Honorary Member: Honorary Members shall be exempt from the payment of dues.

B. Life Member: Following payment of the appropriate fee, the Life Member shall thereafter be exempted from the payment of annual dues.

SECTION 3. Active Member.

An active member (a member in good standing) is one who is qualified for membership and is current in the payment of dues. Active members are entitled to all the rights and privileges of membership including voting and holding office.

SECTION 4. Delinquency.

A member is delinquent if Association dues are not paid within 60 days of the due date. If dues are not paid within 30 days after notification of delinquency, the member shall be removed from the active membership role of the Association for nonpayment of dues.

SECTION 5. Reinstatement.

Any member dropped for nonpayment of dues may be reinstated to member-in-good-standing status on payment of dues for the current year in advance.

ARTICLE XV. FUNDING AND FINANCES

SECTION 1. Funding.

Funds may be raised (a) by dues; (b) by assessments on active members on recommendation of the Council and after approval by the membership; (c) from the publications of the Association at a rate established by the Council; and (d) in any other manner approved by the Council. Funds may be appropriated by the Council to defray the expenses of the Association.

SECTION 2. Finances.

A. Fiscal Year: The fiscal year shall begin on January 1 and end on December 31 each year.

B. Insurance: The Executive Director shall procure Directors' and Officers' Liability Insurance in an amount determined by the Council, the cost to be paid by the Association. The Executive Director, Treasurer, and other persons approved by Council may sign checks.

C. Budget: The Council, at its fall meeting, shall adopt an income and expense budget covering all activities for the next fiscal year. No officer may make or authorize any unbudgeted expenditure without approval of the Executive Committee or the Executive Director. The Executive Director shall not make or authorize any unbudgeted expenditure exceeding the amount stipulated by the Policy and Procedures Manual without approval of the Executive Committee.

D. Audit: An audit shall be made by a certified public accountant at a frequency and time described in the Policy and Procedures Manual. The audit shall be submitted to the Executive Committee at its meeting prior to the Annual Scientific Meeting of the Association. The report of the audit shall be made available to the membership at the Annual Business Meeting of the Association.

ARTICLE XVI. AMENDMENTS.

The Bylaws of the Association may be amended at any Annual Business Meeting of the Association by two-thirds vote of active members present at such meeting. Association Bylaws amendment proposals may be submitted by any member of Council or a petition of at least 2% of the active membership of the Association. Proposed amendments must be communicated to the Association Headquarters by the end of December and approved by two-thirds vote of the Council members for consideration at the Annual Business Meeting. The membership must be notified of the proposed amendments no less than 60 days prior to the Annual Business Meeting. The Policy and Procedures Manual will describe the process for review, modification, and presentation of amendment proposals for the membership vote on each amendment at the annual meeting.

ARTICLE XVII. DISTRIBUTION OF ASSETS UPON DISSOLUTION.

In the event that the Association shall be dissolved, its assets at the time of dissolution shall be distributed to one or more organizations exempt from Federal Income Tax in accordance with Section 501(c)(3) of the Internal Revenue Code of 1954 or subsequent provisions to be used for purposes identical or similar to those of the Association.

Orford Installed as AsMA President; Silberman Is President-Elect

Robert Orford, M.D., CM, MS, MPH, was installed as President of AsMA during the Annual Business Meeting, held May 7, 2024, at the Hyatt Regency Chicago, Chicago, IL, United States. He is currently Consultant Physician, Mayo Clinic, Scottsdale, AZ, and Mayo Clinic Healthcare in Partnership with Oxford University Clinic, London, UK, an Assistant Professor at the Mayo Clinic of Medicine, an FAA Aviation Medical Examiner, and an Associate Professor at the University of Texas Medical Branch in Galveston. He is a Fellow of the Royal College of Physicians and Surgeons of Canada, a Fellow and past Director of the Alberta Occupational Health Society, and a member of the Canadian Occupational Health Society, the American Occupational Health Society, the Occupational Medical Association of Alberta, the Occupational Medical Association of Canada, the Canadian Public Health Association, the American Public Health Association, the Canadian Society of Aviation Medicine, and the Canadian Medical Association.

Dr. Orford was awarded a National Health Fellowship from Canada from 1975–1976 and is licensed by the state of Minnesota, the State of Washington, and the province of Alberta. He is a Diplomate of the National Board of Medical Examiners. He is a member of and was President of the Airline Medical Directors Association. He is also a Fellow of the Aerospace Medical Association, serves on its Scientific Program Committee, and was Parliamentarian on AsMA's Council. He is a recipient of AsMA's Boothby-Edwards and Won Chuel Kay Awards. A more comprehensive biography can be found in the August 2023 issue of *Aerospace Medicine and Human Performance* [AMHP 2023; 94(8):656] or in the August 2023 newsletter (p. N49).

Warren Silberman, D.O., MPH, was elected as President-Elect of AsMA during the Annual Business Meeting on May 7, 2024. He will be installed as President next year. He is currently performing aviation medical examinations and consultations. He earned an AA degree in 1969 from the Community College of Philadelphia in Pennsylvania and then a B.A. degree from Temple University in Philadelphia in 1971. He received his D.O. degree from the College of Osteopathic Medicine and Surgery in Des Moines, IA, in 1974 and his MPH degree in 1991 from the University of Texas Health Science Center of Houston, San Antonio, TX. He served an internship at Lancaster Osteopathic Hospital, Lancaster, PA, from 1974–1978 and a residency at Community General Osteopathic Hospital in Harrisburg, PA, from 1975–1978. He later served a residency in Aerospace/Preventive Medicine at the U.S. Air Force School of Aerospace Medicine, Brooks AFB, TX, from 1991–1992.

Dr. Silberman retired for the second time in late September 2020. Prior to that he was a Medical Officer in the FAA's Aerospace Medical Education Division. From December 2019 until June 2020, he was the medical officer responsible for performing the hazard analysis for all fatal aircraft accidents. He spent 2 years as the Manager of the Occupational Health Clinic at the FAA's Civil Aerospace Medical Institute. He moved from the Aerospace Medical Education Division where he was writing AME courses, teaching AMEs, international aerospace physicians, and residents in aerospace medicine. Prior to that he was working in retirement for 5 years as an AME and Consultant. From June 1997 until January 2012, he was the Manager of Aerospace Medical Certification for the FAA. In that position he ran the largest division in the Office of Aerospace Medicine, lectured extensively both in the United States and internationally, and wrote articles. During the same time, he was the Oklahoma State Air Surgeon responsible for the Air National Guard healthcare.

Dr. Silberman is a past president of the Aerospace Medicine Division of the American Osteopathic College of Occupational and Preventive Medicine and the past Chair of the Fellows Group of the Aerospace Medical Association (AsMA) and a past Vice President of Education and Research. He is a Fellow of AsMA and a member of the Aircraft Owners and Pilots Association, the American College of Osteopathic Internists. the American Osteopathic Association, the American Osteopathic College of Occupational and Preventive Medicine, CAMA, the Experimental Aircraft Association, the International Association of Aviation and Space Medicine, the Society of USAF Flight Surgeons, the Society of U.S. Army Flight Surgeons, and the Airline Medical Directors Association. His awards and honors include the U.S. Army Order of Aeromedical Merit; CAMI Employee of the Year; the Audie and Bernice Davis Award presented by CAMI; the Theodore Lyster, Boothby-Edwards, and Tamisiea Awards from AsMA; Office of Aerospace Medicine Flight Surgeon of the Year (twice); President's Commendation from CAMI for outstanding medical certification of airline pilots; and the Legion of Merit, awarded by U.S. Army Surgeon General Ronald Blanck for service at Raymond W. Bliss Army Community Hospital.

Other elected officials are: **Vice President** Fred Bonato, Ph.D., and **Members-at-Large** Roy Allen Hoffman, M.D., MPH, Thomas Hoffman, D.O., MPH, Bonnie Posselt, B.Sc., MBChB (E), Ph.D., MRCP, D.Av.Med., ARAeS, FAsMA, and Annette Sobel, M.D.

Read the News Online!

Visit AsMA's News page at https://www.asma.org/news-events/asma-news. Members, visit the Members News by logging in via the boxes on the home page.

AEROSPACE MEDICAL ASSOCIATION HONORS NIGHT AWARDS
Hyatt Regency Chicago, Chicago, IL, May 9, 2024

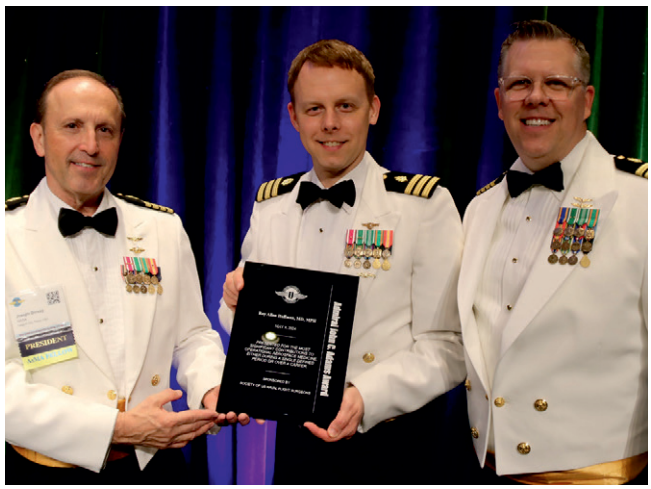
Dr. Joe Dervay, President of the Aerospace Medical Association, presented 21 awards to outstanding members during the Honors Night ceremonies at the 94th Annual AsMA Scientific Meeting, May 9, 2024, at the Hyatt Regency Chicago, Chicago, IL. Eric Olins, M.D., Chair of the Awards Committee, read the citations. The names of the awards' sponsors and representatives, when present, are printed in parentheses.

The Clark award was not presented this year. The Bauer Award was presented after the Reinartz lecture on May 7, 2024, as Dr. Auñón-Chancellor could not attend Honors Night. The Longacre Award was presented, but Mr. Merriman was not able to be there.

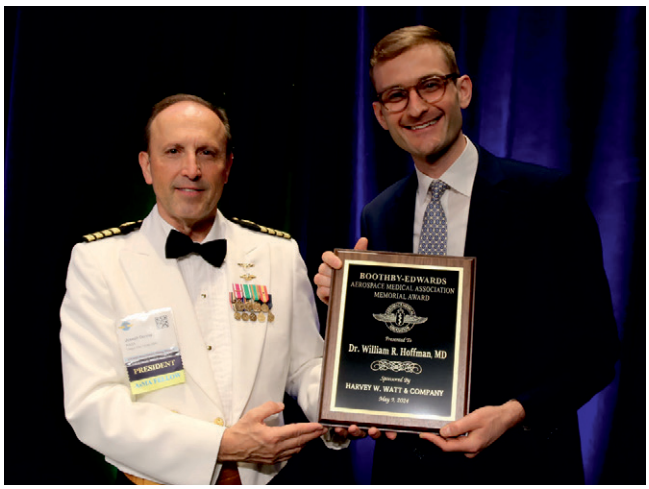
Joseph Dervay, 2023–2024 AsMA President

All photos by Pamela C. Day. A photo gallery is available at: https://aeromed.smugmug.com/Meetings/2024-AsMA-Meeting-in-Chicago/Honors-Night-Select.

2024 Louis H. Bauer Founder's Award
Serena Auñón-Chancellor, M.D., MPH, FACP



2024 John C. Adams Award
Roy A. Hoffman, M.Sc., M.D., MPH
(Robert Krause, Society of U.S. Naval Flight Surgeons)



2024 Boothby-Edwards Award
William Hoffman, M.D.

2024 John Ernsting Award
David Gradwell, B.Sc., Ph.D., MBChB, FRCP, FRCPE, D.Av.Med., FRAeS
(George K. Anderson, Environmental Tectonics Corp.)

2024 Kent K. Gillingham Award
Amanda Lippert, M.S.Ed., MS, MS, CAsP, FAsMA
(Erich Roedig, AMST)

2024 Walter & Sylvia Goldenrath Award
Nereyda L. Sevilla, MPH, Ph.D., CAsP
(Kim Broadwell, Goldenrath Endowed Fund)

2024 John D. Hastings Award
Angus Rupert, M.D., Ph.D.
(Leigh Speicher, Civil Aviation Medical Association)

2024 Won Chuel Kay Award
Paulo M. Alves, M.D., M.Sc., FAsMA, FCAMA
(Young Hwan Kwon, Korean Aerospace Medical Association)

2024 Joe Kerwin Award
Benjamin Johansen, D.O., MPH
(Rob Janney, KBR)

2024 Mary T. Klinker Award
Natacha Chough, M.D., MPH, AFAsMA

2024 Sidney D. Leverett Environmental Science Award
Brian C. Hanshaw, D.O., MPH
(Bob Laurent, Environmental Tectonics Corp.)

2024 Eric Liljencrantz Award
Richard Scheuring, D.O., MS, RMSK, FAsMA, FAAFP
(Michelle Scheuring accepts; Russell Rayman, Aerospace Medical PLC)

2024 Raymond F. Longacre Award
Stephen C. Merriman, BS, MS, ATFBoeing, AFAsMA, FHFES
(Harriet Lester, Aerospace Human Factors Association; Dr. Merriman was unable to be there.)

2024 Theodore C. Lyster Award
Courtney D. Scott, Jr., D.O., MPH, FAsMA
(Jennifer Benincasa, Army Aviation Medical Association)

2024 Marie Marvingt Award
Massamba Diop, M.D.
(Vincent Feuillie, La Société Francophone de Médecine Aérospatiale)

2024 Harry G. Moseley Award
Harriet Lester, M.D., FAsMA, FCAMA, FAAO, FAsHFA
(Chris Bates, International Association of Military Flight Surgeon Pilots)

2024 John Paul Stapp Award
Diego Garcia, M.D., MSHF
(Bob Laurent, Environmental Tectonics Corp.)

2024 John A. Tamisiea Award
Gerald Saboe, D.O., MPH, FAsMA, FAsHFA, FCAMA, FACOEM, FAOCOPM, FACPM
(Leigh Speicher, Civil Aviation Medical Association)

2024 Thomas J. & Margaret D. Tredici Award
Jeffery K. Hovis, O.D., Ph.D., FAAO, FAsMA
(Douglas Ivan and Kim Broadwell, Thomas J. & Margaret D. Tredici Endowed Fund)

2024 Arnold D. Tuttle Award
Desmond Connolly, Ph.D., MBBS
(Casey Pruitt, KBR)

2024 Julian E. Ward Award
Adriana Zuluaga Serna, M.D.
(Diego Garcia accepts; Tory Woodard, Society of U.S. Air Force Flight Surgeons)

2024 President's Citation: Dr. Russell Rayman received the citation from Dr. Joe Dervay, 2023-2024 AsMA President.

Passing the Gavel: Outgoing President Dr. Joe Dervay passes the gavel to incoming Presient Dr. Robert Orford.

Past President's Pin: Mary Dervay pins her spouse with the Past President's pin.

Past President's Gift: Incoming President Dr. Robert Orford presents outgoing President Dr. Joe Dervay with a captain's clock as a token of appreciation.

Surprise Video: Earlier in the evening, Jeff Sventek, AsMA Executive Director, surprised Dr. Dervay with a blast from the past.

2024 Fellows: Those of the new Fellows who were present at Honors Night are pictured here with incoming Fellows Chair Dr. Dan VanSyoc (far right) and outgoing Fellows Chair Dr. Warren Silberman (far left). The names of the new Fellows were printed in the July issue of the journal [AMHP 2024; 95(7):423-424].

Further photo galleries are available on AsMA's SmugMug page: https://aeromed.smugmug.com/Meetings/2024-AsMA-Meeting-in-Chicago.

Annual Lectures

Reinartz Lecture: This year's Reinartz lecture was a panel on space operations. Below, top to bottom, each panelist receives a token of appreciation from Dr. Dervay: Serena Auñón-Chancellor; Joe Kerwin; Joan Higginbotham, and Bob Cabana.

Bauer Lecture: Harrison Schmitt, the Bauer Lecturer, receives an honorarium from Casey Pruitt, representing KBR, the sponsor, as AsMA President Joe Dervay looks on.

Armstrong Lecture: Dr. Dervay presents Dr. Lisa Kaltenegger, the Armstrong lecturer, with a token of appreciation.

50-Year Pin: Felix Meyer receives a 50-year pin from Dr. Dervay, 2023-204 AsMA President, at Opening Ceremonies on Monday, May 6, 2024.

Visit Us on Social Media!
Twitter/X: https://twitter.com/aero_med
FB: www.facebook.com/AerospaceMedicalAssociation
Instagram: @aerospacemedicalassociation
LinkedIn: https://www.linkedin.com/company/aerospace-medical-association-asma

Scholarship Winners

Mantri Scholarship: Dr. Dervay, 2023–2024 AsMA President, presents Nina Purvis with the Anita Mantri, Ph.D., Memorial Travel Scholarship.

Mohler Scholarship: Dr. Dervay presents the Stanley R. Mohler, M.D., Aerospace Medicine Endowed Scholarship to Dora Babocs.

Trailblazer Scholarship: Hellen Vasquez (center left) was presented the AMSRO Trailblazer Scholarship by Kim Broadwell (left), representing the AsMA Foundation, and Dr. Dervay (center right). Anaelle Ndoye (right), the 2023 Trailblazer Scholarship winner, looks on.

Davis Scholarship: Corey Morris (center) was presented with the Jeffrey R. Davis, M.D., Aerospace Medicine Endowed Scholarship by Jeffrey R. Davis (right) as Dr. Dervay (left) looks on.

AsMA International Scholarship: Dr. Dervay (left) and AsMA Executive Director Jeff Sventek (right) present the Aerospace Medical Association International Scholarship to Anthony Rengel (center).

Scarpa Scholarship: Drs. Joe Dervay (left) and Philip Scarpa (right) present the Philip J. Scarpa, Jr., M.D., Aerospace Medicine Endowed Scholarship to Claudio Franc (center).

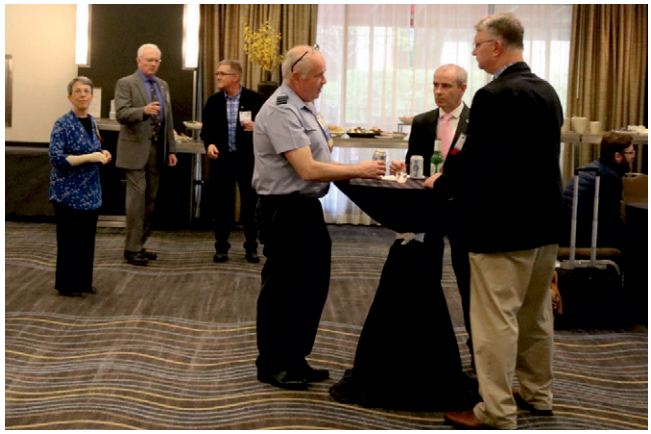
Receptions

Sunday Welcome Reception

International Reception

President's Reception

Corporate Forum



RAM Bowl

The RAM Bowl was held Wednesday, May 8. From the right, clockwise: moderator Becky Blue and referee Walt Dalitsch go over the rules; judges Jan Stepanek and Rahul Suresh; the referees and some of the judges; one of the screens showing the team names and scores; and the top school—UTMB. The winning team was the Astro-Nots: Samantha King, UTMB; Shana Hirchert, U.S. Air Force; Jeffrey Brown, U.S. Army; Noah Kainrad, U.S. Navy; and Wiaam Elkhatib, Mayo Clinic. The top scoring participants from each school were: Samantha King, UTMB; Barrett Campbell, U.S. Army; Bryant Nieto, U.S. Navy; William Smith, U.S. Air Force; and Wiaam Elkhatib, Mayo Clinic.

More photos are available at https://aeromed.smugmug.com/Meetings/2024-AsMA-Meeting-in-Chicago/RAM-Bowl.

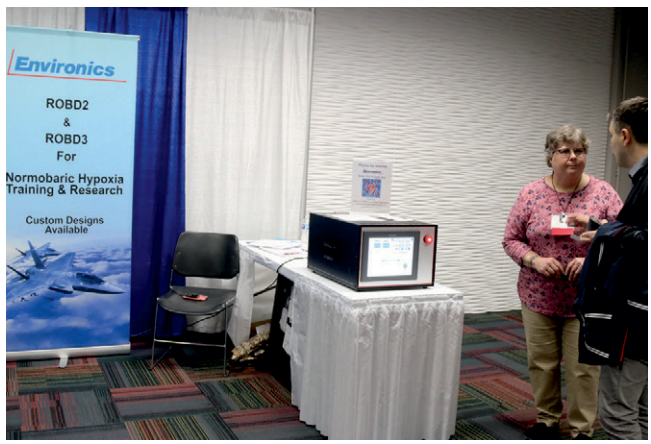
Exhibitors

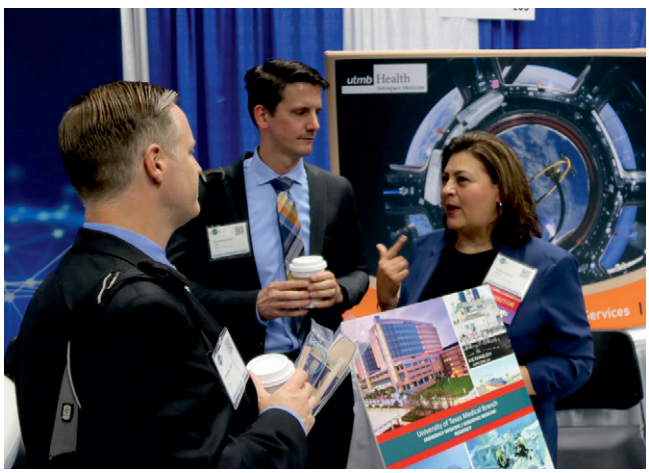
The exhibit hall was open for the Welcome Reception and during the day on Monday and Tuesday, May 6-7, 2024. Pictured here are, from below top to bottom: ETC, KBR, UTMB, the AsMA Foundation, GO_2Altitude, and Environics.

More photos are available on AsMA's SmugMug page at https://aeromed.smugmug.com/Meetings/2024-AsMA-Meeting-in-Chicago/2024-Exhibitors.

The photo in the bottom right is of the Navy Yard.

All photos by Pam Day.





Aerospace Medicine and Human Performance
INFORMATION FOR AUTHORS
http: //editorialmanager.com/AMHP

August 2024

These notes are provided for the convenience of authors considering preparation of a manuscript. Definitive information appears in the **Instructions For Authors** as published on the journal's website. Submissions that do not substantially conform to those instructions will be returned without review. We conform to the International Committee of Medical Journal Editors (ICMJE) Recommendations for the Conduct, Reporting, Editing and Publication of Scholarly Work in Medical Journals.

JOURNAL MISSION AND SCOPE

Aerospace Medicine and Human Performance is published monthly by the Aerospace Medical Association. The journal publishes original articles that are subject to formal peer review as well as teaching materials for health care professionals. The editor will not ordinarily review for publication work that is under consideration or has been accepted or published by another journal except as an abstract or a brief preprint.

TYPES OF PAPERS

The five types of articles specified below should be submitted through the web site and will undergo peer review. Other articles, including **Letters to the Editor**, **Book Reviews**, and teaching materials, should be submitted by e-mail to the Editorial Office. Letters to the Editor are limited to 500 words of discussion and/or criticism of scientific papers that have appeared in the journal within the past year. *If your manuscript does not fit the parameters laid out below, an exception may be granted. Please contact the Editorial Office to discuss your submission.*

Research Articles present the results of experimental or descriptive studies with suitable statistical analysis of results. They should contain an Introduction, Methods, Results and Discussion with a statement of conclusions. Such manuscripts should not exceed 6000 words with approximately 25 references.

Review Articles are scholarly reviews of the literature on important subjects within the scope of the journal. Authors considering preparation of a review should contact the Editor to ascertain the suitability of the topic. Reviews generally may not exceed 6000 words with up to 150 references, but longer reviews of exceptional quality will be considered.

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