(Education - Tutorial / Review)

The 15th 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, JUNE 05, 2025

Thursday, 06/05/2025 ***10:00 AM***
Centennial Ballroom I

[S-54] PANEL: THE FAST AND THE CURIOUS: CHARTING NEW FRONTIERS IN AVIATION MEDICINE

Chair: Sandra Salzman
Co-Chair: Zachary Masters

Panel Overview: *The Fast and the Curious: Charting New Frontiers in Aviation Medicine: Join the International Association of Military Flight Surgeon Pilots discussing forward leaning research on optimizing human performance in aviation as well as case studies of their application. As mechanical airframes push the boundaries of speed, endurance, and agility, it's crucial to understand how the human body and mind can keep pace with the evolving mission set. With an eye on both ops and medicine, IAMFSP will explore cutting-edge strategies in aviation medicine, from enhancing cognitive function to improving physical resilience, ensuring that the operators of tomorrow's aircraft can handle the intense demands of high-speed missions. Don't miss this chance to hear from those uniquely qualified to merge flight expertise with medical innovation!*

[297] MILITARY AVIATOR PEER SUPPORT PROGRAM: FOSTERING A CULTURE OF MUTUAL SUPPORT – WINGMEN, ALWAYS

Sandra Salzman[1], Darrell Zaugg[1], Aedrian Bekker[2], Gerhard Fahnenbruck[3], Keith Frank[4], William Hoffman[5]
[1]*U.S. Air Force, Ramstein AB, Germany;* [2]*Centre for Aviation Psychology, London, United Kingdom;* [3]*Stiftung Mayday, Frankfurt am Main, Germany;* [4]*U.S. Air Force Aeromedical Research Lab, Red Feather Lakes, CA, United States;* [5]*U.S. Air Force, Fort Sam Houston, TX, United States*

(Education - Program / Process Review)

BACKGROUND: Military aviator culture has historically endorsed a persona of an always ready, unwavering, and healthy. Pilots suffering from stress or mental health conditions may worry about seeking medical care due to potential professional or social repercussions, including losing their medical certificate and facing expensive evaluations. A 2019 study reported that 78.6% of pilots felt worried about seeking medical care, and 60.2% delayed care due to concerns about their pilot status. 2023 Stiftung Mayday data finds that 92.5% of stressful events can be completely resolved through a timely discussion with an empathetic and understanding peer. The Andersen Behavioral Model of Health Services Use suggests that pilots' attitudes, social norms, and perceived control may contribute to their reluctance to seek care. Most often, military aviators discuss problems with trusted peers, rather than trained professionals, to prevent any impact of an issue on their ability to fly. **OVERVIEW:** This presentation discusses establishment and utilization of a Military Aviator Peer Support Programs within the USAF, based on those that exist in the United States and European Union civilian aviation. This will include a discussion of the volunteer selection, training, and utilization within the 86th Operations Group at Ramstein Air Base. It will highlight some of the metrics monitored to identify success and challenges and trends in perception, trust, resource utilization and impact on the mission. Finally, we will look at potential short- and long-term considerations if MAPS programs were implemented across the military flying force and how that may build a stronger wingman culture within the USAF. **DISCUSSION:** The operational significance of aircrew culture on mission readiness and aviation safety is one of perception. By training wingmen who are already the social center of their aviation peers to be empathetic listeners armed with knowledge of the many resources available to handle problems of daily life, we may begin to see increased peer connectedness, resilience, and decreased stress index. Applying lessons learned from civilian culture and sharing knowledge with the aviators who already advise their peers, may provide a way for aviators to help each other, and triage those who need professional assistance.

Learning Objectives

1. The participant should be able to describe cultural challenges aviators meet when requesting assistance for non-flying issues.
2. Audience members should understand the key differences between peer support programs and other types of mental health medical care.
3. Participants should be able to discuss the specific reduction in risk of long-term mental health problems gained through early contact with peer support.

[298] UPDATE: INTEGRATED PERFORMANCE AND CARE TEAMS IN A SPECIAL OPERATIONS AIRCREW TRAINING SETTING

Zachary Masters
U. S. Air Force, Navarre, FL, United States

(Education - Program / Process Review)

BACKGROUND: Aeromedical Providers are key in aligning medical support aligns with the mission of the unit they support and furthering aviation safety throughout their organization . In the case of aircrew formal training units, the mission is to produce trained aircrew for operational units throughout the world. The efficiency and effectiveness of the training pipeline at that one unit affects every other unit in the community. The opportunity to establish healthy lifestyle and habits and an understanding of proper protocol relating to changes in health status, initiation of medications and aeromedical disposition early in these flyers careers can have a lasting effect on aviation safety. The reorganization of the military medical system and the U.S. Air Force operational structure necessitates leaders at all levels to re-examine the components of their organization and the value added by each. **OVERVIEW:** This presentation will provide updates on the status of the embedded healthcare and performance optimization team at the largest Aircrew Formal Training Unit in U.S. Air Force Special Operations Command. This will include a discussion of the makeup of the team and why that has evolved along with the process of

acquisition and selection of resources and equipment. It will highlight some of the emerging, high-yield or promising equipment and techniques utilized by the team. We will then turn to current challenges and trends in student and instructor health and explore data regarding training delays and performance on aircrew evaluations. Finally, we will look towards the future of this team and similar teams and how they can continue to stay relevant and prepare Aircrew for the next conflict. **DISCUSSION:** The operational significance is in aircrew training and aviation safety. These small teams and embedded medical units are the trend within the U.S. military and recent policy changes will further necessitate their existence. Applying lessons learned and sharing knowledge to guide their development and improvement is essential to the future of military aerospace medicine. The panel applies to cross-service, international or civilian aeromedical providers who may seek to establish programs for aircrew student performance optimization and aviation safety.

Learning Objectives

1. The participant should be able to describe current trends and challenges for healthcare professionals in aircrew training and apply this knowledge to guide development of similar programs seeking to follow such a construct.
2. Audience members should understand the emerging demands for healthcare and human performance teams associated with Aircrew Training.

[299] HIGH CONSEQUENCE INFECTIOUS DISEASE PATIENT MOVEMENT: NEW FRONTIERS IN A PERSISTENT CHALLENGE

Christopher Backus
TRANSCOM, Scott AFB, IL, United States

(Education - Program / Process Review)

BACKGROUND: Paraphrased from Department of Defense (DoD) Joint Publication 4-02, a high-consequence infectious disease (HCID) includes any infection that either: leads to hazardous waste as categorized by the Department of Transportation, or can cause a high mortality rate among otherwise healthy people and at least some types of direct clinical specimens pose risks to laboratory personnel or poses a known risk of secondary airborne spread within health care settings or unknown mode of transmission, or no effective countermeasure exists. Not all facilities are qualified to treat HCIDs, therefore patients must be moved. Air movement benefits from speed, however, incurs risks to the patient, to the healthcare team, to the aircrew, and to populations at the destination and any enroute stops. As the internationally recognized authority in aerospace medicine, members of the Aerospace Medical Association should stay abreast of new developments in HCID patient movement (PM). While capabilities have existed for decades, a succession of different diseases have shown technology, and processes must continually evolve to reduce the risk of this necessary intervention. **OVERVIEW:** Commander, U. S. Transportation Command is the DoD single manager for PM providing DoD global PM through Defense Transportation System in coordination with other Combatant Commands, and as directed, appropriate U.S. Government agencies. Analyzing existing capabilities for HCID PM, the Command Surgeon (TCSG) initiated a program review and planning process to reduce risk and expand existing capabilities to a wider range of pathogens. Corona Virus 2019 pandemic response confirmed utility and safety of PM using the Negative Pressure CONEX. However, respiratory viruses pose different challenges from other pathogens, such as viral hemorrhagic fevers. Aware of Marburg Virus Disease (MVD) cases in Rwanda, TCSG co-hosted a working group to improve existing capability to safely move HCID patients. **DISCUSSION:** High quality HCID PM improves patient outcomes while reducing risks to population at origin, population at destination, healthcare workers, and aircraft crew members. The ability to operate in any environment regardless of infection risk while maintaining an HCID PM capability enhances operational options for the DoD.

Learning Objectives

1. The participant will be able to define High Consequence Infectious Diseases.
2. The audience will learn about U.S. Transportation Command's role in patient movement.
3. The learner will better understand risks associated with High Consequence Infectious Disease Patient Movement.

[300] AERIAL DELIVERY OF FRESH AND STORED BLOOD PRODUCTS

Emma Robertson[1], Roselyn Fuentes Clemente[2], Grigory Charny[3], Jesse Chasteen[2]
[1]*U.S. Air Force, Eglin AFB, FL, United States;* [2]*U.S. Air Force, Destin, FL, United States;* [3]*U.S. Army, Destin, FL, United States*

(Education - Program / Process Review)

BACKGROUND: This presentation discusses standard operating procedures for airdrop as a potentially viable method to deliver blood products to medics treating hemorrhaging patients in austere environments when timely transport to higher levels of care or regular resupply are not feasible. Comprehensive mortality studies of the Afghanistan and Iraq conflicts suggest that 91% of survivable deaths are related to hemorrhage. Mortality increases by 5% with every minute delay. Whole blood (WB) is the preferred resuscitation product for prehospital treatment of patients in hemorrhagic shock. There is an increasing effort to have medics administer WB to massively hemorrhaging patients as soon as possible to the point of injury. However, not all ground medics will have WB on hand. Additionally, the collection of WB from unit-prescreened type O blood types is time-consuming and resource-intensive. Lastly, prescreened type O blood may be difficult to obtain in sufficient amounts to treat massively hemorrhaging patients, to treat multiple patients in a mass casualty, or in a prolonged field-care setting. **OVERVIEW:** Aerial resupply provides a potential platform to deliver WB to medics when CASEVAC is not possible. Air superiority is not guaranteed in future near peer conflicts, further limiting timely evacuation requiring a shift toward prolonged field care. As military operations shift to more austere and denied areas of operation potentially spanning wide geographic arenas, FDA-approved blood products will not always be readily available. Additionally, Large Scale Combat Operations will result in large numbers of casualties, the inability to evacuate patients, or to medically resupply by the conventional means developed during the War on Terror. Prolonged Critical Care is nearly a certainty. **DISCUSSION:** A review of the literature utilizing various aircraft and unmanned aerial systems as well as different types of blood products overall demonstrated feasibility of airdrop delivery/airdrop. All airdropped and control blood units met criteria for blood transfusion per transfusion guidelines as outlined by the Joint Trauma System Whole Blood Transfusion Clinical Practice Guideline and the Association for the Advancement of Blood and Biotherapies Circular of Information for the Use of Human Blood and Blood Components. Acceptable levels of hemolysis for stored PRBC units is <1%.

Learning Objectives

1. The participant should be able to describe the reasoning behind the need for guidance for airdrop delivery of blood products.
2. Audience members should be able to discuss various delivery systems and data outcomes from published studies supporting the feasibility of blood airdrop.

[301] SUBJECTIVE VS OBJECTIVE MEASURES OF WORKLOAD IN AN EXPERIMENTAL FUTURE VERTICAL LIFT PARADIGM

Ian Curry[1], Matthew D'Alessandro[1], Tom Berger[2]
[1]*U.S. Army, Fort Novosel, AL, United States;* [2]*NASA Ames Research Center, Palo Alto, CA, United States*

(Original Research)

INTRODUCTION: Managing cognitive demand is critical for aviation safety, yet accurately assessing pilot workload during complex flight maneuvers remains challenging. This study evaluated an integrated

methodology combining real-time cognitive engagement indicators to provide a comprehensive assessment and assess the reliability of physiological and subjective measures for monitoring operator state. **METHODS:** Six experienced U.S. Army rotary-wing pilots completed simulated high-workload flight scenarios consisting of low-altitude, reconnaissance, and air threat avoidance maneuvers. Continuous wireless electroencephalography (EEG), heart rate data, and subjective workload ratings were recorded during the flights. These were then analyzed to assess the coherence of subjective and objective measures of workload. **RESULTS:** EEG engagement indices and heart rate variability metrics demonstrated reliable within-subject consistency across trials for individual pilots, with mean intraclass correlation coefficient values ranging from 0.59–0.69. Both measures exhibited synchronized fluctuations across pilots at key events, increasing during high workload segments and decreasing in lower demand periods. Subjective ratings also showed good within-subject reliability, with mean intraclass correlation coefficient values ranging from 0.74–0.85. **DISCUSSION:** The findings of this study provide strong support for the feasibility of using a multi-measure approach that integrates EEG, heart rate variability, and subjective ratings. This approach can continuously monitor real-time cognitive workload fluctuations during simulated rotary-wing operations. While objective measures showed within-subject consistency, substantial between-subject variability highlights the importance of individualized neurocognitive profiling. The integration of neurophysiological, autonomic, subjective, and environmental data holds great promise for the future of pilot workload assessment despite the challenges posed by individual differences.

Learning Objectives

1. Demonstrate an understanding of real-time physiological monitoring techniques in complex simulated flight environments.
2. Describe the aeromedical and human factors challenges associated with Future Vertical Lift (FVL) capabilities, with emphasis on cognitive state monitoring.
3. Discuss individual responses to flight stressors and apply self-referencing methods for assessing workload and performance.

[302] PREVELENCE OF MENTAL HEALTH SYMPTOMS AMONG US ARMY AVIATORS: THE IMPACT OF MISSION TYPE

Aric Raus[1], Fred Volk[2], Sarah Spiridigliozzi[2]
[1]*Army University, Fort Leavenworth, KS, United States;* [2]*Liberty University, Lynchburg, VA, United States*

(Original Research)

INTRODUCTION: Aviation flight operations require constant vigilance where pilots must perform under significant physical and psychological stress. Prolonged or intense stress events can lead to mental health issues, even among those with formal resilience training. While the impact of stress within the aviation community has undergone increased scrutiny, little is known about the effects of specific aviation mission sets on mental wellness. **METHODS:** Quantitative survey responses were collected from a larger study of current and former U.S. Army Aviation personnel recruited via social media and snowball sampling between October 2023 and February 2024. This study utilized the four-question Public Health Questionnaire (PHQ-4) and the four-question Posttraumatic Stress Checklist for DSM 5 (PCL4-5) to determine pilots meeting the screening criteria for Generalized Anxiety Disorder (GAD), Major Depressive Disorder (MDD), and Posttraumatic Stress (PTSD) by the aircraft mission types of Unmanned Aerial Systems (UAS; N=60), Cargo (CH; N=33), Utility/MEDEVAC (UH; N=142), and Attack/Reconnaissance (AH; N=59). **RESULTS:** A total of 294 valid responses were received to determine the selected mental health screening criteria. Among pilots, UAS operators had the highest propensity for meeting screening criteria for all three conditions (61.7% ≥ one condition), followed by Cargo (42.4%), Attack/Reconnaissance (40.7%), and Utility/MEDEVAC (33.1%) aviators. When compared by individual conditions, UAS operators' responses were statistically more likely to meet the anxiety (55.0%) and PTSD (31.7%) screening criteria than all other mission types. **DISCUSSION:** The results indicate a high percentage of current and former US Army flight crews experience discernable levels of anxiety, depression, and PTSD. UAS operators' symptom levels were statistically higher than other pilots for anxiety, PTSD, meeting any condition, and meeting all three screening criteria. UAS operators undergo unique stressors from other mission sets. Some missions require operators to follow targets' patterns of life for days before conducting kinetic operations, allowing pilots to see them as individuals. Additionally, operators are not at personal risk, which may increase moral injury. Finally, distinctive barriers to care may impact mental health seeking among this career field. Future research should focus on specific causes for these increased mental health symptom rates and methods for reducing them.

Learning Objectives

1. Participants will gain additional insight into the prevalence of GAD, MDD, and PTSD symptoms among U.S. Army Aviation Pilots.
2. Attendees will be familiar with the higher prevalence of mental health symptom levels among UAS operators when compared to other US Army aviators.
3. Participants will better understand the gaps in knowledge that need to be researched regarding mental wellness among military aviators.

[303] FACTORS ASSOCIATED WITH PRESCRITPION STIMULANT USE FOR FATIGUE MITIGATION IN MILIARY AVIATION

Jacob Berry
U.S. Air Force, Idaho Falls, ID, United States

(Original Research)

INTRODUCTION: Fatigue management is critical for aviation safety, but there are knowledge gaps regarding the operational use of prescription stimulants by military pilots. This cross-sectional study aims to characterize stimulant use patterns and associated factors in a deployed fighter aviation unit over 5 months. **METHODS:** The study will analyze data from 37 single-seat fighter pilots who flew 1,098 sorties during a deployment. Using de-identified pharmaceutical records, flight schedules, and unit rosters, the research will examine relationships between stimulant use and factors such as mission duration, circadian disruption, deployment length, rank, age, and secondary duties.Key hypotheses include: 1. Pilots flying sorties >4 hours are more likely to use stimulants 2. Greater takeoff time variation increases stimulant use likelihood 3. Stimulant use is not affected by deployment duration 4. Lower-ranking pilots use stimulants more frequently 5. Younger pilots use stimulants more frequently 6.Secondary duties impact stimulant use 7. Pilots become physiologically addicted to stimulants during deployments 8. Pilots become physiologically addicted to stimulants during deployments. **RESULTS:** Statistical analysis will assess associations between the binary outcome of stimulant use and various predictor variables. This will illuminate factors influencing pilots' decisions to use prescribed stimulants. **DISCUSSION:** The findings will provide valuable insights into real-world stimulant utilization patterns in an operational military aviation setting. Results can inform evidence-based policies on fatigue countermeasures, guide commander decision-making on pharmaceutical interventions, and identify opportunities to mitigate pre-existing fatigue factors. Ultimately, this research aims to enhance aviation safety while optimizing pilot performance in demanding operational environments.

Learning Objectives

1. Identified the conditions and regulations regulating pharmaceutical fatigue medication in the US Air Force.
2. Described which factors are associated with pharmaceutical utilization during flights.
3. Identified which concepts regarding pharmaceutical fatigue medication are supported by this research.

Thursday, 06/05/2025 ***10:00 AM***
Centennial Ballroom II

[S-55] SLIDE : BRAIN, BACK, AND BEYOND

Chair: Mary Van Baalen
Co-Chair: Basil Spyropoulos

[304] NOVEL METHOD FOR EVALUATION OF THE EFFECTS OF ROTARY WING TRANSPORT ON A LARGE ANIMAL POLYTRAUMA MODEL

Rachel Kinsler[1], Andrew Mayer[2], Amy Lloyd[1], Laura Kroening[1], Ryan Mackie[1], Ciara Grunig[2], Jessica McQuaid[2], Hans van der Horn[2], Mandy Pacheco[3], Nicholas Michaliszyn[3], Jeffrey Molles[1]
[1]*U.S. Army Aeromedical Research Lab, Fort Novosel, AL, United States;* [2]*Mind Research Network, Albuquerque, NM, United States;* [3]*Lovelace Biomedical, Albuquerque, NM, United States*

(Original Research)

INTRODUCTION: Injuries resulting in hemorrhagic shock (HS) and traumatic brain injury (TBI) are leading causes of mortality and morbidity for combat trauma. Treatments consist of hemorrhage control, rapid fluid infusion, and evacuation to a medical treatment facility. Recent scientific publications suggest aeromedical evacuation (AE) may compound brain and organ damage in TBI/HS patients by increasing hemorrhage, decreasing cerebral blood flow, and further reducing the amount of oxygen reaching vital organs. The objective of this study was to evaluate the effects of flight profiles on survival, neurological function, and vital organ function. **METHODS:** The study was completed at the Lovelace Biomedical Research Institute (LBRI) using a validated swine polytrauma model (TBI/HS). It was a 24-hour survival study with 24 swine randomized to one of three experimental conditions: standard evacuation flight (SEF), tactical evacuation flight (TEF), or mock AE flight. Animals were exposed to a rapid acceleration/deceleration TBI. After TBI, animals underwent a controlled blood loss of 40% blood volume. AE was initiated 90 minutes post-blood loss with standard interventions (blood reinfusion, ventilation, and warming). After a 60-minute flight aboard a U.S. Army HH-60M medical helicopter, the animals were monitored for 24 hours. Sensors that measure acceleration, altitude, temperature, and noise were placed in the aircraft and on the animal. Invasive intracranial pressure (ICP), invasive blood pressure, and standard vital signs (VS) were also recorded during flight. **RESULTS:** Full datasets for were obtained for 20 animals (TEF [N=7], SEF [N=7], and mock [N=6]). Most animals showed improved VS upon receipt of standard interventions during AE. Notable events observed during AE include dislodged catheters, increased sedation, VS motion artifact, and tachycardia during maneuvers. Rotational velocity values were significantly different between the TEF and SEF profiles. Post-processing of the VS measures indicated they can be linked to environmental parameters during transport. ICP readings revealed distinct patterns specific to vehicle vibration, in particular vibration transmitted through the head. The clinical outcomes combined with these transport parameters are examined for patient transport algorithm development. **DISCUSSION:** A novel method for quantitative characterization of the effects of rotary-wing flight on a polytrauma model was employed.

Learning Objectives

1. The audience will be able to discuss the unique stresses of the rotary-wing flight environment on patients.
2. The participant will be able to understand the data analysis process for flight data collected and understand how it can be used to improve patient transport.

[305] DETERMINING CLINICALLY RELEVANT FINDINGS FOR MAGNETIC-RESONANCE IMAGING OF THE SPINE IN ASTRONAUTS: A FOCUSED LITERATURE REVIEW

Dacia Boyce[1], Danielle Anderson[2], Richard Scheuring[2]
[1]*U.S. Army, Fort Carson, CO, United States;* [2]*NASA - JSC, Houston, TX, United States*

(Original Research)

INTRODUCTION: Astronauts are routinely exposed to spaceflight hazards during occupational duties. The spine is greatly affected, with losses in strength, bone density, and risk for herniated nucleus pulposus (HNP) postflight. Astronaut spine health is monitored by magnetic resonance imaging (MRI). Historically, control groups consist of age and sex matched cohorts or the crewmembers' preflight MRI, with decision making guided by military waiver standards. With few comorbidities and high standards for physical performance, aviators and elite athletes are suitable populations for comparison. To refine interpretation of astronaut spine imaging, a focused literature review was conducted to determine the clinical relevance of MRI findings in astronauts and these analog groups. **METHODS:** A search of English language peer-reviewed literature published from 1985 to 2024 in PubMed and EMBASE was conducted to elicit studies related to MRI findings and spine pathology in astronauts, analog study participants, elite athletes, and aviators. Waiver practices in military aviation and NASA technical reports were also considered. **RESULTS:** In aviators, accelerated degenerative changes in the spine are frequently noted on imaging, regardless of pain. With age, control populations do not differ significantly from their aviator peers. Back pain is common, but not disabling. Military standards focus on ruling out underlying pathology or risk of sudden incapacity. In those with HNP, after surgical intervention many professional athletes and aviators successfully return to duty, even in collision sports or high-acceleration airframes. In athletes, disabling back pain often requires surgical management to enable return-to-play. Degenerative changes vary with age, sport, and play frequency. Astronauts develop spinal musculature atrophy in microgravity, findings which correlate terrestrially with athletic injury and back pain. Changes in disc height and water content are more pronounced in analog studies than are evident postflight. **DISCUSSION:** Astronauts, athletes, and aviators with a variety of spine conditions continue service or successfully return to duty after rehabilitation. Obtaining pre- and postflight MRIs enable characterization of changes to the spine in microgravity, and provides valuable considerations for mission training. Athlete and aviator data can inform aeromedical decision making for astronauts, especially as their mission tasks expand under the Artemis program.

Learning Objectives

1. Identify MRI findings which are likely of minimal clinical significance in the aviation, athletic, and astronaut populations.
2. Understand medical similarities and key differences between astronauts and selected comparison groups.
3. Understand considerations for return to duty clearance in these special populations.

[306] LOW BACK PAIN IN AVIATION: A LITERATURE REVIEW ON PAIN DEVELOPMENT.

Nina Frings[1], Jan Schmitz[2], Denis Bron[3]
[1]*Hospital of the Augusterinnen, Cologne, Germany;* [2]*University Clinique of Cologne, Cologne, Germany;* [3]*Aeromedical Centre Swiss Air Force, Duebendorf, Switzerland*

(Original Research)

INTRODUCTION: Lower Back Pain (LBP) represents a significant health burden in aerospace medicine, particularly affecting flight personnel and astronauts exposed to high G-forces and microgravity environments. This study examines molecular pain mechanisms in LBP and evaluates therapeutic approaches specific to aviation conditions. **METHODS:** A systematic PubMed review analyzed publications from 2019-2024 regarding molecular pain mechanisms, established medications, and innovative therapies in LBP. The analysis focused on early pain stages and intervertebral changes, incorporating data from long-term space missions and fighter pilot cohorts to assess aerospace-specific risk factors. **RESULTS:** LBP involves complex molecular cascades featuring inflammatory mediator-activated nociceptors. Key pathways include TNF-α binding to TNFR1/2 receptors activating NF-κB, IL-1β triggering IL-1R signaling, and IL-6/gp130 complex activating JAK-STAT pathways. Microgravity environments

demonstrate altered cytokine profiles and accelerated disc degeneration. While conventional treatments (NSAIDs, opiates) work through established mechanisms, emerging approaches using monoclonal antibodies targeting specific cytokines and stem cell therapies show promise for treating acceleration-induced spinal damage. **DISCUSSION:** Understanding molecular pain mechanisms in aerospace-specific LBP reveals new therapeutic possibilities. While traditional medications provide symptomatic relief, targeted therapies such as cytokine receptor antagonists and stem cell approaches offer potential causal treatments with fewer side effects—crucial for maintaining flight fitness. Future research should focus on evaluating these approaches under aerospace conditions and developing personalized treatment strategies addressing aviation and space medicine demands.

Learning Objectives

1. Microgravity environments significantly alter inflammatory cytokine profiles, accelerating intervertebral disc degeneration through activation of molecular pathways.
2. Traditional pain management approaches may be insufficient for aerospace-specific LBP due to operational constraints and altered physiological responses.
3. Personalized medicine approaches, particularly those targeting specific cytokine pathways, show greater promise for maintaining flight readiness than conventional treatments.

[307] POST-CRASH RECOVERY: BACK TO CROP-DUSTING AFTER SEVERE TRAUMATIC BRAIN INJURY

Alexandra Mejia[1], Diego M. Garcia[2], David Puerta[1], Gloria Quinonez[1]

[1]*The Colombia Civil Aviation Authority, Bogotá, Colombia;* [2]*Universidad Nacional de Colombia, Ormond Beach, FL, United States*

(Education - Case Study)

INTRODUCTION: This case study examines the aeromedical fitness evaluation of a crop-dusting pilot who sustained a severe traumatic brain injury (TBI) following an aircraft crash. After a period of treatment, recovery, and assessments for residual neurocognitive impairment, the pilot was granted a special issuance to return to flight duties. **BACKGROUND:** Crop-dusting pilots face high neurocognitive and physiological demands, including g-forces, thermal stress, precise see-and-avoid requirements, and low-altitude maneuvering. The lack of specific evidence for this unique field necessitates a performance-based, individualized approach to aeromedical certification, supported by close monitoring. Standard neuropsychological assessment tools are valuable for initial screening but often require supplementation by in-depth neurocognitive evaluations tailored to operational needs. This case underscores the need for specialized assessments to manage the risk of neurocognitive impairment in TBI-affected pilots, particularly in high-demand operations like agricultural aviation. **CASE PRESENTATION:** The case involves a 49-year-old male agricultural pilot with no significant personal or family medical history, who suffered a TBI with cerebral edema and microhemorrhages after an aircraft accident during a fumigation flight in 2022. Decompressive surgery was not required. After a two-year period of restricted flying duties, he was re-evaluated by a neurologist, an orthopedist, and the Colombian Civil Aviation Authority (ColCAA) aerospace medical team. Flight proficiency tests were also administered with satisfactory results, and follow-ups consistently indicated preserved cognitive function. Additionally, various psychometric scales were used to rule out PTSD. **DISCUSSION:** The ColCAA aeromedical team, following ICAO regulations, deemed the pilot fit to resume agricultural aviation duties with continued surveillance, including biannual neurocognitive assessments. This case illustrates the critical importance of establishing performance-based baselines and conducting individualized aeromedical evaluations across diverse pilot populations and operational settings. Such tailored assessments help ensure that aeromedical evaluations are fair, consistent, and suitable for the demands of specialized aviation roles, thereby promoting both flight and public safety.

Learning Objectives

1. The audience will learn about the aeromedical decision process after a traumatic head injury.
2. To understand the comprehensive assessment process according to ICAO regulation and another international dispositions in difficult aeromedical certification cases.
3. The audience will learn about the complexity and physiological demands on high-performance aviation, like crop dusting pilots.

[308] THE RELATIONSHIP BETWEEN COGNITIVE ABILITY AND RESILIENCE OF FLIGHT STUDENTS

Yujiao Zhu, Kaiyong Xu

Civil Aviation Medicine Center of CAAC, Beijing, China

(Original Research)

INTRODUCTION: To investigate the possibility of auxiliary evaluation of flight students' resilience by making use of cognitive ability tasks, and to provide competence evaluation reference for flight students' selection and training. **METHODS:** 709 flight students were tested by computer-based cognitive ability tests with tablets, including visual matrix comparison task and corresponding variant task, the Resilience Scale for Chinese Adolescent and several basic cognitive tasks. We compared differences in various indicators of tasks among flight students and analyzed whether students' performance in stress scenarios has something to do with their resilience. **RESULTS:** There were significant differences in various indicators between visual matrix comparison task (daily context) and corresponding variant task (stress context) ($t = 27.97 \sim 117.77$, $P < 0.01$). Stress resistance scores of flight students was positively correlated with positive cognition scores (one dimension of resilience) ($P < 0.05$). **DISCUSSION:** The stress situation triggered by cognitive tasks can help to evaluate flight students' resilience to a certain extent so that it could provide scientific evidence and feedback for screening, selecting and training flight students.

Learning Objectives

1. The audience will learn about new ideas and methods that can be tried in the process of screening flight trainees.
2. The audience will learn that, in addition to questionnaires, cognitive tasks can be used to assess trainees' psychological resilience.

[309] MISHAP MENTAL HEALTH RECOMMENDATIONS FOLLOWING MILITARY PILOT SURVIVAL

Kevin Heacock

USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Case Study)

INTRODUCTION: This case report describes a military pilot with multiple mental health disorders who was involved in a mishap resulting in loss of aircraft, with the pilot surviving. **BACKGROUND:** Military pilots with mental health disorders pose a unique challenge in the aviation community. Obtaining a waiver for these conditions requires careful consideration of the individual's ability to safely perform their flight duties. The literature has shown that mental health disorders can negatively impact a pilot's performance and increase the aeromedical risk. Additionally, obtaining a waiver for multiple mental health disorders can be particularly risky, as the interaction between these conditions can be complex and unpredictable. **CASE PRESENTATION:** The subject pilot had a history of multiple mental health disorders. They had a one-year waiver for their mental health conditions as was recommended by the Aeromedical Consultation Service (ACS) at the United States Air Force School of Aerospace Medicine (USAFSAM). The waiver was extended by the waiver authority for 6 months. The pilot was involved in a mishap a few months after the waiver extension, resulting in loss of aircraft. The mishap report recommended this case be used to educate aeromedical professionals across all services about the dangers inherent in obtaining a waiver for multiple mental health disorders and evaluating each case

studiously to ensure that aircrew are truly safe to fly. **DISCUSSION:** This case underscores the critical importance of cautious evaluation and decision-making in determining the fitness of military pilots with mental health disorders. The literature has shown that mental health disorders can negatively impact a pilot's performance and increase the aeromedical risk. Obtaining a waiver for multiple mental health disorders can be particularly risky, as the interaction between these conditions can be complex and unpredictable. This case can serve as a valuable case study for the training of aeromedical professionals, emphasizing the need for rigorous evaluation and careful consideration of each individual's unique circumstances and the potential risks involved in granting a waiver for multiple mental health disorders. Distro A: Cleared for Public Release, AFRL/PA, AFRL-2024-5999, 25 Oct 2024

Learning Objectives

1. Understand the unique challenges and risks posed by military pilots with multiple mental health disorders.
2. Recognize the importance of careful evaluation, decision-making, and waiver considerations for military pilots with mental health disorders, as highlighted in the case of a military pilot with multiple mental health disorders involved in a mishap.

Thursday, 06/05/2025 ***10:00 AM***
Centennial Ballroom III

[S-78] PANEL: THE VSS UNITY SUBORBITAL FLIGHT EXPERIENCE: MEDICAL OUTCOMES AND LESSONS LEARNED

Chair: Duncan Hughes

Panel Overview: BACKGROUND: *This panel presents medical results of the suborbital flight experience with the now-retired spaceship VSS Unity from 2021-2024, during which time it flew 9 fully crewed suborbital spaceflights involving a total of 36 SFPs and 18 pilots.* ***DESCRIPTION:*** *The first presentation provides an overview of specific medical conditions, risk mitigation efforts, and spaceflight outcomes for suborbital spaceflight participants (SFPs) that were evaluated via the Virgin Galactic standard medical screening process. The second presentation describes observed biopsychosocial effects of the suborbital spaceflight experience. This includes a discussion of anxiety, the effects of prior high-adventure activities, and the "overview effect." Each has implications for screening, training, monitoring, and post-flight follow-up. The third presentation examines radiation monitoring in a high-operations-tempo commercial suborbital spaceflight environment including requirements, equipment selection considerations, the regulatory environment, and implementation challenges. The final presentation provides a first-hand account from a flown researcher regarding the challenges of designing, integrating, and executing human-tended research payloads on a suborbital vehicle platform.* ***DISCUSSION:*** *Discussion will include results, future research plans, and implications for the field of space science. The VSS Unity flight experience illustrates that the learning period continues to be extremely important to iterative integration of lessons learned to improve medical screening, training, and follow up for commercial SFPs.*

[310] MEDICAL CONDITIONS, RISK MITIGATION, AND OUTCOMES FOR COMMERCIAL SUBORBITAL SPACEFLIGHT PARTICIPANTS

Karen Ong, Duncan Hughes, Johnene Vardiman-Ditmanson
Virgin Galactic, Las Cruces, NM, United States

(Education - Program / Process Review)

BACKGROUND: At present, no regulatory standards exist for medical screening of commercial spaceflight participants (SFPs). Additionally, little evidence exists for best practices in screening and medical care for commercial suborbital SFPs, who come from a wider demographic background, may have multiple medical conditions, and receive limited training compared to professional/governmental astronauts. Understanding the outcomes of a broad population of layperson SFPs after spaceflight will inform decisions about risk assessment, safety, and regulation. **OVERVIEW:** Participants of 9 suborbital spaceflights were medically screened, trained, flown, and assessed after return from space as part of routine operations (the Virgin Galactic "Medical Journey"). We summarize observed medical conditions, risk mitigation, and outcomes of commercial suborbital SFPs from the VSS Unity flights (aged 18-80y) flying suborbital profiles on a winged vehicle with maximum acceleration of +4.5 Gz/+2.5 Gx. We discuss notable medical conditions, medical mitigation efforts, medications flown, and outcomes including rates of illness, injury, motion sickness, and accommodations. **DISCUSSION:** No major injuries were reported. The sole minor injury (back strain) resolved with conservative measures. Few SFPs reported motion sickness with all cases being either self-limited or resolved after rescue medication with zero cases of emesis. Of greater concern were unplanned SFP actions, unreported medications (particularly sedative hypnotics), and participant anxiety. No adverse outcomes were observed for SFPs or reported by pilots flying multiple spaceflights (including consecutive monthly missions). In summary, layperson SFPs with a variety of common medical conditions tolerated suborbital spaceflight with no major injuries, cases of emesis, or adverse medical outcomes related to pre-existing conditions.

Learning Objectives

1. The participant will be able to describe rate of injury observed in commercial suborbital spaceflight participants.
2. The participant will be able to describe rates of motion sickness and emesis observed in commercial spaceflight participants.
3. The audience will be able to understand considerations for medical screening and postflight care in scaled operations.

[311] BIOPSYCHOSOCIAL CONSIDERATIONS IN COMMERCIAL SUBORBITAL SPACEFLIGHT

Johnene Vardiman-Ditmanson, Duncan Hughes, Karen Ong
Virgin Galactic, Las Cruces, NM, United States

(Education - Program / Process Review)

BACKGROUND: Considerable interest exists in layperson and scientific communities regarding the biopsychosocial implications of spaceflight. To date, much attention has been paid to potential positive outcomes of spaceflight such as the "overview effect," with less attention paid to the possible adverse sequelae. Previous spaceflight analog (centrifuge) studies have shown anxiety to be one of the most significant medical risks. **OVERVIEW:** We provide an overview of selected biopsychosocial observations from 9 suborbital spaceflight missions involving pilots, mission and research specialists, government, and/or private spaceflight participants (SFPs). We discuss the Virgin Galactic approach to mental health screening for biopsychosocial factors that impact training, safety, and enjoyment of flight. Important considerations include anxiety, crew composition & dynamics, unplanned/undisclosed actions, media and social media pressures, organizational expectations, guest/friends/family concerns, and the influence of previous adverse events. We discuss physiologic arousal, emotional interpretations, the "overview effect", and potential long-term considerations. Finally, we discuss countermeasures and the need for additional observations in this area. **DISCUSSION:** Knowledge regarding the biopsychosocial effects of suborbital spaceflight on layperson SFPs is still in its infancy. The medical screening process and integration of medical personnel into spaceflight training (which can be a novel, stress-inducing environment) allows development of trusting relationships, identification of potential problem areas, implementation of preventive measures, observation of SFP affect and behavior, and early intervention and mitigation if needed. We discuss clinical practices found to be effective, lessons learned, and the importance of providing clinical input on psychosocial and crew dynamics as part of the overall risk assessment.

Learning Objectives
1. The participant will be able to describe the importance of screening for previous adverse effects and possible mitigation measures.
2. The participant will be able to describe factors that may cause anxiety in commercial suborbital spaceflight participants and potential countermeasures.
3. The participant will be able to describe existing biopsychosocial measures for spaceflight and potential limitations.

[312] RADIATION MONITORING FOR SUBORBITAL PROFILES: IMPLICATIONS AND LESSONS LEARNED

Kristen Taraszewski, Duncan Hughes, Karen Ong
Virgin Galactic, Las Cruces, NM, United States

(Education - Program / Process Review)

BACKGROUND: Suborbital spaceflight profiles bring spaceflight participants (SFPs) to altitudes exceeding 50 miles. Historically, suborbital flight profiles have been considered low dose radiation exposures due to both altitude and duration of exposure. However, the anticipated frequency of suborbital spaceflights at planned operational scale, will yield a flight rate involving multiple flights per day. While no current regulatory guidance exists for radiation monitoring, expert consensus is to treat pilots as radiation workers. Additionally, there is heightened public perception and concern regarding the potential effects on SFPs. **OVERVIEW:** Radiation monitoring of all vehicle occupants involved in suborbital spaceflight missions is being performed at Virgin Galactic. We provide an overview of the development of a human radiation monitoring program in a commercial setting, including equipment selection, evolution of processes, technology & software advancement, data retrieval & interpretation, individual radiation monitoring, and cumulative exposure assessments. Space weather forecasting will also be discussed as it relates to operational preparation and exposure avoidance. We discuss considerations in the implementation of radiation monitoring at scale, including automation of various aspects of data processing, linkage with pilot/SFP electronic medical records for occupational health monitoring, and long-term implications. Finally, we discuss how industry collaboration has catalyzed innovation and government support for developing the next generation of radiation tools and software. **DISCUSSION:** The decision to monitor any human health parameter requires careful consideration of the benefits expected, especially given the mass constraints of missions, the necessity of cost efficiency, and tradeoffs with other critical systems. Despite these constraints, radiation monitoring is a standard practice on Virgin Galactic flights. Data from VSS Unity flights have shown that radiation exposure from a single suborbital spaceflight is similar to that of a commercial airline flight from Denver to Los Angeles. Space weather forecasting efforts ensured 2 planned missions were deconflicted with solar events that may have increased radiation exposure up to six-fold. Thus, continued forecasting, prediction, and monitoring of human radiation exposure for suborbital missions is essential.

Learning Objectives
1. Participants will be able to describe the expected amount of radiation exposure for a single suborbital spaceflight.
2. Participants will be able to understand the challenges in implementing a commercial spaceflight radiation monitoring system.
3. Participants will be able to describe the benefits of long-term monitoring of cumulative radiation exposure for pilots involved in frequent suborbital spaceflight missions.

[313] SUBORBITAL RESEARCH AND HUMAN-TENDED PAYLOADS: LESSONS LEARNED

Kellie Girardi[1], Duncan Hughes[2], Karen Ong[2], Johnene Vardiman-Ditmanson[2]
[1]*International Institute for Astronautical Sciences, Boulder, CO, United States;* [2]*Virgin Galactic, Las Cruces, NM, United States*

(Education - Program / Process Review)

BACKGROUND: Opportunities to conduct space research have traditionally been quite restricted in terms of access, cost, and flexibility. Parabolic flight provides only a limited microgravity duration, whereas orbital flight is cost prohibitive, has years-long planning and manifesting cycles, and generally relies on persons outside of the research team (e.g., government astronauts) for payload manipulation or troubleshooting. **OVERVIEW:** We present a summary of successfully completed suborbital research from the perspective of a flown research specialist. The experiments included the first suborbital, human-tended, free-floating payload, the first continuous glucose monitor worn during dynamic phases of flight, and a wearable sensor system collecting biometric data throughout the spaceflight. Some important considerations for suborbital flight experimentation include the flight profile (acceleration force ranges of -1.5/+4.5 Gz and -0.5/+2 Gx), cabin ergonomics, payload safety reviews, and the coordination, choreography and deconfliction of biologic sampling and the pre-/post-flight access to payloads & astronauts. Special attention will be paid to the process of integrating research with flight operations and maximizing opportunities for science (e.g., aerobatic training flights, dress rehearsal opportunities, etc.). **DISCUSSION:** Suborbital research is often envisioned as part of the experimental progression from parabolic flight to experiments on orbit. However, suborbital research has distinct advantages and challenges which requires its own paradigm for experiment planning and execution. Advantages include rapid access to payloads before/after missions, interaction during the mission, flexibility leading up to the spaceflight, and the possibility of multiple, iterative missions allowing scientist interaction with payloads. Challenges include ergonomics, integration with the flight suit, knowledge of timelines in which interaction is limited or impossible, power sources, and qualification for flight. Wider understanding of these factors can help improve suborbital experimental design and improve efficiency for flight integration.

Learning Objectives
1. The audience will learn about considerations for physiologic evaluation over the course of a suborbital spaceflight.
2. The audience will learn about the unique opportunities and challenges of a suborbital spaceflight platform for experimentation.
3. The audience will learn about emerging best practices for designing and integrating experiments for a suborbital spaceflight profile.

Thursday, 06/05/2025 ***10:00 AM***
Centennial Ballroom IV

[S-57] PANEL: SURGERY IN SPACE: REALITIES AND CHALLENGES OF PROCEDURAL MEDICINE AND CRITICAL CARE FOR EXPLORATION-CLASS SPACE MISSIONS

Chair: Danielle Carroll
Co-Chair: Matthew Melin

Panel Overview: *Delivery of procedural and critical care is resource intensive and requires skilled medical staff, infrastructure, and equipment. Long-duration missions involving deep space transit and planetary surface operations may bring with them unplanned medical events in which respiratory and cardiovascular compromise mandate critical care support. With the evolution of space travel to incorporate a broader swathe of civilian spacefarers, this reality is truer than ever: the space medical community must plan for the provision of medical care and support for individuals with more chronic medical conditions than the average professional astronaut. Even seemingly simple terrestrial medical tasks, such as continuous vital sign monitoring, supportive ventilation, and point-of-care imaging, pose much greater challenges in the exploration-class mission environment. Similarly, establishing prompt access to medication and blood products is often difficult, and availability of skilled staff will likely be limited. Furthermore, physiologic*

alterations in response to microgravity can predispose astronauts to sepsis and other systemic physiologic conditions, as a result of spaceflight-induced changes in endovascular physiology. This panel, delivered on behalf of the Space Surgery Association, will discuss the current and potential future states of technology and concerns related to procedural support and surgical critical care in the spaceflight environment. Dr. Pantalos will discuss his team's work with dehydrated red blood cells, a promising, developing technology for transfusion therapy both on Earth and during exploration space flight. Ms. Rothrock will discuss the impact of variations in gravitational forces on arterial resistance and blood pressure, highlighting the role of tissue compressive forces in microgravity and hypergravity conditions. Dr. Formanek will discuss the statistical models that his team created to evaluate the effect of level of anesthesiology training on basic perioperative care needs, with relevant applications to space medicine. Finally, Dr. Mathyk will describe her recent work with gynecologic ultrasound in parabolic flight, in support of women's health for upcoming space missions.

[314] UPDATE ON 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, Inc., Louisville, KY, United States*

(Original Research)

INTRODUCTION: We have previously reported on the need for a method to deliver a transfusion of red blood cells for crewmembers experiencing spaceflight-induced anemia or traumatic blood loss. 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. Updates on the status of the dRBC approach is reviewed. **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 (e.g. trehalose) 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. Current efforts are optimizing the dehydration process to maximize the oxyhemoglobin/methemoglobin ratio and dRBC recovery. Manual and automated rehydration and performance assessment is being prepared for suborbital and orbital flight evaluations. Preliminary tests are checking the appropriateness of methods used to prepare dRBC from animal blood for human blood. **RESULTS:** Successful rehydration and recovery of dRBCs (>70%) comparable to 1-g values was demonstrated in parabolic flight with in-flight pO2 ≥ 150 mm Hg. Effective simulation of dRBC infusion was demonstrated in parabolic flight. The oxyhemoglobin/methemoglobin ratio is very close to clinical acceptance (90%) with the level of hemolysis declining. Creating dRBC from human blood will be similar to the process with animal blood with minimal modification. **DISCUSSION:** Steady progress is being made to create clinically acceptable dRBC for terrestrial and spaceflight transfusion therapy. 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. 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. Further evaluation of dRBC rehydration will occur in a suborbital flight in 2026 and in orbital flights in 2025 and 2026. [NASA-80NSSC18K1664, DOD W81XWH-20-1-0866, NSF PFI-1827521, NASA 80NSSC23K0855]

Learning Objectives

1. Understand the concept of red blood cell preservation by optimized dehydration processes.
2. Understand the options for rehydration of dehydrated red blood cells.
3. Appreciate the logistical advantages of using dehydrated red blood cells over current blood preservation methods.

[315] BODY MASS AND GRAVITATIONAL FORCES: A MODELING APPROACH TO UNDERSTANDING BLOOD PRESSURE REGULATION

Sara Rothrock[1], Mimi Lan[2], Jay Buckey[3]
[1]*Brown University, Providence, RI, United States;* [2]*Dartmouth College, Hanover, NH, United States;* [3]*Dartmouth College, Lebanon, NH, United States*

(Original Research)

INTRODUCTION: Understanding blood pressure dynamics in microgravity is crucial for managing critical care patients during spaceflight. Continuous blood pressure measurements in space show reductions compared to preflight values, but the mechanisms driving these changes remain unclear. Though previous research has emphasized blood volume reduction due to fluid shifts, this alone cannot explain both the immediate and sustained drops in blood pressure observed in astronauts. The elimination of tissue compressive forces on the vascular system in weightlessness represents another critical factor beyond fluid dynamics. These absent forces may decrease arterial resistance, potentially contributing to lower blood pressure. To better understand these mechanisms of blood pressure regulation, this study examines the relationship between body mass and blood pressure across varying gravitational forces. **METHODS:** Using a lumped-parameter cardiovascular model developed in MATLAB® Simscape Fluids™, blood flow dynamics were simulated to examine how varying gravitational forces and body mass alter blood pressure through changes in transmural pressure. Body mass variations were simulated by adjusting anthropometric measurements in 10% increments. Measurements were taken at the aortic arch, a region shown to be an optimal location for predicting cardiovascular events. **RESULTS:** Simulations demonstrated a reduction in blood pressure under microgravity (0G) conditions, with the extent of this reduction varying by body mass. Individuals with greater simulated body mass experienced more pronounced decreases in both systolic and diastolic pressures in microgravity. Conversely, in hypergravity (2G) conditions, blood pressure increased due to elevated tissue compressive forces, which raised vascular resistance and, consequently, blood pressure. **DISCUSSION:** These findings suggest that body mass and gravitational forces play a role in regulating blood pressure by modulating transmural pressures. Although long-term spaceflight involves reductions in blood volume, the immediate decrease in blood pressure observed in microgravity may stem from the absence of tissue weight effects on vessels, particularly in individuals with higher body mass. This mechanism is further supported by the hypergravity findings, where increased tissue weight elevates vascular resistance and blood pressure—an effect that also scales with body mass.

Learning Objectives

1. Understand how the absence of tissue compression in microgravity can lead to reduced arterial resistance and lower blood pressure.
2. Learn about how cardiovascular lumped parameter modeling can assist in predicting blood pressure responses to gravitational changes.

[316] EFFECTS OF INEXPERIENCED PROVIDERS ON PERIOPERATIVE CARE AND SPACEFLIGHT IMPLICATIONS

Arthur Formanek[1], Taania Girgla[1], Gavin Ovsak[2]
[1]*Brigham and Women's Hospital, Harvard Medical School, Boston, MA, United States;* [2]*MD Anderson Cancer Center, Houston, TX, United States*

(Original Research)

INTRODUCTION: Delivery of perioperative care is highly resource intensive and requires skilled medical staff, infrastructure, and equipment. Safe perioperative care in spaceflight remains a large potential problem, and a trained anesthesiologist will likely not be readily available. Spaceflight could lead to scenarios requiring airway, cardiovascular,

and pharmacologic support both in low Earth orbit and exploration class missions. Furthermore, care provided by skilled anesthesia providers versus relatively unskilled providers could necessitate more resources to provide for adequate care. In addition, spaceflight would introduce unique constraints to perioperative care, such as upmass. **METHODS:** Anesthesia induction, emergence, procedure start and end times, level of anesthesia training (clinical anesthesia (CA) years 1-3), case urgency, ASA patient status, intubation attempts, and IV attempts for laparoscopic appendectomies and cholecystectomies from August to October 2021-2023 were extracted from the Epic electronic medical health record at the Brigham and Women's Hospital. 64 cases were identified, and a multivariate linear regression model was created via Eviews statistical software using least squares method to forecast anesthesia relevant task times and were controlled for resident training level, case acuity, and ASA status. **RESULTS:** The multivariate linear regression induction start to intubation complete time in minutes = 2.68 + 2.00(CA1) - 1.79(urgent case) + 2.45(CA3 on call) + 0.81(ASA number) was statistically significant for forecasting intubation time. F-statistic probability was 0.000017 and adjusted R2 0.32. All predictor variables had a p-value <0.05 except for ASA number, which was 0.079. Breusch–Pagan test for heteroskedasticity revealed F-statistic probability 0.95. Number of intubation attempts, IV attempts, and emergence time did not reach statistical significance. **DISCUSSION:** New trainees required a significantly increased time to complete intubation. For perioperative care to be safely administered peri-spaceflight, knowing the impact of relative lack of training and limited resources is needed. Using terrestrial analogues and models to forecast possible spaceflight perioperative needs gives greater insight into possible crew and hardware requirements. Length of time to complete medically necessary tasks, especially with no ability for an experienced provider to rescue, can have profound implications. Further research, including communication delay and inability of a skilled provider to directly intervene is warranted.

Learning Objectives

1. The participant will learn about the effect of inexperienced providers on performance of basic perioperative tasks.
2. The participant will understand the implications of relatively unskilled providers being directed by skilled providers in a spacecraft or remote environment.
3. The participant will learn about methods of delivery of safe perioperative care in remote environments.

[317] HANDHELD POINT-OF-CARE ULTRASOUND FOR GYNECOLOGICAL IMAGING UNDER MICROGRAVITY

Begum Mathyk[1], Shawna Pandya[2], Heather Wright Beatty[3], Matthew L. Anderson[1], Adrian Kohut[1]

[1]*Morsani College of Medicine, University of South Florida, Tampa, FL, United States;* [2]*International Institute for Astronautical Sciences (IIAS), Alberta, BC, Canada;* [3]*National Research Council Canada, Ottawa, ON, Canada*

(Original Research)

INTRODUCTION: Gynecologic emergencies are prevalent across all ages, often presenting with symptoms such as abdominal pain and abnormal vaginal bleeding. Females frequently visit emergency departments more than males, with genitourinary system conditions being a common diagnosis. Given the closed and shared spaces of long-duration spaceflights, it is crucial to anticipate and manage such emergencies in space. This study evaluates the feasibility and effectiveness of astronauts performing self-administered transabdominal gynecologic imaging using handheld Point-of-Care Ultrasound (POCUS) under microgravity conditions, focusing on maintaining the privacy of the subject. **METHODS:** The study utilized a parabolic flight profile to achieve ~20 seconds of microgravity per parabola on the National Research Council's (Ottawa, Canada), Falcon 20 aircraft over the course of a series of parabolas. A female medical practitioner performed a transabdominal self-scan of her lower abdomen during the microgravity phases of parabolic flight using a commercially available handheld ultrasound (HHU) device. **RESULTS:** The subject successfully completed the self-scan of the uterus within 20 seconds of entering microgravity, obtaining clear images of the uterus, fundus, myometrium, endometrial lining, and cervix (video). During the scan, a 3D volume of the bladder was also measured (video). The quality of the images was sufficient to exclude the presence of macroscopic masses, such as fibroids, and to delineate the borders of the endometrial lining. The images were automatically saved to the cell phone application. **DISCUSSION:** This is the first study to report on self-performed handheld POCUS for transabdominal gynecologic imaging under microgravity. The findings confirm the potential of portable ultrasound devices to independently diagnose and monitor gynecological conditions in space, enhancing medical autonomy and preserving privacy.

Learning Objectives

1. Understanding of female anatomy, recognize common gynecologic emergencies, and identify associated symptoms as they might present during space missions.
2. Learning the principles and techniques involved in conducting self-administered handheld Point-of-Care Ultrasound (POCUS) for gynecologic imaging under microgravity conditions.
3. Developing strategies to maintain privacy and enhance autonomy in medical diagnostics during space missions, ensuring ethical standards and crew safety.

Thursday, 06/05/2025 ***10:00 AM***
Regency V

[S-58] WITHDRAWN

[S-76] PANEL: THE GOOD, THE BAD, AND THE UGLY OF ARTIFICIAL INTELLIGENCE

Chair: Estrella Forster
Co-Chair: Annette Sobel

Panel Overview: *Artificial Intelligence (AI) has become ubiquitous in our society. This panel will introduce the subject with a focus on human factors, medical, and allied health sciences professions. It will start with Dr. Stephen Veronneau, who will address the history of AI since the 1950s and how it continues to develop into an integral part of our domestic and professional lives. His presentation will be followed by Dr. Melchor Antuñano with a review of the latest AI advances in technology applicable to medical research and practice. Dr. Annette Sobel will then discuss human factors AI applications involving civilian, military and emerging operations with a focus on the human-computer relationship. The panel will close with Dr. Estrella Forster, who will provide a review of the ethical issues associated with AI, its management, and the attempt to humanize its future capabilities. The panel promises to be a balanced review of AI and how we can best exploit it to enhance aerospace safety.*

[416] HISTORY OF ARTIFICIAL INTELLIGENCE

Stephen Veronneau

FAA, Office of Aviation Medicine, Des Moines, WA, United States

(Education - Tutorial / Review)

INTRODUCTION: Historical Overview of Artificial Intelligence. **TOPIC:** The history of artificial intelligence(AI) began in the 1950s when early computer scientists like Alan Turing and John McCarthy explored the idea of machines that could think. Turing proposed the Turing Test to evaluate a machine's intelligence, while McCarthy coined the term "artificial intelligence" and organized the first AI conference in 1956, marking the official birth of AI as a field. Early AI focused on symbolic reasoning and problem-solving but struggled

due to limited computing power and data. In the 1980s, "expert systems" became popular in medicine, attempting to replicate human clinical decision-making. However, the AI "winter", the marked decrease in government funding, soon followed due to the PC revolution, the high computational needs of AI software, and unmet expectations and loss of profit seen by businesses. The 1990 and early 2000 decades saw a shift toward statistical methods and machine learning, which advanced as computing power grew exponentially. Breakthroughs like IBM's Deep Blue close defeat of chess champion Garry Kasparov in 1997 demonstrated AI's growing capability. In 2007 IBM's Watson development led to it winning Jeopardy in 2011. In the 2010s, deep learning and neural networks spurred rapid progress in AI, leading to applications in image and speech recognition, natural language processing, and more. This era saw the rise of AI tools like Siri, Alexa, self-driving car technology and image generation. Today, AI continues to evolve, powering applications across industries and inspiring debate over ethics, privacy, and the future of humanity. There are some analogous comparisons between internet search engine history, the infinite monkey theorem, and the development of the internet itself. **APPLICATION:** The use of any technology to assist or replace human intelligence will encompass beneficial, neutral and adverse associations. Understanding the history of the technological development will benefit the end user. Challenges in input data quality and availability, inadequate risk control measures or regulation, escalating power requirements, rising costs, coupled with unrealistic expectations and fears are some of the current issues in AI. **RESOURCES:** 1. ChatGPT. 2. Crossnohere NL, Elsaid M, Paskett J, Bose-Brill S, Bridges JFP Guidelines for Artificial Intelligence in Medicine: Literature Review and Content Analysis of Frameworks J Med Internet Res 2022;24(8):e36823. 3. Gastrointestinal Endoscopy. (Gastrointest Endosc 2020;92:807-12.)

Learning Objectives

1. The audience will learn about Artificial Intelligence history and timeline.
2. The audience will learn about Artificial Intelligence and the non-linear changes in its development and application over time.
3. The audience see an illustrative Artificial Intelligence hallucination example.

[417] THE PRACTICAL APPLICATION OF NEW AI TOOLS IN MEDICINE – CHALLENGES AND OPPORTUNITIES

Melchor Antunano
FAA, Oklahoma City, OK, United States

(Education - Tutorial / Review)

INTRODUCTION: This presentation will discuss the use of AI tools in medicine, current practical applications, regulatory approval, potential applications in Aerospace Medicine, and implementation challenges. **TOPIC:** The first applications of Artificial Intelligence (AI) tools in medicine started in the 60's and 70s using rule-based systems intended to provide support in medical diagnosis and decision making. These foundational AI medical tools included Dendral, MYCIN, Internist-I and CASNET. In addition to their potential benefits, these tools also showed significant technical, ethical and regulatory challenges. Between 1995 and August 2024 the US FDA has authorized nearly 1,000 AI/ML enabled medical devices (hardware and software). More than 75% of them are medical imaging tools. Other specialties being increasingly impacted by AI tools are Cardiology and Neurology. Almost all of the AI medical tools in the US have been cleared through the FDA's less stringent, faster and cheaper 510(k) Pathway. However, the FDA clarified that any AI tools intended to make specific recommendations about diagnosis or treatment must be considered medical devices and certified accordingly. The International Medical Device Regulators Forum published a Possible Risk Categorization Framework to help identify risk categories of Software as a Medical Device based on how it is used for healthcare decisions. **APPLICATION:** Several of the leading medical AI tools include IBM Watson Health, Google DeepMind Health, Zebra Medical Vision, PathAI, Viz.ai, Aidoc, Tempus, Qure.ai, Enlitic, etc. As of today, none of these tools are being used to replace humans for medical decision-making. Several areas to improve healthcare through the use of AI include: 1) Personalized care, 2) Patient access to medical care, 3) Patient monitoring and education, 4) Discovery of new drugs, 5) Targeted Clinical Trial Recruitment, 6) Physician training, 7) Surgical procedures, 8) Surgical effectiveness and efficiency, etc. Any improvements in these areas will have an impact on aerospace personnel and passengers. Potential application of AI tools in Aerospace Medicine include Health monitoring and diagnosis, 2) Predictive analytics for health risks, 3) Mental health and cognitive assessment, 4) Autonomous medical assistance, 5) Radiation exposure management, 6) Adaptive exercise regimens, 7) Telemedicine support and decision-making aid, 8) Medical simulation & training, 9) Fatigue & sleep management, etc. **RESOURCES:** 1. ChatGPT. 2. US Food and Drug Administration. 3. The Medical Futurist.

Learning Objectives

1. The audience will learn about the use of AI tools in medicine.
2. The audience will learn about the most common applications of AI in medicine today.
3. The audience will learn about potential applications of AI tools in Aerospace Medicine.

[418] THE DILEMMA OF AI AND HUMAN FACTORS: ADVANCING THE PARTNERSHIP IN AEROSPACE MEDICINE

Annette Sobel
Texas Tech University, Lubbock, TX, United States

(Education - Tutorial / Review)

INTRODUCTION: The evolution of Artificial Intelligence (AI) over the past seventy years has been punctuated by maturation of a number of enabling tools and increasing integration of human factors considerations that both broaden and limit its application to health care. **TOPIC:** As AI matures and potential applications to aerospace medicine become increasingly apparent, it is beginning to take on many more humanoid qualities. These qualities reflect characteristics such as neurologic dysfunction such as hallucinations and fabrication of information, perceptual difficulties, and illusions. and integration of fake information into real information to enhanced capability for information integration and fusion with varying degrees of validity and reproducibility. Corresponding decision assisting software intended to be task-oriented may lose focus of attention and integrate ancillary data demonstrating relevant human interdependence on information. An essential characteristic of the human's willingness to rely on AI tools is trust. **APPLICATION:** This presentation will demonstrate aerospace medicine examples of the process of developing the human computer relationship and the bond that results in collaborative AI-human decision-making. The audience will gain an enhanced understanding of the pitfalls and opportunities associated with AI and begin to appreciate the multi-domain environment supported by these systems. Specific examples of the end-user's (whether health care provider or patient) opportunities to derive conclusions with human like biases, ethics-based conclusions, and subjective clinical assessments. An introduction to mitigation strategies for effective healthcare use will be presented to enhance the audience's understanding of paths to effective use of this emerging technology.

Learning Objectives

1. The audience will understand the complexities of the AI - Human Bond.
2. The audience will be able to identify some specific concerns regarding AI reliability and trust.
3. The audience will be able to describe qualitative metrics of human performance using AI tools.

[419] THE PHILOSOPHICAL INTRICACIES OF EMULATING HUMANS

Estrella Forster
Self (retired), San Antonio, TX, United States

(Education - Tutorial / Review)

INTRODUCTION: While Artificial Intelligence (AI), along with the humanoid robots emerging from the same are evolving at astonishing speed, the questions regarding their benefit and management continue to raise concerns by both users and developers. This presentation will discuss the issues associated with AI, including the ethics regarding its use and the extent of its ability to ultimately emulate humans. **TOPIC:** The word robot first appeared in 1942 in Isaac Asimov's science fiction short story titled "Runaround." In this comic, the laws of robotics were first presented and have been known to us since our childhood. Through his work, Asimov set a new standard of plausibility on the likely difficulty of developing intelligent robots and the technical and social problems that could result. These controversies have been considered by all of us and are constantly illustrated by the media, the press, and academia. Studies have found that AI can lead us to new insights and accelerate the pace of innovation, including the realization of Eureka! moments as we conduct scientific research. However, ethical and moral issues such as privacy, accountability, bias, transparency, interpretability, robustness, and reproducibility raise innumerable questions that demand responsibility in the management of AI. Some have asked: "Can AI, which operates through lines of code and algorithmic processing, harbor a 'soul' in some sense similar to humans? While AI can replicate certain aspects of human intelligence and emotional responses, therein lies a critical distinction. Replication is not equivalence. The 'understanding' of emotions by AI is a programmed mimicry, devoid of the subjective quality of phenomena… that keep living beings with 'soul." Will we be able to discern and/or control the implicit camouflage of AI? In some future, Will some of us confuse AI with GOD? **APPLICATION:** This discussion summarizes how AI may be responsibly implemented in aerospace medicine and human performance.

Learning Objectives

1. The participant will be able to understand how issues associated with AI may be managed in aerospace medicine and human performance.
2. The participant will be able to understand the technical and social problems that may result from AI.

Thursday, 06/05/2025 ***10:00 AM***
Regency VII

[S-59] PANEL: UTILIZATION OF ARTIFICIAL INTELLIGENCE-BASED TOOLS TO SUPPORT AUTONOMOUS MEDICAL OPERATIONS

Chair: Jay Lemery
Co-Chair: Kris Lehnhardt

Panel Overview: INTRODUCTION: *This panel summarizes recent activities that the Exploration Medical Capability (ExMC) Element of NASA's Human Research Program (HRP) is utilizing to leverage the power and efficiency of artificial intelligence (AI) tools to reduce human system risk in space medicine operations.* ***TOPIC:*** *The first presentation describes the adaptation and fine-tuning of an open-source large language model (LLM) based on the OpenBIO 8 billion parameter LLM. This "Doc-in-a-Box" (DIB) LLM features multi-modal capability (interactive voice and image acquisition) and following containerization was deployed on an IoT core in collaboration with the Lunar Command and Control Interoperability (LuCCI) Project. The second presentation in this panel outlines the novel approach to development and utilization of the Objective Structured Clinical Examination (OSCE) for evaluating the performance of DIB. Features of the OSCE and performance of the model as scored by physicians trained in Aerospace Medicine will be discussed. The third presentation describes the use of AI-based tools to collect and summarize vast amounts of information necessary to create Clinical Finding Forms (CliFFs) as part of an Evidence Library for use by the IMPACT probabilistic risk assessment tool. Utilizing AI-tools to streamline the labor-intensive process of CliFF development could substantially reduce the amount of physician labor necessary to complete such tasks in the future. The fourth presentation in this AI Panel explores the breadth and depth of AI-related activities currently ongoing or in planning stages within ExMC and HRP. Topics include LLM use at the edge, directed acyclic graph analysis, synthetic clinical data generation. The final presentation presents the possibilities of incorporating Agentic AI to automate tasks and facilitate in the movement of data using integrated data systems platforms. Following a Federated model, an Agent can control the flow of information to maximize the overall performance using AI tools via distribution of computing capacity over multiple APIs.* ***APPLICATION:*** *Taken together, the presentations in this panel summarize the challenges to be overcome and potential solution spaces to be explored and matured to progressively enable autonomous medical operations using AI-based tools.*

[323] DOC-IN-A BOX: ADAPTATION AND FINE TUNING OF AN OPEN-SOURCE LARGE LANGUAGE MODEL TO SUPPORT AUTONOMOUS MEDICAL OPERATIONS

Martin Garcia[1], Giovanni Marchetti[2], Ali Al[3], Jay Lemery[1]
[1]*NASA, Houston, TX, United States;* [2]*Google, Palo Alto, CA, United States;* [3]*KBR, Houston, TX, United States*

(Education - Tutorial / Review)

INTRODUCTION: Autonomous Medical Operations can be enhanced with decision support modalities that leverage the power of artificial intelligence-based tools. **TOPIC:** Here we describe the adaptation and fine-tuning of an open-source large language model (LLM) based on the aaditya/Llama3 OpenBIO 70BN parameter model. This "Doc-in-a-Box" (DIB) model incorporates multi-modal capability (interactive voice using Open AI/whisper-large-3 model and image acquisition using Google PaliGemma open-vision model) with the goal of deployment on an IoT core as part of the Lunar Command and Control Interoperability (LuCCI) Project. The DIB was originally developed in Google Cloud's Vertex AI environment and Colab with code written in Python and structured as a Jupyter notebook to leverage cloud computing resources for efficient execution. The models were loaded and presented via a Gradio-based interface for a user-friendly experience. The server was specifically designed for machine learning-intensive workloads via use of graphics processing units (GPUs). An embedding model was used for retrieval augmented generative processing of data extracted from pdf files. Each individual model was assigned to one of either the eight or four available GPUs to maximize parallel processing capabilities during the early development. Preliminary testing of the model demonstrated high levels of accuracy in response to specific prompts derived from Objective Structured Clinical Exam questioning (results of the testing are detailed in another abstract within this panel). Demonstration of good model performance in a cloud environment was the requirement necessary to move into an edge device application. **APPLICATION:** The DIB model was further reduced to 3BN and 1BN parameter models for containerization and evaluation at the edge. This IoT core edge device was designed to provide on-premise cloud-like computing capabilities for secure IoT applications utilizing data not rated for cloud platforms and hosting containerized applications, e.g., Lunar Surface Operations. The prototype was designed to extend the open-sourced capabilities of the Cloud onto remote, isolated locations such as the Lunar surface to define a loosely coupled, hardware independent, highly automated hosting platform. Further testing, further refinement and validation of DIB on similar IoT platforms are necessary steps toward enabling Autonomous Medical Operations in a variety of settings.

Learning Objectives

1. The participant will be able to identify the constituent elements of a large language model needed to develop a functioning language clinical decision support.

2. The participant will be able to appreciate the use of the objective structured clinical exam [OSCE] as a benchmark in measuring the success of the AI clinical decision support.
3. The participant will be able to appreciate the limitations of early AI models in processing and memory whose limitations will ultimately serve as preconditions for successful AI clinical decision support in flight.

[324] AGENTIC ARTIFICIAL INTELLIGENCE TO SUPPORT AUTONOMOUS MEDICAL OPERATIONS

David Hilmers[1], Martin Garcia[2], Truong Le[2], Carlos De Los Santos[2], Jay Lemery[2]
[1]*KBR, Houston, TX, United States;* [2]*NASA, Houston, TX, United States*

(Education - Tutorial / Review)

INTRODUCTION: Agentic artificial intelligence (AI) systems can independently plan, make decisions and even "learn" as they manage automated tasks and facilitate the movement of data using integrated data systems platforms. Following a Federated model, an AI Agent can control the flow of information to maximize the overall performance using AI tools via distribution of computing capacity over multiple platforms. **TOPIC:** AI-based tools are being developed at an astounding rate and despite the already vast market, AI is expected to grow at approximately 37% per year from 2023 until 2030. Key to fully realizing the potential of all these new tools is incorporation of AI Agents designed to function with minimal human assistance. The possibilities for Agentic AI in healthcare have been described as revolutionary by enabling round-the-clock monitoring of patient status (e.g., vital signs, laboratory results, electronic records), real-time adjustments to treatment plans and perhaps the capacity to provide a predictive and/or diagnostic function for sub-clinical presentation of disease. Through analysis of multiple data streams from a panoply of sources including wearable sensors, Agentic AI systems have the potential to improve patient monitoring and treatment all while freeing the clinician from many rote, and often mundane tasks. Similarly, by leveraging multiple reference databases, informed, evidence-based decisions can be reached by Agentic AI at speeds and capacity that are far beyond the capability of humans. Critical to the success of these systems and currently a significant barrier for entry in mainstream medical practice is the lack of verification and validation necessary to gain trust from both the patient and the caregiver perspectives. **APPLICATION:** The potential for AI-based systems to task off-load caregivers and provide real-time analysis and treatment recommendations is compelling. Recent examples of such systems at NASA portends giant leaps forward as these systems become more trusted and validated. Paramount in deployment of Agentic AI systems will include assurance of data privacy and security and as discussed in this panel the role of synthetic data must be carefully considered.

Learning Objectives

1. The participant will understand how an AI Agent can control the flow of information to maximize the overall performance using AI tools via distribution of computing capacity over multiple platforms.
2. The participant will be able to describe how Agentic AI-based systems can reduce task loading for caregivers and provide real-time analysis and treatment recommendations.
3. The participant will have a greater understanding of how deployment of Agentic AI systems must include assurance of data privacy and security of personal information.

[325] NASA HUMAN RESEARCH PROGRAM'S USE OF AI TECHNOLOGY TO MITIGATE EXPLORATION MEDICAL RISK

Truong Le[1], Jordan Blackwelder[2], Kurt Berens[2], Carlos De Los Santos[1], Jay Lemery[1]
[1]*NASA, Houston, TX, United States;* [2]*KBR, Houston, TX, United States*

(Education - Tutorial / Review)

INTRODUCTION: NASA's Human Research Program (HRP) has employed a rigorous approach to understanding and mitigating risk through countermeasure development to optimize crew health and performance. The scope of available artificial intelligence (AI) tools continues to expand at a remarkable pace and the use AI technologies to facilitate human system risk management has presented key opportunities including application in clinical decision support systems (CDSS). **TOPIC:** The Exploration Medical Capability (ExMC) Element of HRP is leading the effort to capitalize on the strengths of AI tools through several current projects (e.g., development of space medicine-literate large language models and updating a probabilistic risk assessment (PRA) tool evidence library) are that leverage AI-tools in collaboration with data scientists from Google and Microsoft to improve autonomous CDSS capability. Projects currently in the planning stages seek to foster collaboration across numerous and diverse working groups by removing barriers between organizations and our commercial partners to support the overall Agency AI goals and the vision promulgated by the Agency AI Working Group. Utilizing AI-tools to analyze directed acyclic graphs will help the Human System Risk Board track risks as they evolve from spaceflight hazards to mission-level outcomes. Development of synthetic data sets will allow multi-disciplinary Teams to conduct modeling of astronaut health and performance without the impediments related to data privacy and security. Additional efforts with data systems platforms and improvements to the AI data pipeline are envisioned using the Insight Data platform (a data pipeline "development initiative and process" based on Microsoft best practices). Future endeavors to support CDS involve utilization of commercially available tools and databases using an integrated data systems platform through a Federated, multi-modal AI system. Deployment of such Agentic-AI platforms will considerably benefit the effort to mitigate and ultimately eliminate medical risks while simultaneously reducing crew medical officer cognitive load. **APPLICATION:** Implementation of the ExMC AI strategy has enabled creation of AI prototyping in Agile environments to rapidly assess viability of AI tools to reduce development cycle times and accelerate the path toward infusion for operationally relevant solutions for HRP and its stakeholders.

Learning Objectives

1. The learner will understand the ExMC projects that leverage AI-tools.
2. The learner will be able to describe the strengths and challenges of public-private partnerships surrounding AI research and development.
3. The learner will be able to discuss the need and the barriers to development of synthetic data sets.

[326] OBJECTIVE STRUCTURED CLINICAL EVALUATION OF AN ARTIFICIAL INTELLIGENCE CLINICAL DECISION SUPPORT SYSTEM TOOL

Arianna Nelson[1], Ali Al[1], David Hilmers[1], Jay Lemery[2]
[1]*KBR, Houston, TX, United States;* [3]*NASA, Houston, TX, United States*

(Education - Tutorial / Review)

INTRODUCTION: Clinical integration of artificial intelligence (AI) has revealed the need for novel evaluation frameworks to assess the efficacy and reliability of AI clinical decision support systems (CDSS). Objective Structured Clinical Evaluations (OSCEs) are an established method for summative assessment of clinical skills and decision-making of human clinicians. Employing OSCEs to evaluate AI CDSS offers a promising approach to validating their clinical utility and efficacy in diverse clinical scenarios, and benchmark AI performance using established clinical standards. **METHODS/RESULTS:** We conducted an AI CDSS evaluation under the Lunar Command and Control Interoperability (LuCCI) project. The CDSS "Doc-in-a-Box" (DIB) is an 8 billion (B) parameter large language model (LLM) model (reduced from the 80 B parameter OpenBio LLM) trained on curated aerospace medicine textbooks. DIB was tested across clinical scenarios designed to model real-life spaceflight cases using an OSCE framework adapted to assess the AI tool's medical decision-making. Key evaluation metrics included accuracy of recommendations for diagnoses, medical exams/tests, and therapeutic

interventions. The OSCE was scored by three physician evaluators using a 100-point rubric designed to align with best practices and standard of care. Descriptive statistics were used to report scores and inter-rater reliability was assessed using a one-way ANOVA. OSCE assessing the psychomotor domain of the DIB resulted in scores between 68-83/100 [Mean: 76, StDev: 6.16], corresponding to "good" clinical competency. There was no significant difference in scores between the raters ($p < 0.05$), suggesting that the assessments were consistent and reliable. **DISCUSSION:** DIB demonstrated accuracy in diagnostic recommendations and decision support across various scenarios. However, certain limitations were noted, including difficulty in suggesting/identifying "can't miss" diagnoses if the presentation was atypical. Additionally, the tool scored higher on the diagnostic portion of the rubric, with lower scores in therapeutic recommendations. These findings highlight the importance of continuous refinement and validation of AI tools specific to deployment in spaceflight through rigorous evaluation frameworks like OSCE. Remaining challenges include ensuring that these evaluations capture the full spectrum of clinical decision-making scenarios that will be confronted by CMOs during missions and adequately reflecting real-world variability of the austere spaceflight environment.

Learning Objectives

1. Participants will gain insight into how Objective Structured Clinical Evaluations can be used in benchmarking AI performance.
2. Participants will understand the key evaluation metrics used to evaluate the performance of a large language model.
3. Participants will realize the limitations observed and the importance of continuous refinement and validation necessary to develop rigorous evaluation frameworks.

[327] ARTIFICIAL INTELLIGENCE (AI) METHODS FOR AUTOMATING THE IMPACT TOOL EVIDENCE LIBRARY

Gina Vega, Ali Al, Kurt Berens, David Hilmers, Chris Zahner, Lynn Boley
KBR, Houston, TX, United States

(Education - Tutorial / Review)

INTRODUCTION: The development of the Evidence Library for use with the IMPACT (Informing Mission Planning via Analysis of Complex Tradespaces) probability risk assessment tool involved a multilayered, time intensive process of data collection and analysis by subject matter experts from the Exploration Medical Capability (ExMC) Element Clinical and Science Team to produce clinical findings forms (CliFFs) for 120 medical conditions. Artificial Intelligence Large Language Models (LLMs) can be leveraged to facilitate this process, thus reducing labor and time. **TOPIC:** CliFFs contain information about medical conditions as they pertain to spaceflight. This includes condition definitions, incidence data, crew task impairment estimates caused by conditions, treatment protocols and references to literature used for gathering condition evidence. Guided by the Evidence Library Methods document [1] and the CliFF development instructions, a team has leveraged Microsoft Azure AI services and open-source documentation to construct an AI-assisted automated pipeline for CliFF development. This process is designed to search, retrieve, and evaluate the applicable data, and ultimately generate a completed CliFF. The LLM evaluates the relevance of each of the source materials to spaceflight, either as direct evidence or as an analog. The model extracts keywords and generates brief summaries to enhance search and retrieval in later stages of CliFF development. For instance, it can calculate epidemiological statistical data, such as incidence rates and the likelihood of best or worst-case scenarios. **APPLICATION:** Large Language Models (LLMs) can efficiently summarize large amounts of text. Leveraging this technology will automate data retrieval and evidence gathering for medical databases, like the IMPACT tool, by aiding in the labor-intensive process of analyzing large bodies of literature and organizing it into a formatted document like a CliFF. This added efficiency will enable expeditious expansion of the Evidence Library with additional medical conditions and update previous CLiFFs as new technology becomes available.

Learning Objectives

1. Participants will gain insight into how use of Large Language Models can significantly reduce the amount of time necessary to summarize literature when building an Evidence Library.
2. Participants will understand the process of building an Evidence Library for probabilistic risk assessment.
3. Participants will be able to describe how AI tools can improve trade space analysis.

Thursday, 06/05/2025 ***10:00 AM***
Hanover F/G

[S-60] SLIDE : VENTILATION BLUES

Chair: Thomas Hoffman
Co-Chair: Barrett Campbell

[328] THE PRESSURE DYNAMICS OF ENDOTRACHEAL TUBE CUFFS WITH REDUCING ALTITUDE

Alicia Tucker, Luke Dimsey
Tasmanian Health Service, Hobart, Australia

(Original Research)

INTRODUCTION: Endotracheal intubation is commonly employed for safe transport of critically ill patients requiring aeromedical retrieval or transfer. There is a paucity of literature demonstrating the relationship between altitude and pressure in endotracheal tube (ETT) cuffs. If intubation occurs in an aircraft at altitude, we theorised that as ambient pressure increases, on landing, there would be a reduction in the volume of the air in the ETT cuff, and ergo, loss of cuff pressure with resultant adverse risks to the patient. We hypothesised that ETT cuffs filled with fluid would maintain their pressure during descent compared with air-filled cuffs. Additionally, fully aspirating the ETT cuff of any residual, manufacturing, air prior to inflation with fluid, would provide further benefit. **METHODS:** This study was undertaken in a hypobaric chamber. Pig tracheas were used to simulate a human trachea given their similar anatomy. ETT cuffs were connected to a pressure transducer for continuous real-time monitoring. The tracheas were intubated at 8000ft and ETT cuffs were inflated with either air (AF), fluid (FF) or fluid post full aspiration of any residual cuff air (AspFF), to a standard cuff pressure of 14-22mmHg (20-30 cmH2O). Pressure readings were recorded at 1000ft intervals during descent to, and including, sea level. Changes in cuff pressure were compared between each of the inflation method used. **RESULTS:** 12 endotracheal intubations at 8000ft were completed for each of the cuff inflation methods. All three groups showed a reduction in cuff pressure with reduced altitude, however, this is most marked in the AF and FF groups. Average starting cuffs pressures were 20, 19.7 and 20mmHg respectively for AF, FF and AspFF methods. Cuff pressures reached 0mmHg in all AF cuffs by 2000ft, and 1+-1mmHg in FF cuffs by sea level (0 ft), $P<0.01$. By contrast, the AspFF ETT cuffs retained a greater cuff pressure, with sea level pressures of 9.8+-0.5mmHg. Although still a significant reduction ($p<0.05$) in pressure, there was maintenance of cuff pressure, to near acceptable levels, when compared to the other techniques. **DISCUSSION:**This study demonstrated that inflating ETT cuffs with fluid during intubation at altitude does not protect against under inflation of the cuff during descent in an aircraft. Full aspiration of air prior to inflation with fluid results in better maintenance of cuff pressures and is advised as a change of practice within this industry.

Learning Objectives

1. Understand that increased ambient pressure on landing significantly reduces cuff pressures in air filled ETTs following intubation at altitude.
2. Learn that for intubation at altitude, aspirating residual air, from manufacturing, from ETTs and inflation of ETT cuffs with fluid leads to better maintenance of cuff pressures during landing in an aircraft and thereby may reduce adverse risks to the patient.

[329] NON-INVASIVE VENTILATION FOR RESPIRATORY FAILURE: A RETROSPECTIVE CROSS-SECTIONAL STUDY OF A RURAL AUSTRALIAN AEROMEDICAL RETRIEVAL SERVICE

Mina Arsanious, Rebecca Burn, Peter Brendt
Royal Flying Doctors Service Australia (South Eastern Section), Dubbo, Australia

(Original Research)

INTRODUCTION: Respiratory Failure (RF) can be supported either with endotracheal tubing & invasive ventilation (ETTIV) or non-invasive ventilation (NIV). NIV for RF has become commonplace in hospitals yet its uptake pre-hospitally is poorly documented in literature. NIV uses significantly more oxygen which is important for hypobaric-hypoxia and long retrieval times. ETTIV for RF pre-hospitally is done typically to avoid the complications of NIV. Limited space and access to equipment for in-flight intubation, has historically made ETTIV prior to take-off a more attractive strategy. This retrospective cross-sectional study looks at all patients over a 57-month period who suffered RF needing support with either NIV or ETTIV, retrieved by a rural Australian fixed-wing aeromedical service. Feasibility and challenges of NIV in aeromedical retrieval were examined. **METHODS:** Ethical approval was gained, and all missions reviewed. Exclusion criteria included road-retrievals or incomplete records. Demographic data for all eligible patients were collected and retrieval timings compared using two-tailed Man-Whitney U. Primary endpoints were the type of respiratory support received, and any subsequent complications associated with NIV as per Weller et al. 2021 definition. Management strategies for said complications were examined. **RESULTS:** Total doctor-onboard missions = 6,406. For all cases of RF needing support, 56 cases met exclusion criteria. Final n = 90. 69 retrieved with NIV. 21 intubated prior to transfer. Median scene time for NIV = 70 mins (IQR 50-100) & 115 mins (IQR 85-145) for ETTIV (p-value = 0.0004). Median transit time for NIV = 100mins (IQR 70-130) & 110mins (IQR 89-125) for ETTIV (p-value = 0.68). 30% of all NIV cases experienced a complication, all of which were managed in transit, not resulting in significant harm or deterioration. Only 1 patient retrieved with NIV required intubation in-flight. The most common complication was mask intolerance which was successfully managed with medications. All patients who were intubated prior to departure had an observable period of deterioration or complications on NIV prior to retrieval team involvement. **DISCUSSION:** Complications with NIV do occur but are shown to be manageable in-flight with no harm to patients. Patient optimisation with opiates, benzodiazepines or ketamine improves respiratory mechanics and mask compliance. ETTIV still has a role in deteriorating RF which can be largely predicted.

Learning Objectives

1. NIV can be safely used in aeromedical retrievals though the potential complications need to be understood and planned for.
2. Prudent patient selection and optimisation increases the chances of success with NIV for the aeromedical retrieval of respiratory failure.
3. Not all respiratory failure can be retrieved on NIV, and for such patients endotracheal intubation and invasive ventilation is prudent - there are key features that can identify this patient group.

[330] CREATION OF A MOBILE O2 TRANSPORT REQUIREMENTS (MOTR) CALCULATION TOOL FOR AEROMEDICAL EVACUATION

Jason David[1], Mike Sibel[2], Russ Day[3]
[1]*U.S. Air Force, Las Vegas, NV, United States;* [2]*U.S. Air Force, Baltimore, MD, United States;* [3]*U.S. Air Force Special Operations Command, Birmingham, AL, United States*

(Education - Program / Process Review)

BACKGROUND: Transporting patients requiring supplemental oxygen is a critical component of aeromedical evacuation, especially in high-stress military environments. Accurate O2 calculations are essential to ensure that patients receive adequate oxygen throughout transport and enroute care. Current manual calculation methods are time-consuming, prone to errors, and detract from the primary focus on patient care, especially in the Aeromedical Transport enviornment. **OVERVIEW:** The MOTR App is an innovative solution designed to address the limitations of manual O2 calculations in aeromedical transport. This tool automates the process of determining O2 requirements for various transport durations, monitoring tank durations in real-time, and assessing transport capabilities based on available O2 supplies. By streamlining these calculations, the MOTR App enhances resource allocation and operational efficiency. It directly addresses current gaps in O2 management during transport and provides a scalable solution for future needs in military and civilian aeromedical operations. **DISCUSSION:** Operational/Clinical Significance: The MOTR App significantly improves the accuracy of O2 calculations, which is crucial for maintaining patient stability and safety during transport. It reduces the risk of errors and ensures that medical personnel can focus on critical care rather than manual calculations. Advancement in Aeromedicine/Human Performance: By automating O2 requirements, the app advances aeromedicine by integrating technology to enhance decision-making and operational effectiveness. It supports improved human performance by reducing cognitive load and allowing healthcare providers to concentrate on patient care. Cross-Service/International/Military-Civilian Support: The MOTR App is designed for use across various DoD medical transport teams, including Aeromedical Evacuations (AE), Critical Care Aeromedical Transport Teams (CCATT), and Medevac units. Its applicability to both military and civilian settings underscores its value in fostering cross-service and international cooperation, improving patient care standards universally.

Learning Objectives

1. The Participant will be able to understand the factors that go into calculating oxygen supply requirments for patients undergoing long aeromedical transports.
2. The participant will be able to download the app for (free) use - the app is non-monitized, without ads. This is an attempt to dessiminate a useful medical tool to the wider aeromedical community.

[331] AIRWAY MANAGEMENT IN OFFSHORE RESCUE HELICOPTERS: EVALUATING TRACHEAL INTUBATION IN LATERAL AND ICEPICK POSITIONS USING VIDEO AND DIRECT LARYNGOSCOPY

Lydia Johnson Kolaparambil Varghese[1], Tobias Warnecke[2], Nina Schnackenberg[3], Jochen Hinkelbein[1], Andreas Klausen[3]
[1]*Johannes Wesling Klinikum Minden University Hospital; Ruhr-University Bochum Minden Germany, Minden, Germany;* [2]*University Clinic of Anaesthesiology, Intensive Care, Emergency Medicine, and Pain Therapy, Klinikum Oldenburg, Oldenburg, Germany;* [3]*Carl von Ossietzky University Oldenburg, Faculty of Medicine, Oldenburg, Germany, Oldenburg, Germany*

(Original Research)

BACKGROUND: Effective airway management in offshore rescue helicopters is hindered by spatial constraints and the patient's lateral position, rendering standard intubation techniques unfeasible. Despite the critical need for rapid airway control in these settings, there is a lack of evidence-based guidance on alternative intubation methods suitable for confined spaces. This study addresses this gap by evaluating novel intubation strategies, including the icepick method, using both direct and indirect laryngoscopy under simulated helicopter conditions. **METHODS:** Following ethical approval (Ethics Committee of Carl von Ossietzky University Oldenburg, file number 2023-074), a randomized simulation study was conducted. 20 experienced paramedics, each with at least 5 years of field experience, performed 440 intubation attempts on a high-fidelity manikin replicating helicopter cabin constraints. 7 airway management techniques, including the icepick method, were evaluated in random order using both direct and indirect laryngoscopy (VLS). Participants received standardized training on all techniques prior to the study. Success rates, first-pass success, intubation times,

and subjective ease-of-use ratings were recorded. Data were analysed using ANOVA and chi-squared tests. **RESULTS:** The standard intubation position (control group) achieved a 100% first-attempt success rate with VLS. Among alternative methods, kneeling sideways with VLS showed a 94.5% first-pass success rate, reaching 100% on the second attempt. The fastest intubation times were observed in the standard position (19.1 ± 9.8 seconds) and kneeling sideways (21.3 ± 9.5 seconds), with VLS being faster in both (16.6 ± 8.8 seconds and 14.6 ± 4.5 seconds, respectively). The icepick position without VLS had the longest intubation time (34.0 ± 13.4 seconds). Significant differences were found between methods ($p < 0.05$). Participants rated the kneeling sideways position with VLS as the easiest alternative method under simulated conditions. **DISCUSSION:** In simulated offshore rescue helicopter conditions, indirect laryngoscopy from the side demonstrated high success rates and efficient intubation times. Participants found this method easy to perform. These findings suggest it may be a viable alternative to conventional intubation in constrained environments. Limitations include the use of manikin simulations and experienced operators. Clinical studies are needed to confirm its efficacy in real-world settings.

Learning Objectives

1. The participant will be able to identify the limitations of standard tracheal intubation techniques in the confined space of an offshore rescue helicopter and understand the need for alternative airway management strategies.
2. The audience will learn to evaluate the effectiveness of alternative intubation methods, including kneeling sideways and the icepick position, using direct and indirect laryngoscopy under simulated helicopter conditions.

[332] A NEW CONCEPTUAL M0DEL OF CARDIOPULMONARY RESUSCITATION BASED ON A LEVER MECHANISM (MMM PROJECT): FIVE YEARS OF EXPERIMENTAL EXPERIENCE.

Arkadiusz Trzos[1], Krzysztof Kowalczuk[2], Mateusz M. Harasymczuk[3], Joanna Zyznawska[1], Grzegorz Frankowski[1], Magdalena Kozak[2], Ryszard Pokładnik[4], Daria Sałacińska[2]
[1]*Jagiellonian University Medical College, Krakow, Poland;* [2]*Military Institute of Aviation Medicine, Warsaw, Poland;* [3]*Analog Astronaut Training Center, Krakow, Poland;* [4]*Safe Diving Academy, Bielsko-Biala, Poland*

(Original Research)

BACKGROUND: Long missions to the Moon and Mars and space tourism on the low Earth orbit (LEO) pose unprecedented risks to astronauts' lives and health. These new challenges are likely to require appropriate medical support soon. Microgravity and hypogravity transform the reality of performing cardiopulmonary resuscitation (CPR) and providing advanced emergency medical care (AEMC). The success of space medical support depends on how effectively emergency medical assistance and CPR are adapted to these new conditions. The main problem for astronauts performing CPR and AEMC is to assume and maintain a stable position of the rescuer vis-à-vis the patient. This study aimed to investigate the possibilities of using the lever mechanism to stabilise rescuers and enable effective chest compression and airway ventilation in microgravity. **METHODS:** An innovative model of the Crew Medical Restraint System (CMRS), called Mobile Medical Module (MMM), was tested. This new construction maintains a stable rescuer-patient position without external handles, additional straps or harnesses. Instead, the MMM uses a new restraint system, called the Atmed Restraint System (ARS), based on the lever mechanism achieved by placing the lower limbs of the rescuer against specially designed handles. Its testing was conducted in 2020-2024 in terrestrial conditions, neutral buoyancy, and a human training centrifuge. **DISCUSSION:** The results demonstrate that the ARS maximises the effectiveness of basic CPR in simulated microgravity in neutral buoyancy and a human training centrifuge. It allows for better stabilisation of rescuers next to the patient compared to the traditional stabilisation system that relies on the "V" belts. The measurement of the rescuers' muscle tension determined the activity of the new muscle groups, generating additional force necessary for effective CPR in microgravity conditions. Regrettably, similar generation of additional force during chest compressions and ventilation does not occur in the traditional CMRS. With the ARS, the stable position obtained by rescuers allows them to perform all advanced terrestrial medical procedures. Using the lever mechanism in MMM improves CPR's effectiveness and facilitates medical assistance in microgravity, compared to the traditional method of attaching rescuers to the CMRS.

Learning Objectives

1. The audience will learn about an innovative system for stabilizing rescuers next to the patient in microgravity conditions.
2. The audience will learn about methods of generating additional force facilitating chest compression and airway ventilation during CPR in microgravity.
3. The audience will learn about a new solution for managing a medical team while providing care to the patient in microgravity.

[333] THROMBOSIS FOLLOWING RECENT COVID-19 INFECTION AND-LONG HAUL FLIGHT: A CASE REPORT

Gordon Cable[1], Tracy Smart[1], Heidi Blain[2]
[1]*Australian National University, Canberra, Australia;* [2]*Annie Lim Family Practice, Deakin, Australia*

(Education - Case Study)

INTRODUCTION: Long-haul air travel is a recognized risk factor for venous thromboembolism (VTE). The prevalence of SARS-CoV-2 has introduced new challenges in managing thromboembolic diseases, as evidence suggests that it induces a hypercoagulable state. This case report aims to highlight the compounded risk of VTE following COVID-19 infection and extended air travel. **BACKGROUND:** SARS-CoV-2 induces a prothrombotic state via inflammation-mediated endothelial activation, which persists beyond the acute infection phase. While the risk of thromboembolism is well-documented in critically ill COVID-19 patients, there is limited literature on VTE in asymptomatic or mildly symptomatic patients, especially following long-haul travel. Air travel itself is a known risk for VTE due to prolonged immobility and environmental factors, such as reduced cabin pressure. **CASE PRESENTATION:** A 60-year-old female presented with dyspnoea, cough, and left calf pain following a 17-hour international flight. She had tested positive for COVID-19 nine days prior and had been treated with PAXLOVID. A repeat rapid antigen test on the day of travel was weakly positive. Her past medical history included a prior 2cm deep vein thrombosis (DVT) of the right soleal vein after knee surgery. On admission, her oxygen saturation was 92%, and a CT pulmonary angiogram confirmed bilateral pulmonary emboli. She was treated with anticoagulation and discharged after two days on oral anticoagulants. Post-discharge ultrasound revealed a non-occlusive DVT in her left leg. Testing for underlying coagulopathies was unremarkable. **DISCUSSION:** This case underscores the elevated risk of VTE in post-COVID-19 patients following long-haul flights. The combination of a hypercoagulable state from recent SARS-CoV-2 infection and the immobility during air travel likely contributed to the development of thromboembolism. The case highlights the need for awareness of DVT risk post SARS-CoV-2 and possibly preventive anticoagulation in at-risk individuals. Further research is needed to establish guidelines for managing travel in post-COVID-19 patients.

Learning Objectives

1. The audience will learn about the possible link between SARS-CoV-2 infection, thromboembolism and long-haul air travel.
2. The participant will be able to consider the requirement for prophylactic anticoagulation for long haul airline passengers recently diagnosed with SARS CoV-2.

Thursday, 06/05/2025 ***10:00 AM***
Grand Hall East Corridor - Posters Only

[S-61] POSTER : CAN MY BODY HANDLE IT? GZ TO SLEEP TO HYPOXIA

Chair: Jaime Harvey
Co-Chair: Patrick Edwards

[334] DETAILED LOCALIZATION OF SPINAL TRAUMA IN SEVERE ROTARY WING MISHAPS: LESSONS FROM FATAL ACCIDENTS IN GERMAN MILITARY AVIATION BETWEEN 1965 AND 2017

Naomi Kono, Michael Schwerer
German Air Force, Cologne, Germany

(Original Research)

INTRODUCTION: A significant number of aircraft accidents involve complex forms of interfering impact in the three-dimensional space resulting in severe, frequently lethal blunt force trauma. Detailed knowledge of those injury patterns substantially contributes to understanding the bio-mechanical interactions between the aviator and the cockpit design, including the aircraft's crew protective systems, during the impact. Considering the differences in e.g. the vertical and horizontal speed, obstacle geometry, impact vectors and angles between fixed-wing and rotary-wing crash events, helicopter mishaps, particularly from military aviation, undoubtedly require a distinct scientific evaluation. **METHODS:** The medico-legal records of 115 death victims from 55 lethal rotary wing mishaps in the German military between the years 1965 and 2017 were reviewed for the detailed location and extent of spinal injuries. Information about the helicopter type and accident scenario were correlated. **RESULTS:** In 63 decedents (54.7%), spinal lesions were reported. Twenty-three of these victims (36.5%) demonstrated complex, multi-segmental spinal injury patterns. Two decedents even showed total body fragmentation. In contrast, isolated injuries in the cervical, thoracic and lumbar compartment occurred less frequently. Most common fracture locations were in the cervical and thoracic spine (60.3% and 61.9%, respectively). Injuries of the cervical or thoracic spine alone occurred in 28.5% of the cases. Isolated lumbar spine fractures were found in only 6.3% of the victims. The injury types included simple and dislocated fractures, spinal cord transection, and even decapitation. The helicopter types most often involved in all deadly mishaps were the Bell UH-1D (36%) and the Alouette II (22%). **DISCUSSION:** Successful analysis of spinal injuries in rotary wing accidents in military aviation undoubtedly depends on the comprehensive evaluation of the detailed location and fracture morphology in every respective segment of the spinal cord. The comprehensive reconstruction of three-dimensional blunt force impact, torsion and deceleration provides soil for the improvement of flight crew protective systems. Decreasing numbers of spinal injuries in modern military helicopters compared to the UH-1D or Alouette II emphasizes the positive effects of updated cockpit designs. Further improvements can be expected from the distinct bio-mechanical evaluation of present-day accidents.

Learning Objectives

1. Our results emphasize that most spinal injuries after lethal helicopter accidents are multisegmented.
2. The audience will learn about how the distinct morphological and bio-mechanical investigation of injuries basically supports continuing improvements in cockpit-design and flight-crew protective systems.

[335] WITHDRAWN

[336] FIFTEEN YEARS OF EXPERIENCE IN HIGH-G CENTRIFUGE TRAINING AT THE GERMAN AIR FORCE CENTRE OF AEROSPACE MEDICINE

Michael Nehring, Anthony Schwarz, Helmut Fleischer
German Air Force Centre of Aerospace Medicine, Koenigsbrueck, Germany

(Education - Program / Process Review)

BACKGROUND: With modern fighter aircraft such as the Eurofighter which are capable of sustaining 9 Gz, aircrew are operating at the limit of human performance. A sudden critical reduction of cerebral blood flow can cause pilots to lose consciousness (G-LOC: G-induced loss of consciousness). Human centrifuges (HC) are used to improve and maintain pilots' G-tolerance. 15 years (2009-2023) of HC training at the Air Force Centre of Aerospace Medicine were reviewed and analyzed. **OVERVIEW:** In 2006, the German Air Force HC was upgraded to support the introduction of the Eurofighter. This modernization provided more realistic centrifuge training to cover NATO requirements. An onset of 6 Gz/s, a maximum of 9 Gz and a dynamic flight simulation mode for simulated air combat maneuvering (sACM) are now the standard of training. Between 2009 and 2023, 2863 jet aircrew (age 30 ± 8 years) were trained in the centrifuge.The pilots were equipped either with (five bladder) anti-G trousers or with the Aircrew Equipment Assembly (AEA, full coverage anti-G trousers and positive pressure breathing). The anti-G straining maneuver (AGSM) training is done in a special simulator where pilots get biofeedback about the effectiveness of their AGSM.In the AEA group (n=1347), 9 pilots fell into G-LOC. This is a share of less than 1 %. In the group using only anti–G trousers (n=1519), 74 G-LOC cases occurred, which is a share of 5 %. Due to safety reasons, pilots underwent the runs under medical monitoring: ECG and an ear pulse curve generated by photoplethysmography. This ear pulse curve provides a helpful information of concomitant arterial pressure at brain level.Cardiac arrhythmia (ventricular extrasystoles, bigeminy and couplets) under Gz exposure occurred frequently (20 %), but after completion of the centrifuge runs, the heart rhythm was self-limited and returned to normal in all cases. Common side effects were arm pain and " G measles". **DISCUSSION:** International High-G training in the GAF HC is well established and has shown to be medically safe. The AEA has proven to provide very effective anti-G protection. For future centrifuge training of F 35 pilots, the HC will get an upgraded modular cockpit design to provide a more realistic training. A major research project will be the G-LOC detection by electromyography and ear pulse photoplethysmography to integrate it into physiological sensing technology used in flight and increase the safety of aircrew.

Learning Objectives

1. The audience will learn about the benefits of centrifuge training.
2. The audience will learn about the effectiveness of two different anti-G systems.

[337] COULD HEART AGE SERVE AS A POTENTIAL PARAMETER RELATED TO THE G TOLERANCE?

Wun-Wei Huang[1], Chin-Sheng Lin[2], Chin Lin[3], Min-Yu Tu[4], Chung-Yu Lai[3], Chia-Lin Tsai[2], Pin-Huei Lai[5], Hsin-Hui Chen[2]
[1]*Kaohsiung Armed Forces General Hospital Gangshan Branch, Kaohsiung City, Taiwan (Greater China);* [2]*Tri-Service General Hospital, National Defense Medical Center, Taipei City, Taiwan (Greater China);* [3]*National Defense Medical Center, Taipei City, Taiwan (Greater China);* [4]*Medical Affairs Bureau, Ministry of National Defense, Taipei City, Taiwan (Greater China);* [5]*Air Force Headquarters, Ministry of National Defense, Taipei City, Taiwan (Greater China)*

(Original Research)

INTRODUCTION: In clinical medicine, the various age measurement—such as chronological age (CA), biological age, and bone age—serve as indicators of the health status. Recently, heart age (HA) estimation based on the electrocardiogram (ECG) data has been established using a deep learning model (DLM). A greater disparity between the HA and CA has been linked to cardiac diseases and poor health outcomes. During the flight maneuvers, the gravitational force (G force), acting from head to toe, places a significant amount of stress on the cardiovascular system of the military aircrew. Consequently, this study primarily aims to investigate as to whether the heart age is related to the G tolerance. **METHODS:** This cross-sectional study was conducted from November 2023 to June 2024, involving military pilots participating in the high G training at the Aviation Physiology Research Laboratory.

During the registration process, a Watch Series 8 (Apple Inc, Taipei City, Taiwan) was utilized to collect the ECG data, from which the HA was calculated using our DLM as the baseline. The HA was also recorded prior to the centrifuge ride. The relaxed G tolerance (RGT) was assessed under slow acceleration (onset rate: 0.1 G/sec), with the RGT defined as a complete loss of peripheral vision or a 50% loss of central vision. The association between the RGT and HA was analyzed using the SPSS. **RESULTS:** Among the 110 subjects, the average age and RGT were 23.9 ± 1.8 years and 4.9 ± 1.0 G, respectively. The HA increased significantly before the centrifuge ride to 45.4 ± 9.5 years, which corresponded with a rise in the heart rate to 94.7 ± 16.6 beats per minute. A moderate positive linear correlation was observed between the HA and the heart rate prior to training. In the logistic regression analysis using the backward selection, our findings indicated that the military pilots with an elevation in their HA of less than 10 years had a 2.94-fold greater likelihood of achieving a higher RGT. **DISCUSSION:** We believe that this research is the first to illustrate the relationship between the G tolerance and the cardiac status as described by the artificial intelligence technology. However, it is concerning that the HA estimated by the previous DLM was significantly higher than the CA, despite an inverse relationship between the two in relation to the G tolerance. For the military pilot population, we intend to adjust and refine the developed model in the near future.

Learning Objectives

1. Application of clinical artificial intelligence in the high G training.
2. The development status of clinical artificial intelligence technology in our country.

[338] RELATIONSHIP BETWEEN BASELINE AIRCREW CONDITIONING PROGRAM ASSESSMENT METRICS AND PRIMARY ACCELARATION TRAINING PERFORMANCE IN AIR FORCE PILOTS

Justin Reed[1], Alex Kasak[2], John Harrell[2], Derek Haas[3], Sarah Pfahler[4], Hannah Graves[1], Molly Wade[2]

[1]711th Human Performance Wing RHB KBR, Wright-Patterson AFB, OH, United States; [2]711th Human Performance Wing RHB, Wright-Patterson AFB, OH, United States; [3]711th Human Performance Wing RHB JYG, Wright-Patterson AFB, OH, United States; [4]711th Human Performance Wing UES, Wright-Patterson AFB, OH, United States

(Original Research)

INTRODUCTION: High Gz flying is physically demanding for fighter aircrew requiring primary acceleration training for G-qualification. G-qualification requires withstanding up to 7.5Gz and completing simulated aerial combat maneuvers, which may be influenced by one's physiological traits. Since 2022, student pilots have completed a standardized aircrew conditioning program-assessment (ACP-A) upon flying training entry and have access to human performance specialists through the comprehensive readiness for aircrew flying training (CRAFT) program. The purpose of this study is to investigate associations between ACP-A and CRAFT metrics with G-qualification. **METHODS:** G-qualification form 4293, CRAFT specialist utilization rates, and ACP-A results of 97 pilots (89-males, 8-females) were analyzed. Three aerospace physiologists independently scored 4293's to differentiate those who passed all training on the first try (score=0) from those needing extra coaching, and thus higher scores for additional G-exposures. Specialist utilization rates of cognitive performance, strength and conditioning, and dietetics were tabulated. Finally, characteristics of age, height, weight, body composition, broad jump, isometric deadlift, inverted row, plank, and estimated VO2max were taken from the ACP-A. Linear regression and ordinal logistic regression analysis were used to create models to describe the relationship between independent variables and final G-qualification score and score bins. **RESULTS:** Final scores ranged from 0-6 and bin counts were 56, 25, and 16 for ≤0.5, 1-2, >2, respectively. The model did not explain the variance in final score (R2=0.04) and no variables were significant at α.05. A sub-analysis of males retained 8 variables with 55% accuracy predicting score bin. Height was significant ($p<0.01$) indicating that for each additional centimeter in height the odds of a higher score bin increased (Odds Ratio=1.14, 95% Confidence Interval 1.09-1.12). **DISCUSSION:** No metrics from the ACP-A or CRAFT were predictive of G-qualification score. In males, height was significantly associated with G-qualification, as has been previously reported. While characteristics in this study were not predictive of G-qualification score, additional ACP-A metrics tested in the fighter pilot pipeline and associations with G-qualification warrant investigation. Continuing to obtain standardized data throughout the pilot lifecycle is essential for future data-driven decisions.

Learning Objectives

1. Attendees will learn how the aircrew fitness assessment was standardized.
2. Attendees will understand efforts to explore associations between aircrew fitness assessments and centrifuge training.

[339] GZ TOLERANCE AND THE ANATOMICAL AND BIOMECHANICAL PROPERTIES OF THE EXTRACRANIAL VENOUS SYSTEM

William Fraser

Silatyuk Research, Toronto, ON, Canada

(Original Research)

INTRODUCTION: Under 1 Gz, the cranial vasculature dominates cerebral blood flow (CBF) resistance. Mathematical models have shown that with increasing acceleration the collapse of the internal jugular vein (IJV) and the resulting increase in blood flow resistance, GLOC will occur at approximately 4.5 Gz. However, these models did not consider the individual anatomical and biomechanical variability of cerebral venous outflow, nor the changes in vessel biomechanics during complex Gz maneuvers. **METHOD:** A steady-state model of CBF under Gz was developed to take into account blood flow through the IJV and the vertebral plexus (VV). Data from tilt table, Valsalva maneuver, and positive pressure breathing (PPB) studies, and data from in vitro studies on isolated veins were used to determine the variation in the vessel stiffness and changes in the cross-sectional area and shape as a function of the transmural pressure. The resulting system of non-linear algebraic equations relating perfusion pressure, cross-sectional area and flow was simulated with the fsolve function of the SciPy python library. The model was used to investigate the impact of anatomical variation in the IJV and VV among subjects, variability in the biomechanical properties of the veins, and the impact of myogenic and baroreceptor reflex-induced changes in blood vessel biomechanics on CBF during complex Gz exposures. **RESULTS:** Differences in the baseline anatomical and biomechanical properties of the IJV and VV can account for the range of Gz tolerances reported in the literature. Simulated complex Gz profiles, Valsalva manoeuvres, and PPB that impact the neurogenic and myogenic regulation of IJV and VV stiffness, cross-sectional area, and cross-sectional shape resulted in second-by-second changes in CBF. **DISCUSSION:** Routine imaging of the venous drainage pathways and blood flow during tilt table and Valsalva maneuvers may be useful in predicting the Gz tolerance of individuals. The non-linear, time-dependent biomechanical properties of the IJV and VV, which can be affected by repeated pressure loading, circulating hormones, and baroreceptor inputs may explain individual tolerance to the push-pull maneuver, variation of Gz tolerance with repeated exposures, and the efficacy of Valsalva maneuvers and PPB in reducing the risk of GLOC.

Learning Objectives

1. The audience will learn about the importance of mathematical modeling and simulation in investigating the role of the extracranial venous system in regulating cerebral blood flow under complex Gz maneuvers.
2. The audience will learn about the importance of the cerebral venous drainage system in explaining the variability in Gz tolerance.

[340] WITHDRAWN

[341] EVALUATING EEG DURING HIGH WORKLOAD WHILE ACCOUNTING FOR SLEEPINESS SCORES

Jordayne Wilkins, Kathryn Feltman, Ryan Mackie
U.S. Army Aeromedical Research Lab, Fort Novosel, AL, United States

(Original Research)

INTRODUCTION: Measuring cognitive workload with physiological measures can be challenging due to factors that may influence physiology outside of workload manipulations (e.g., fatigue). Electroencephalography (EEG) has been shown to detect changes in brain activity for fatigue such that alpha power spectral density (PSD) increases with fatigue and beta decreases. The Karolinska Sleepiness Scale (KSS) is a subjective measure of sleepiness on a 9-point scale. In this analysis of archival study data, the relationships between EEG variables and KSS scores were evaluated. **METHODS:** Preexisting data from a replication study of psychophysiological indicators was conducted at USAARL were used. Army aviators completed a high workload flight in the UH-60 simulator. KSS was collected before the simulator flight. EEG was recorded during the en route flight task. PSD values for alpha, beta, and theta bands were calculated. The ratio of alpha and beta to theta was also derived. Mixed-effects linear regression models were run predicting the EEG outcomes using workload level and KSS scores (fixed effects) with participant number included as a random intercept. **RESULTS:** The linear regression model was significant for the EEG beta values ($t(15) = 8.82$, $p < 0.001$), indicating for every one unit increase in KSS scores, beta is predicted to decrease by 0.12248 units.The model did not show any significance in KSS and EEG alpha, theta, or ratio values. However, KSS and EEG theta values trended toward significance ($p = 0.056$) and could potentially change with a larger sample size. **DISCUSSION:** Workload manipulations had greater influence on EEG outcomes than KSS scores, with beta values results showing consistency with past literature. The results showed that alpha EEG values decrease as fatigue increases using KSS scores, which is inconsistent with past literature. Measuring subjective fatigue can aid in explaining the variability in the data due to individual differences in experience of fatigue. Limitations in the preexisting data can account for the insignificant results of other EEG outcomes and KSS measure that were not accounted for, such as age, and small sample size. We can possibly find a consistency in fatigue prediction using a different fatigue measure or measuring multiple times throughout data collection.

Learning Objectives

1. The audience will be able to understand the trend in KSS scores and EEG values from the preexisting data.
2. The audience will be able to identify factors that may impact accuracy in fatigue prediction measures.
3. Highlighting the limitations of using fatigue measures to predict EEG outcomes.

[342] PILOTS SUBJECTIVE WORKLOAD AS A RESULT OF PERFORMANCE - TEMPERAMENT INTERACTION

Marcin Biernacki, Piotr Zieliński, Łukasz Dziuda
Military Institute of Aviation Medicine, Warsaw, Poland

(Original Research)

INTRODUCTION: Research on the individual factors that determine workload is important from the perspective of psychological selection of pilots and flight safety. Workload can be described as an effect of task difficulty. The same task may be difficult for one person and easy for another. In addition, difficulty can result from the effort expended on the task. The purpose of our work was to describe the phenomenon of workload as an effect of the interaction of individual operator characteristics and the level of task performance. **METHODS:** The study included 84 participants aged 18 to 24 years (M=19.4; SD=1.4). Workload was assessed using the NASA-TLX, while individual characteristics were assessed using the FCB Temperament Inventory. Executive processes were measured with the SMK Test. Statistical analyses were performed using R software version 4.3.2 with the lme4 package. Analyses focused on a regression model in which mental workload intensity, reported after the SMK test (NASA-TLX score), was treated as a function of task performance level. **RESULTS:** The regression models showed that introducing interactions between performance level and temperament traits significantly improved the model fit, explaining nearly 20% of the variance. Significant interactions were found for Perseverance (B=-14.24) and Persistence (B=11.88). Subjects with high Endurance experienced greater mental workload as their SMK performance declined, whereas subjects with low Endurance experienced high workload during effective performance and lower workload during ineffective performance. A similar pattern was observed for Perseverance individuals with low levels experienced high workload during effective performance and lower workload during ineffective performance. In contrast, individuals with high levels of Perseverance felt low workload during effective performance and high workload during ineffective performance. **DISCUSSION:** For pilots, where high task performance is essential, an optimal temperament profile appears to be high Endurance with moderate Perseverance, potentially reducing fatigue and enhancing sustained functioning. Such individuals experience relatively low strain during efficient task performance, potentially leading to less fatigue and sustained effectiveness. However, those with high Endurance and high Perseverance may show increased strain under low performance, indicating reduced resilience in challenging situations, which could pose safety risks.

Learning Objectives

1. The participant will be able to understand the role of temperamental traits in assessing the workload experienced.
2. The audience will learn about the importance of the interaction between performance and individual differences due to temperamental traits for workload assessment.

[343] CASE OF SUSPECTED OXYGEN PARADOX REACTION DURING AIRCREW TRAINING IN HYPOBARIC CHAMBER

Kristian Thidemann Andersen, Karsten Lindgaard
Danish Defence Medical Command, Vojens, Denmark

(Education - Case Study)

INTRODUCTION: This case report describes a suspected oxygen paradox reaction in a pilot trainee during hypobaric training.**BACKGROUND:** NATO military aircrew must undergo mandatory aviation physiology training to prepare them for physiological changes encountered during flight, which can pose risks to flight safety. Part of this training includes time in a hypobaric chamber, where aircrew are exposed to pressures equivalent to approximately 25,000 feet of altitude, inducing hypoxia symptoms. After hypoxia exposure, participants refit oxygen masks to breathe 100% oxygen, recovering from hypoxia. However, some individuals may experience an acute worsening of hypoxia symptoms during this recovery phase, known as a paradoxical reaction to oxygen. Typically, this reaction causes visual disturbances, although rare cases can result in loss of consciousness. **CASE PRESENTATION:** We present the case of a 22-year-old healthy pilot trainee, who experienced a loss of consciousness during hypoxia training in a hypobaric chamber. The student was exposed to a pressure altitude of 25,000 feet for approximately 2 minutes. Upon refitting his oxygen mask and breathing 100% oxygen, he reported feeling increasingly unwell with a worsening of visual symptoms. Moments later, he lost consciousness for approximately 30 seconds. Chamber technicians reported suspicion of trainee hyperventilation during the hypoxia exposure. Subsequent cardiological evaluations found no underlying pathology, leading to a conclusion that this was a case of paradoxical reaction to oxygen following hypoxia exposure. **DISCUSSION:** The physiological mechanism behind the paradoxical oxygen reaction remains unclear. The risk of this response may increase with hypocapnia, often due to hyperventilation, and may involve a marked reduction in peripheral vascular resistance. This combination could result in an abrupt drop in blood pressure and reduced cerebral perfusion, potentially leading to transient loss of consciousness. Further research is warranted to understand this phenomenon and develop guidelines to mitigate such risks during hypoxia training in military settings.

Learning Objectives
1. The audience will learn about the physiological mechanisms suspected to be behind the oxygen paradox reaction, which sometimes can be seen during aircrew training in the hypobaric chamber.
2. The oxygen paradox reaction usually limits to visual disturbances, but as the audience will learn, it can also cause loss of consciousness. Especially if the subject has been hyperventilating.

Thursday, 06/05/2025 ***1:30 PM***
Centennial Ballroom I

[S-62] PANEL: CLINICAL APPROACHES TO COMPLEX AEROMEDICAL CASES: ARE THEY SAFE FOR DUTY?

Chair: Brian Hanshaw
Co-Chair: Paul Newbold

Panel Overview: *Clinical cases within the Flight Medicine Clinic can be broad and diverse in nature. The complexity of these medical scenarios is compounded by the persistent and growing demands of operational readiness and unique occupational challenges. This panel comprises clinical cases presented by current clinicians in Aerospace Medicine at MacDill AFB. These presentations embody one theme: approaching complex medical conditions involving aviators and special operators with significant aeromedical and occupational health considerations. The presenters will provide an overview for each case, approach to diagnosis and workup, along with the pathway to an aeromedical waiver. Additionally, current medical standards and policies from each sister service, as well as the FAA, will be discussed. The clinical care approach and insights gained from these presentations will be valuable to other aerospace medicine clinicians, ultimately benefiting the patients they serve.*

[344] SEVERE MITRAL VALVE REGURGITATION IN A KC-135 PILOT

Tyler Pitchforth
U.S. Air Force, Tampa, FL, United States

(Education - Case Study)

INTRODUCTION: This case describes an asymptomatic military pilot who was diagnosed with a heart murmur during his annual flight physical and subsequently required open heart surgery to correct severe mitral valve prolapse/regurgitation (MVP/R). **BACKGROUND:** MVP has a prevalence of 0.6-3% and only 4% of those patients have severe MVR. A majority (70%) of MVP cases have mild to trace MVR and are asymptomatic. MVP is usually identified on physical exam (holosystolic murmur) and diagnosed by echocardiogram. Symptoms are rare, but include exertional dyspnea, arrhythmias, weakness, fatigue, and exercise intolerance. **CASE PRESENTATION:** A mid-30's male KC-135 pilot presented for his annual flight physical, and an incidental murmur was identified on physical exam. He was referred to cardiology and diagnosed with severe MVP/R via transthoracic echocardiogram. Transesophageal echocardiogram confirmed diagnosis with effective regurgitant orifice (ERO) of 0.65 cm2 (severe MR ERO > 0.40 cm2), he was then referred to the cardiothoracic surgeon The pilot underwent open complex mitral valve repair. 3-month post op echocardiogram showed successful repair with only trace MR. An aeromedical waiver was subsequently granted after evaluation by the Aeromedical Consultation Service 12 months after his murmur diagnosis. **DISCUSSION:** Severe mitral valve regurgitation is very uncommon and is asymptomatic in most cases. A thorough physical exam is critical, even on otherwise healthy individuals. If the aviator's MVP had progressed, he may have required a MV replacement. It is crucial to consult the waiver guide early as the type of MV surgery can end a pilot's career. If the member required a mitral valve replacement, he would be ineligible for a waiver due to the increased risk of thromboembolic events.

Learning Objectives
1. The audience will recognize the importance of quality chest auscultation during an annual flight physical on an asymptomatic patient with no complaints.
2. The audience will develop an understanding of the medical standards for mitral valve regurgitation and the importance of referencing the aeromedical waiver guide early to assist aviators in making informed decisions.

[345] FACIAL FRACTURE AND TRAMAUTIC BRAIN INJURY IN A KC-135 PILOT

Michael Klemm
[1]*U.S. Air Force, Tampa, FL, United States*

(Education - Case Study)

INTRODUCTION: This case report describes a military pilot who experienced a depressed right frontal sinus and orbital roof fracture with associated traumatic brain injury (TBI) after a head-on collision. **BACKGROUND:** Pilots are subjected to a variety of environmental conditions with unique risks related to rapid changes in altitude, temperature, and ambient pressure. This elevated risk requires pilots to maintain situational awareness of multiple factors concurrently; any deficits in cognitive processing can lead to catastrophic outcomes. Appropriate evaluation and risk stratification is paramount in determination of a pilot's ability to return to flying. **CASE PRESENTATION:** 27-year-old, male, KC-135 pilot presented to a local ER after a significant facial injury during a sporting event. Initial CT scan showed a depressed fracture of the right frontal sinus with likely fracture of the right orbital roof but no intracranial abnormalities. His MACE2 was positive for concussion but a full neurologic exam and cognitive testing were normal. The patient denied any headache, LOC, amnesia, or dizziness. Local oral & maxillofacial surgeon recommended surgery for cosmetic reasons and member returned home for surgical evaluation at the VA. Member had a repeat CT that confirmed the prior findings and a physical exam notable for diplopia with extreme upward gaze. Member was evaluated by plastics, ENT, and ophthalmology with the ultimate recommendation to not proceed with surgery as diplopia was likely related to swelling and would improve as the swelling decreased. Member continued to deny any sequelae from the injury and was observed for 45 days with a final brain MRI to ensure no long-term injury. Throughout the observation period he continued to report no cognitive deficits and resolution of his diplopia with upward gaze. Member has since had an aeromedical waiver approved and returned to full flight duties without issue. **DISCUSSION:** This case highlights the variability in individual responses to TBI and the aeromedical risks associated with facial fractures. Initial and follow up cognitive testing and physical examinations are essential when monitoring an aviator's response to a significant cranial injury. Utilizing appropriate imaging studies for risk stratification of facial injuries are critical when considering aeromedical implications.

Learning Objectives
1. The audience will learn aeromedical considerations with facial fractures and requirements for returning to flying status.
2. The audience will learn about the value of initial and follow up evaluations for appropriate risk stratification after traumatic brain injuries in aviators.

[346] CHRONIC MYELOGENOUS LEUKEMIA IN A KC-135 PILOT

Vasant Dabhi[1], Paul Newbold[2]
[1]*U.S. Air Force, Tampa, FL, United States,* [2]*U.S. Air Force, Arcadia, OK, United States*

(Education - Case Study)

INTRODUCTION: This case report describes a military KC-135 pilot who was diagnosed with Philadelphia chromosome positive chronic myelogenous leukemia (CML). **BACKGROUND:** CML is a hematological neoplasm characterized by the fusion of the BRC to ABL1 genes (BRC:ABL1), also called the Philadelphia gene, resulting in the

uncontrolled production of granulocytes. Roughly half of the patients are asymptomatic, however others may develop symptoms such as fatigue, malaise, and excessive sweating. Fatigue as the predominant symptom, can be a major concern for the pilots of military aircraft. The impacts from this disease, in addition to associated treatment modalities, can lead to significant loss in workdays, detriments to mission readiness, and degraded operational capabilities. **CASE PRESENTATION:** The subject was a 33YO male Air Force KC-135 pilot with more than 1000 flying hours. He was a fully trained asset, avid runner, and multiple marathon champion; presented to the clinic with fatigue and decreased stamina. Routine labs revealed elevated white cell count and subsequently referred to a hematologist. Bone marrow biopsy revealed 63% positivity of total ABL1, p210 product. The subject pilot was treated initially with hydroxyurea, then switched over to dasatinib. After 6 months of the treatment, the subject regained his energy, and was able to resume marathons. Since then, the subject remained asymptomatic, highly active, running, and without any evidence of medication side effects. The pilot was recommended for an aeromedical waiver and was granted for 1 year. **DISCUSSION:** This case highlights the importance of addressing even seemingly minor symptoms such as fatigue in aviators. Improper nutrition, inadequate sleep, and dehydration in aircrew are major concerns for fatigue, but rare neoplasms are still a possibility. A thorough history, focused physical exam, along with appropriate laboratory and diagnostic testing is paramount. Life expectancy with CML has improved with the advancement in chemotherapeutic agents, however flying status and operational readiness can be significantly impacted. This case emphasizes the significance of timely and appropriate evaluation and treatment of aviators diagnosed with CML.

Learning Objectives

1. Importance of thorough history, physical and work up for nonspecific symptom like fatigue, which could be a manifestation of underlying neoplasm.
2. CML itself or the treatment can have significant impact on mission readiness in aviators.

[347] PRONATOR TERES SYNDROME IN A MILITARY ROTARY-WING PILOT

Korey Kasper
U.S. Air Force, Tampa, FL, United States

(Education - Case Study)

INTRODUCTION: This case report describes an active-duty helicopter pilot with chronic elbow pain caused peripheral nerve entrapment due to helicopter flight control manipulation. **BACKGROUND:** Maneuvering a helicopter's cyclic requires repetitive resisted wrist movements which predispose pilots to wrist and elbow overuse injuries. **CASE PRESENTATION:** A 40-year-old Army helicopter pilot presented to sports medicine for a 4-year history of right medial elbow pain, unsuccessfully treated as medial epicondylitis with PT and PRP injection. Pain occurred with maneuvering his aircraft's cyclic and doing pull-ups wherein he experienced tearing pain limiting him to just a couple repetitions. He noted tingling in the proximal medial forearm. MRI of elbow showed strains at the common flexor tendon and flexor digitorum profundus. The medial epicondyle was tender, and his common flexor mass was taut, tender, and painful with resisted palmar flexion and pronation. Point-of-care ultrasound revealed the median nerve was edematous and enlarged adjacent to the pronator teres; tracing this nerve distally approximated pain distribution. He was prescribed median nerve glide exercises. At 4-week follow-up, he reported compliance with exercises and significant reduction in pain with flying and ability to complete 10 pull-ups without discomfort. At five months, patient reported no pain with pullups or flying and had stopped nerve glide exercises all together due to lack of pain. **DISCUSSION:** Pronator teres syndrome (PTS) is a median nerve entrapment near the pronator teres resulting in the weakness, numbness, and pain in the forearm and hand. PTS is often misdiagnosed as medial epicondylitis. This patient developed PTS due to piloting helicopters, wherein repetitive and quick pronation movements to maneuver the cyclic caused hypertrophy and/or repetitive contraction of the of the pronator teres muscle, entrapping of the median nerve. Nerve glide exercises focus on alleviating the entrapment by enhancing nerve mobility and reducing compression. Peripheral nerve entrapment should be considered in cases of chronic occupational extremity pain not responding to usual care. Prompt referral to a sports medicine physician can expedite diagnosis and recovery of full function.

Learning Objectives

1. The audience will expand their differential diagnosis for occupational elbow pain in aviators to include nerve entrapments.
2. The audience will understand pathology and treatment options for pronator teres syndrome and the potential value of early referral to sports medicine when caring for flyers.

[348] WOLFF-PARKINSON-WHITE SYNDROME SEEN IN SECURITY FORCES MEMBERS

Melissa Lincoln
U.S. Air Force, Tampa, FL, United States

(Education - Case Study)

INTRODUCTION: This case examines three separate Security Forces Squadron (SFS) members who had a Wolff-Parkinson-White pattern noted on their electrocardiogram (ECG) during their routine occupational health exam (OHE). **BACKGROUND:** Wolff-Parkinson-White (WPW) is a preexcitation syndrome that occurs when abnormal electrical conduction occurs through an accessory pathway, which can lead to symptomatic and life-threatening arrhythmias. It affects 1 to 3 in 1,000 people worldwide, with a lifetime risk of sudden cardiac death (SCD) of 3-4%, mostly occurring with exercise. The frequency of WPW pattern is 10 to 100 times more common than WPW syndrome, with the development of symptomatic arrhythmias over three years seen in as high as 20% of individuals. Currently, only baseline ECGs are required for SFS members and not completed until their first assignment out of technical training. **CASE PRESENTATION:** 26 y/o male came in for his OHE prior to deployment clearance. WPW pattern was noted on his initial and repeat ECG on the subsequent day. He denied any previous palpitations, tachycardia, presyncope, or syncope. He was referred to cardiology, where he underwent a diagnostic electrophysiology study. During the study, he was found to have an easily inducible ventricular tachycardia. He underwent an ablation of typical AVNRT. He remained inducible after the ablation and went into ventricular fibrillation, requiring defibrillation. He was given a life vest and had a follow-up electrophysiology study for re-risk stratification, which was normal, and the life vest was discontinued. 35 y/o male with WPW pattern noted on initial and repeat ECG. He denied any current or previous symptoms. He was referred to cardiology, where a diagnostic electrophysiology study is pending. Lastly, a 24 y/o female with a WPW pattern noted on initial ECG with no reported symptoms. A repeat ECG and echocardiogram were normal, and no further work-up was required.

Learning Objectives

1. The audience will learn about the risks associated with WPW that aerospace and occupational medicine clinicians need to consider for flyers and special duty members.
2. The audience will learn about the prevalence of asymptomatic WPW and the potential risk of life-threatening arrythmias, taking into account occupational and operational considerations.

Thursday, 06/05/2025 ***1:30 PM***
Centennial Ballroom II

[S-22] PANEL: AAMIMO GRAND ROUNDS- CROSS CULTURAL CLINICAL CASES IN AEROSPACE MEDICINE

Chair: Jeffrey Harris

Panel Overview: BACKGROUND: *The Advanced Aerospace Medicine for International Military Officers (AAMIMO) course is a 6-month training program for military flight surgeons from all over the world. The course is*

conducted by the US Air Force School of Aerospace Medicine. 2025 will be the 63rd edition of the course and will include 10-12 physicians representing 8-10 different countries. The international flight surgeons will present interesting and educational clinical cases from their countries. **DESCRIPTION:** *The panel will consist of 6 case presentations designed to teach about fundamental and/or novel aerospace medicine concepts.* ***DISCUSSION:*** *Attendees will learn the similarities and differences of practicing aerospace medicine in different cultures. The medical flying standards for each country and branch of military will be highlighted.*

[113] AAMIMO CASE PRESENTATION #1 - CHRONIC STIMULANT USE FOR IDIOPATHIC HYPERSOMNIA IN A PILOT

Gerardo Montenegro Urrutia
Chilean Air Force, USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Case Study)

INTRODUCTION: This case report will describe a Chilean female helicopter pilot with idiopathic hypersomnia in treatment with chronic stimulant use. **BACKGROUND:** Idiopathic hypersomnia is a condition that significantly impacts a person's daily life, causing problems not only in health but also socioeconomic and work-related issues. It is classified as a central origin hypersomnia, alongside narcolepsies type 1 and 2. It is primarily characterized by excessive daytime sleepiness despite normal or prolonged sleep duration, and frequent severe sleep inertia. However, its pathophysiology remains unknown, making diagnosis difficult and uncertain, as there is no objective method to perform a specific diagnosis. Its treatment, while varying among published guidelines and lacking a strong base of supporting publications, relies on both non-pharmacological approaches and the use of low-sodium oxybate, modafinil, methylphenidate, and amphetamines, which are not without significant adverse effects. **CASE REPORT:** This case is of a 42-year-old female helicopter pilot, who was diagnosed with idiopathic hypersomnia, characterized by hypersomnia despite sleeping approximately 12 hours a day, a pathology that she had been dragging for some time. She was initially treated with sertraline and modafinil, later changing the latter for lisdexamphetamine. **DISCUSSION:** In this case, we will review the diagnosis of idiopathic hypersomnia, the progress in its diagnosis as well as its treatment, we will review what measures were taken in this particular case in the Chilean Air Force and we will compare it with the guidelines used in the United States.

Learning Objectives

1. The audience will learn about the signs/symptoms, pathophysiology, and/or treatment for an educational patient scenario.
2. The audience will learn about the similarities and differences in practicing aerospace medicine in various countries.

[114] AAMIMO CASE PRESENTATION #2 - AEROMEDICAL DECISION MAKING IN A CASE OF CARCINOMA CAECUM & APPENDIX IN MILITARY PILOT: CASE REPORT

Avinash Krishnegowda[1]; Hasan Alabbasi[2]
[1]*Indian Air Force, USAFSAM, Wright-Patterson AFB, OH, United States;*
[2]*Iraqi Air Force, USAFSAM, Wright-Patterson AFB, OH, United States*

(Education - Case Study)

BACKGROUND: This paper discusses a rare case of military pilot with goblet cell adenocarcinoma of caecum & appendix followed by aeromedical decision making in the case. **INTRODUCTION:** Appendiceal neoplasms account for 0.4-1% of all GI malignancies. Goblet cell tumors are rare tumors of appendix with an incidence of 1-5 per 10 million people per year. The 5yr overall survival is 76% and 33% cases that show recurrence occur within 2-3 years. **CASE SUMMARY:** A 48 years old fighter aircrew of IAF had multiple episodes of abdominal pain and was treated as a case of colitis, but eventually he was detected to have Goblet cell adenocarcinoma of appendix, terminal ileum, colon. He underwent Right hemicolectomy & adjuvant chemotherapy. In the initial assessment, he was given permanent non-flying category in view of potential long term neurological side effects of chemotherapy which could compromise flight safety and poor prognosis of the condition. But the aircrew appealed against the decision. The relook into the case revealed no signs of neurotoxicity due to chemotherapy during the evaluation & minimal risk to flight safety due to goblet cell type carcinoma of appendix & caecum (Operated, Post chemotherapy) as calculated using the recurrence rates from scientific literature. Therefore, he was recommended to restricted flying category. **DISCUSSION:** In a case of carcinoma appendix & caecum once diagnosis and treatment is made, the potential for recurrence becomes important health and aeromedical concern. Also in addition if chemotherapy is instituted its side effects may be a flight safety hazard. These points are considered and assessed in the present case to ensure flight safety.

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 aeromedical risk assessment in case of malignancies.

[115] AAMIMO CASE PRESENTATION #3 - A RARE CASE OF "CONGENITAL ANOMALY OF THE KIDNEY AND URINARY TRACT" IN AN AVIATOR: APPROACH TO AEROMEDICAL DISPOSITION

Kishore Kumar Dalpati
Reconaissance & Observation Flight, Imphal, Manipur, India, USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Case Study)

INTRODUCTION: This case report describes a trained Indian fighter pilot with bilateral malrotated kidneys with left supernumerary kidney. The Congenital Anomaly of the Kidney and Urinary Tract (CAKUT) was detected incidentally on routine ultrasound examination. **BACKGROUND:** CAKUT encompass a range of developmental malformations of the kidneys and urinary tract that arise during embryogenesis, primarily between the 5th and 9th weeks of gestation. Bilateral malrotated kidneys with one sided supernumerary kidney is one of the rarest congenital anomalies of kidney and urinary tract with less than 100 cases reported in literature and the first case detected in an active duty aviator. It poses unique challenges in aeromedical decision making and disposition of aircrew. **CASE PRESENTATION:** A 24 year old asymptomatic male fighter pilot with a total of 200 flying hours in high performance aircrafts, was detected to have CAKUT on routine ultrasound examination. The pilot had no history of recurrent UTIs, dysuria, or hematuria and was normotensive. On further evaluation using CT urogram he was found to have bilateral malrotated kidneys with left supernumerary kidney. Detailed imaging and functional assessments revealed no signs of CKD, evidence of obstruction, or urinary stasis. Considering his asymptomatic status and normal renal function with Gz exposure in high performance aircrafts, the aircrew was medically upgraded to full flying status in fighter stream. However, considering the potential long-term complications, the aircrew was advised monthly BP monitoring at base flight clinic and annual review at nephrology center and Indian Air Force boarding center. **DISCUSSION:** This case of bilateral malrotated kidneys with a supernumerary kidney, a rare CAKUT variant, highlights the challenges of managing such anomalies in military aviation. Despite the anatomical rarity, thorough evaluation confirmed stable renal function, allowing the aircrew to continue flying. The potential impact of acceleration stress in fighter stream and the long-term risks of CAKUT emphasize the need for individualized aeromedical decisions. Reflighting the individual, along with regular follow-up, balances operational demands with effective long-term health monitoring.

Learning Objectives
1. The audience will learn about the signs/symptoms, pathophysiology, and/or treatment for an educational patient scenario.
2. The audience will learn about the similarities and differences in practicing aerospace medicine in various countries.

[116] AAMIMO CASE PRESENATATION #4 - CASE OF EUSTACHIAN TUBE DYSFUNCTION: CAUSE OF HEARING LOSS IN A YOUNG PILOT

Mbaye Diaw
Senegal Army, USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Case Study)

INTRODUCTION: This case report describes a fighter jet pilot who was found to have barotraumatic otitis due to Eustachian tube dysfunction (ETD) during periodic aviation medical examination and converted in transport pilot with waiver. **BACKGROUND:** The Eustachian tube connects the middle ear to the back of the throat. During flight, or situations where altitude or pressure changes rapidly, if the tube does not function properly, the pilot may experience earache, headache, hearing loss, dizziness. Therefore, a lack of communication can occur and leads to disaster. **CASE PRESENTATION:** The pilot was a 30-year-old man with 6-years of experience in fighter aircraft when ENT clinical examination showed a bilateral tympanic retraction. He also reported a history of humidity feeling in both ears with itching. He was suspended from flight duties for medical treatment and further investigations. The tympanogram was disturbed and the audiogram showed an average hearing loss of 30dB in the left ear. He underwent CT scan which showed bilateral thickening of the tympanic membrane. He was diagnosed eustachian tube dysfunction and benefited from surgical treatment in the form of myringotomy and set of bilateral pressure equalization ear tube. The control with audiogram revealed mild bilateral conductive hearing loss (-15dB on the left, -20dB on the right) and tympanometry showed a curve with reduced compliance on both sides. The follow up CT scan had no sign of otitis and normal ventilation of the tympano-mastoid cavities. He was declared unfit for fighter pilot but obtained a waiver for transport pilot with limitations to fly as, or with, co-pilot and with ENT reassessments every 3 months. **DISCUSSION:** We will discuss the tests allowing the early diagnosis of ETD, the traditional treatment of ear tube and new treatment of balloon tuboplasty which may heal the pilot and keep airmen airborne.

Learning Objectives
1. The audience will learn about the signs/symptoms, pathophysiology, and/or treatment for an educational patient scenario.
2. The audience will learn about the similarities and differences in practicing aerospace medicine in various countries.

[117] AAMIMO CASE PRESENTATION #5 - PROLONGED GRIEF DISORDER IN A FIGHTER PILOT: A CASE REPORT

Shamsul Arafin[1], Tung-Yao Lin[2]
[1]*Bangladesh Air Force, Dhaka, Bangladesh, USAFSAM, Wright-Patterson AFB, OH, United States;* [2]*Taiwan Army, Kaohsiung, Taiwan, USAFSAM, Wright-Patterson AFB, OH, United States*

(Education - Case Study)

INTRODUCTION: This case report describes a Bangladesh Air Force fighter pilot with prolonged grief disorder (PGD) and its impact on his flying career emphasizing the relevance of this disease to the military flying communities. **BACKGROUND:** PGD is the newest mental disorder to be added to the DSM-5-TR in 2022. 7%-10% of bereaved adults experience PGD. Patient shows distinct set of symptoms following death of a family member or close friend. They are preoccupied by grief and feeling of loss to the point of clinically significant distress and impairment which can manifest in a variety of symptoms including depression, emotional pain, emotional numbness, identity disturbance and difficulty in managing inter personal relationships. **CASE PRESENTATION:** A 31-year-old somewhat introvert fighter pilot experienced the death of his copilot who was his closest buddy in an incident of unplanned ejection on ground due to ejection seat malfunction. Following the incident, he stopped interacting with anyone and started being alone. He started blaming himself for the death of his copilot and admitted to be extremely stressed over that. He sometimes felt like life is meaningless and suffered from emotional numbness. He was irregular and unmindful in his office. He lost interest in most of his daily activities. He was suffering from sleep disturbance after the incident. As his symptoms persisted and all relevant clinical examination and lab parameters were within normal limits, base flight surgeon restricted his flying and sent him for psychiatric evaluation. Cognitive behavioral therapy was initiated. Sleep interventions were done. He was provided with social support. In spite of all the interventions he was having pervasive grief response and persistent preoccupation with the deceased after one year and he was labeled as a case of PGD and was temporarily grounded for the condition. He evenutally opted for voluntary retirement considering that he would feel better once he was away from the places full of memories with his deceased copilot. **DISCUSSION:** Risk factors for PGD includes sudden death due to violent or unnatural method and close kinship to the deceased. These factors are commonly encountered in military aviation mishaps that carries a potential risk for someone of close kinship getting affected by PGD.

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.

[118] WITHDRAWN

Thursday, 06/05/2025 ***1:30 PM***
Centennial Ballroom III

[S-64] SLIDE : SURVEILLANCE AND COUNTERMEASURES FOR SPACE

Chair: Judith Hayes
Co-Chair: Kayla Jaime

[354] MRI ANATOMIC FEATURES PREDICT INTERNAL JUGULAR VEIN STASIS IN MICROGRAVITY

James Pavela[1], Ashot Sargsyan[2], Stephan Moll[3], Millennia Young[1], Aaron Everson[2], Ryan Dervay[4], Deepak Bedi[5], Larry Kramer[4]
[1]*NASA JSC, Houston, TX, United States;* [2]*KBR, Houston, TX, United States;* [3]*University of North Carolina at Chapel Hill, Chapel Hill, NC, United States;* [4]*McGovern Medical School, Houston, TX, United States;* [5]*University of Texas, MD Anderson Cancer Center, Houston, TX, United States*

(Original Research)

INTRODUCTION: Surveillance for deep vein thrombosis in the internal jugular veins (IJV) was conducted in 31 long duration NASA astronauts aboard the ISS using a standardized ultrasound protocol. Previously reported findings from a smaller subset found flow anomalies in the left proximal IJV in ~20%, suggesting a potentially heightened risk of thrombosis. We hypothesized that certain anatomic features may predispose some individuals to craniocervical drainage reorganization. **METHODS:** Anatomic features of 31 long-duration crewmembers were derived from retrospective 3-Tesla magnetic resonance imaging (MRI) data and included bilateral IJV cross-sectional areas (CSA) at skull base,

transverse sinus side dominance, and torcula configuration. Values were computed by two analysts independently and averaged. Terrestrial and in-flight ultrasound was reviewed for IJV flow anomalies, defined as more-than-mild spontaneous echo contrast (SEC) grade, unprovoked stasis (UPS), and retrograde flow (RF). Data was modeled with linear mixed models, predictors identified with LASSO variable selection, and receiver operating characteristic (ROC) curves generated. **RESULTS:** No IJV thrombi were detected. Left UPS occurred in 7 individuals, RF in 5, and more-than-mild SEC- in 7. MRI-derived IJV right-to-left CSA ratio at the skull base (IJV CSA R/L) predicted SEC at the optimal threshold of 1.55, with sensitivity and specificity of 0.8 and 0.62, respectively, and an area under the ROC curve of 0.71. For RF, the optimal IJV CSA R/L threshold was 2.19, with sensitivity, specificity, and AUC-ROC curve values of 0.83, 0.76, and 0.8Gend1, respectively. Other preflight measures did not reach this level of prediction. **DISCUSSION:** The MRI-derived degree of preflight asymmetry of the IJV at the level of skull base appears to be the first reported predictor of left IJV SEC and RF in microgravity. Continued improvement of measurement technique and optimization of MRI sequences may increase the specificity of this prediction model. Preflight MRI may be useful in predicting individual thrombosis risk.

Learning Objectives

1. The audience will learn about venous flow anomalies that occur in a significant minority of long duration astronauts.
2. The audience will learn about MRI-derived anatomical measures that predict flow anomaly development in internal jugular vein in microgravity. Right-to-left ratio of IJV cross-sections at the skull base thus appears to predict individuals predisposed to IJV thrombosis.

[355] HEARING ASSESSMENTS AND TYMPANOMETRY IN NASA ASTRONAUTS ON THE INTERNATIONAL SPACE STATION

David Wexler[1], Martin B. Robinette[2], Christopher Coble[3], Azalea Coste[4], Thomas Hoffman[5], Richard Danielson[2]

[1]*University of Massachusetts Medical School, Worcester, MA, United States;* [2]*UTMB, Galveston, TX, United States;* [3]*Aegis Aerospace, Webster, TX, United States;* [4]*University of Texas at Dallas, Richardson, TX, United States;* [5]*Acuity International LLC, Cape Canaveral, FL, United States*

(Original Research)

INTRODUCTION: Exposure to prolonged microgravity is associated with cephalad fluid shifts that potentially could affect tympanomastoid ventilation and auditory mechanisms. We conducted a retrospective review of NASA astronaut on-orbit hearing assessments (OOHAs) and middle-ear pressure measurements obtained during ISS missions, to search for evidence of spaceflight-related hearing changes and disturbances of middle-ear aeration. **METHODS:** Nine NASA astronauts conducted OOHAs and tympanometry at least twice while on the ISS missions, at days 16-294 (median 81). Kuduwave audiometric instrumentation was used for self-administered air-conduction tests of pure-tones at 250, 500, 1000, 2000, 3000, 4000, 6000 and 8000 Hz, and for the middle ear pressure measurements. Limited bone-conduction data were also obtained. Pre- and postflight audiometric data, obtained under direction of an audiologist, were used for comparison. The data for each frequency were evaluated by ANOVA with repeated measures. **RESULTS:** OOHAs showed modest low-frequency hearing threshold increases only at 250 Hz (9.3+/-10.5 dB, $p<0.01$) and 500 Hz (5.6+/-7.7 dB, $p<0.01$), compared to the preflight Kuduwave baseline. Tympanometry was normal in each of 28 technically adequate measurements. Bone-conduction audiometry, while limited, showed no trend of elevated bone conduction thresholds. At all frequencies, postflight audiograms showed no significant differences from preflight testing. **DISCUSSION:** In this group of astronauts, hearing tests obtained during spaceflight showed a modest low-frequency hearing loss, with thresholds increasing on average no more than 10 dB above preflight baseline measurements. This is unlikely to be of operational significance. The magnitude of these changes did not correlate with length of time on the ISS. As tympanometry was normal, there was no indication of middle ear fluid or other aspect of Eustachian tube dysfunction. Postflight audiometry demonstrated preservation of hearing thresholds across frequencies with no significant difference from preflight levels. The results suggest relative resilience of auditory function and maintenance of tympanomastoid aeration on prolonged orbital spaceflight, but with small, temporary, low-frequency hearing threshold increases in some astronauts. Our findings warrant confirmation and further study with the larger cohort of NASA astronauts for whom hearing data were obtained with earlier OOHA instrumentation.

Learning Objectives

1. The audience will learn about the mild low-frequency hearing decrements that were measured during orbital spaceflight.
2. This listeners will understand the evidence that normal middle ear ventilation was maintained during prolonged spaceflight.
3. The audience will learn that postflight audiometry indicated no significant changes from preflight hearing levels.

[356] SPINE DEGENERATION IN ACTIVE-DUTY MILITARY PERSONNEL: A SYSTEMATIC REVIEW AND META-ANALYSIS FOR NASA MEDB GUIDELINE DEVELOPMENT

Kyle Anderson[1], Benjamin Swanson[2], Hung-I Hsaio[1], Taylor Zuleger[1], Jed Diekfuss[1], Greg Myer[1], Danielle Anderson[3], Richard Scheuring[3]

[1]*Emory University, Flowery Branch, GA, United States;* [2]*Walter Reed National Military Medical Center, Bethesda, MD, United States;* [3]*NASA JSC, Houston, TX, United States*

(Original Research)

INTRODUCTION: Approximately 60% of NASA astronauts have a military background, which predisposes them to an increased risk of spinal pathology due to cumulative spinal loading from years of rigorous physical training. However, isolating spinal pathology specifically attributable to military service is challenging. This systematic review and meta-analysis aims to evaluate MRI-based spine findings in military personnel relative to an asymptomatic civilian population, in order to better estimate the expected spinal pathology in NASA astronauts with military backgrounds. **METHODS:** PubMed, Scopus, and Google Scholar databases were systematically queried in April 2024, using the MeSH terms: active-duty military, spine, and MRI. Abstracts were screened for inclusion based on the following criteria: military personnel cohorts, MRI of the spine, and reports on average age, sample size, and prevalence of disc degeneration. A mixed-effects meta-analysis was conducted to compare disc degeneration and average age between military personnel and asymptomatic civilians. **RESULTS:** The meta-analysis found moderate heterogeneity ($I^2 = 34.19\%$), with some variability that is not fully accounted for by group and age effects (SE = 0.0686). However, heterogeneity was not statistically significant ($p=0.075$), and the model had a high R^2 value (90.16%) which indicates effective explanation of the variability across studies. Meta-analysis revealed a significant group effect, with military personnel showing higher overall prevalence disc degeneration compared to civilians (effect size = 0.999, CI [0.588, 1.411], $p < 0.001$). Age was also a strong predictor, with age associated with an increased prevalence of disc (effect size = 0.108, 95% CI [0.075, 0.140], $p < 0.001$). **DISCUSSION:** Our findings indicate that military personnel have a higher baseline of disc degeneration compared to civilians, likely due to physical demands of military service. These results may support the inclusion of MRI spine screening in NASA's medical protocol for astronauts with military background, given their evaluated disc degeneration, however caution is warranted as the previous studies have focused on younger military populations with relatively short service duration. Future work should aim to characterize the variety of military duties and their potential contribution to spinal degeneration.

Learning Objectives

1. Understand why MRI spine is a valuable addition to Med B protocols for NASA astronauts to monitor spinal pathology prior to spaceflight and understanding the effects of spaceflight on the spine.
2. Understand that the majority of NASA astronauts have a military background that significantly increases the prevalence of any level disc degeneration.

3. Understand that by the average age of a NASA astronauts' first flight, almost all astronauts (~99%) with a military background will have disc degeneration as compared to most of civilians (~70%).

[357] EVALUATING THE EFFECTS OF SPACEFLIGHT AND COUNTERMEASURES ON ASTRONAUT SKELETAL HEALTH USING QUANTITATIVE COMPUTED TOMOGRAPHY (QCT)

Kyle Anderson[1], Jean Sibonga[2]
[1]*Emory University, Flowery Branch, GA, United States;* [2]*NASA JSC, Houston, TX, United States*

(Original Research)

INTRODUCTION: QCT offers a significant advantage over DXA in its ability to separately evaluate cortical and trabecular bone compartments. The purpose of this study was to demonstrate the utility of QCT to delineate specific effects of spaceflight on these distinct bone compartments and to evaluate spaceflight countermeasures to mitigate those induced changes. Based upon evidence that spaceflight affects trabecular bone more profoundly than cortical bone, the primary study hypothesis was that the combination of resistive exercise (ARED) with a circulating anti-resorptive bisphosphonate (BP) provides maximal protection of both bone compartments. **METHODS:** Astronaut data were grouped by countermeasure (Pre-ARED n=18, ARED n=20, and ARED + BP n=7). Measurements of total hip bone mineral density were performed preflight, within 1 week of postflight (R+1 wk), and at 1-year postflight (R+1 yr). Subject-specific random intercepts were included to address the repeated measures within subjects. When the overall F-statistic was significant, pairwise comparisons tested for pre-to-postflight changes within groups, as well as contrasting these changes between countermeasure groups. **RESULTS:** At R+1wk, significant losses in Ct.vBMD and Tb.vBMD were detected except in the ARED+BP group. By R+1yr, Ct.vBMD was restored to preflight in the ARED group while Tb.vBMD was still significantly reduced. Interestingly, while Tb.vBMD was not different than preflight in the ARED+BP group at R+1yr, Ct.vBMD was significantly reduced. In terms of countermeasures, there were no statistically significant differences between groups with regard to Ct.vBMD at either timepoint. In terms of Tb.vBMD changes, ARED was statistically different than Pre-ARED at both R+1wk and R+1yr while ARED+BP was also statistically different from Pre-ARED at R+1wk but not at R+1yr. **DISCUSSION:** At R+1yr, study hypotheses were partially supported as Tb.vBMD was significantly reduced from preflight while Ct.vBMD was recovered in the ARED group. However, there were no detectable differences between countermeasures for either cortical bone and trabecular bone possibly due to insufficient statistical power. Overall, our study further supports the addition of QCT to medically required testing because of the independent assessment of cortical and trabecular bone compartments and the improved evaluation of spaceflight countermeasures of different mechanisms of action.

Learning Objectives

1. Understand why quantitative computed tomography (qCT) is a valuable addition to monitoring astronaut skeletal health and evaluating spaceflight countermeasures.
2. Understand that ARED is sufficient to maintaining aBMD by R+1yr but not trabecular bone mass (Tb vBMD).
3. Understand that ARED + Bisphosphonates was the only countermeasure able to maintain trabecular bone mass.

[358] AN OVERVIEW OF HIBERNATION PHYSIOLOGY AND THE VALUE OF RESEARCH IN SUSPENDED ANIMATION. A POTENTIAL SOLUTION FOR LONG DURATION SPACE TRAVEL.

Shreyas Iyer[1], Peter Hodkinson[1], Phillip Hopkins[2], Carole Dangoisse[3], Samantha Moore[4], Sarah Flarherty[5], Andrew Proctor[6]
[1]*Frimley Health Trust, National Health Service, United Kingdom, Slough, United Kingdom;* [2]*King's College London, London, United Kingdom;* [3]*King's College Hospital, Denmark Hill, London, United Kingdom;* [4]*NHSE Education North West, Manchester, United Kingdom;* [5]*University of Toronto, Toronto, ON, Canada;* [6]*Health Education Kent, Surrey and Sussex, Haywards Heath, United Kingdom*

(Education - Tutorial / Review)

INTRODUCTION: Hibernation is an adaptive behavioural pattern preserved across many mammalian species which confers significant benefit to their survival in harsh winter months. The adaptive behaviour is characterised by periods of torpor during which animals demonstrate reduction in metabolism and physiological activity and reduced temperature allowing for their preservation and survival. Though characterised by a significant low flow and diminished distribution of blood there is a remarkable restoration of physiological functioning after hibernation has been completed. **TOPIC:** Understanding Hibernation as a physiological process could allow for translational benefits in medical practice on earth. By appreciating reduced metabolism and states of torpor, we may be able to transfer benefits to our critically unwell terrestrial patients, by addressing muscle and bone loss, minimising end organ damage and thrombosis. As well as applications to terrestrial medicine, we will explore the potential for utilising hibernation in long term space travel. **APPLICATION:** We can stimulate further discussion on the types of research that can take place to successfully induce torpor in humans for therapeutic purposes. Given the wide presence of hibernation in the animal kingdom, genetic mechanisms are preserved in humans. Unlocking the mechanism through pharmacological cues, changes in environment and precisely altering genetic and cellular mechanisms could be the keys. A vast array of exciting scientific questions lie ahead, and proposing good hypotheses and finding the means to test them well will allow for progression in this field. From the perspective of critical care medicine, there are hypotheses that humans conserve hibernating phenotypes when critically ill. Indeed if we can discover the human capability to exhibit torpor in their critically ill state, we may learn how to induce it safely for the application of long duration space flight. In the animal kingdom, we are aware of how hibernation provides benefits with regards to radiation protection, hypoxia tolerance, mitigation of thrombosis and maintenance of bone and muscle mass, which may well confer benefits in long term space flight and stasis when crew visit other worlds with inhospitable environments. We propose to examine these scientific possibilities and discuss our own ongoing research in the field.

Learning Objectives

1. The audience will come away with a brief insight into the remarkable physiological adaptation of hibernating animals.
2. The audience will learn about potential therapeutic benefits that could be conferred through understanding the safe induction of torpor in non-hibernating mammals and humans.
3. The audience will gain an insight into the benefits of hibernation for astronaut crew in long duration spaceflight from a physiological, psychological and resource utilisation perspective.

[359] SKIN CANCER IN SPACE: EVALUATING THE PREVALENCE, MORTALITY, AND RISK FACTORS IN ASTRONAUTS POST-SPACEFLIGHT

Cameron Shetler[1], Lisa Brown[1,2]
[1]*The University of Melbourne, Melbourne, Australia;* [2]*The University of Auckland, Auckland, New Zealand*

(Original Research)

INTRODUCTION: With long-duration space travel on the horizon, understanding the exposure of Astronauts to radiation and the increased risk of skin malignancies is important for mitigating further health risks. This is the first review to systematically evaluate the risk of skin malignancies to Astronauts and the underlying factors for this. **METHODS:** PubMed and MEDLINE (Ovid) were systematically searched in April 2024, with no date limitations. The keywords and Boolean operators include: 1. (astronaut*) OR (cosmonaut*) OR (spaceflight) OR (space flight) 2. (skin) OR (dermatology) 3. (neoplasm*) OR (cancer*) OR (malignancy*) 4. #1 AND #2 AND #3. **RESULTS:** This search yielded 61 articles from PubMed and 25 articles on MEDLINE (Ovid). Two NASA reports were also included. Following exclusions a total of 17 papers were included in the review. N = 12 papers

focused on the effects of unique environmental factors such as cosmic radiation and microgravity at the cellular level. Other papers (n = 5) focused more broadly on the incidence and mortality of skin malignancies, emphasizing the potential risks and confounders. One paper highlighted the immunosuppression occurring in space.The results showed that there has been a higher incidence of skin cancers among Astronauts, with over 33 reported basal cell carcinomas (BCC) and squamous cell carcinomas (SCC), and 11 cases of melanoma amongst 338 Astronauts. This is well above the global standardized incidence ratio of melanoma globally, predicted at 3.8 for males and 3.0 for women. Cosmic radiation exposure as a cause is cited due to high atomic mass, high-energy (HZE) particles, and their secondary particles were shown to be particularly damaging, creating microlesions and DNA damage. **DISCUSSION:** This systematic literature review was performed to assess the risk of skin cancer post-spaceflight and highlights the increased risk that Astronauts have. The cause of the increase in skin cancer among Astronauts is distorted by confounding factors such as 89.9% of Astronauts being of Caucasian descent, the "healthy-worker effect," and increased ultraviolet radiation exposure due to typical Astronaut lifestyle factors. Knowledge of the risks can lead to advanced mitigation strategies.

Learning Objectives

1. The audience will learn about the effects of Space travel on the development of skin malignancies.
2. The audience will learn the risk to Astronauts of skin malignancies including the rate of these malignancies and how to mitigate them.

Thursday, 06/05/2025 ***1:30 PM***
Centennial Ballroom IV

[S-65] SLIDE : NEUROLOGY & BIOMECHANICS

Chair: John Crowley
Co-Chair: Peter Letarte

[360] WITHDRAWN

[361] WITHDRAWN

[362] COMPARISON OF A COMPUTATIONAL NECK MODEL TO ELECTROMYOGRAPHY DURING PILOT-RELEVANT HEAD MOTIONS WITH HEAD-SUPPORTED MASS

Nathan Pickle[1], Ryan Middle[1], Phil Whitley[1], Paulien Roos[1], Howard Chen[2], Sara A. Harper[2], Hailey N. Hicks[2]
[1]*CFD Research Corporation, Huntsville, AL, United States;* [2]*University of Alabama in Huntsville, Huntsville, AL, United States*

(Original Research)

INTRODUCTION: Neck pain affects military aviators, diminishing mission performance and negatively impacting long-term quality of life. Aviators wear head-supported mass (HSM) including helmets, night-vision-goggles (NVGs), and counterweights (CWs). Despite the prevalence of neck pain, the root cause is still not fully understood. This study aimed to evaluate accuracy of musculoskeletal simulations for use in studying neck pain. Our hypothesis was that the simulated muscle excitations would agree with electromyography (EMG), demonstrating accuracy of the simulated muscle excitation. **METHODS:** Twelve subjects (6M, 6F) were recruited to represent three anthropometric groups (small, medium, large). Subjects were required to produce neck flexion and extension strength greater than the 20th percentile for their age and height. Subjects wore three HSM configurations (helmet, helmet/NVG, helmet/NVG/CW) while looking at targets at 0°, ±30°, ±60°, and ±90° axially, with 3 different head pitches (0, ± 25 degrees) following a slow cadence. Maximum voluntary isometric contraction (MVIC) trials were conducted before and after the motion trials for neck flexion, extension, and left/right lateral bending. EMG and motion capture data were collected. A computational musculoskeletal (MSK) model of the cervical spine, scaled to size and strength based on published population averages, was used to simulate the experimental protocol. **RESULTS:** Data from a single male subject (1.84 m, 83.4 kg, 25 years) were compared to the generic "large male" model. The timing of simulated muscle excitation and EMG showed general agreement. No trends were observed between HSM configuration and magnitude of muscle excitations, consistent with findings in recent studies. Magnitudes of simulated excitations were higher than EMG (10%-40% MVIC versus 10-20% MVIC). The model strength was 9.6% and 26.6% weaker in flexion and extension, respectively, compared to measured subject data. **DISCUSSION:** An MSK model capable of accurately simulating neck muscle excitation has utility in researching strategies for mitigating neck pain. Our preliminary results demonstrate general agreement between simulated and measured muscle excitations (and by extension, muscle force) in response to HSM configurations, although subject-specific strength scaling may be required. Future extensions of this work include analyzing additional subjects, using subject-specific model strength, and analyzing intervertebral loading.

Learning Objectives

1. The progress made in musculoskeletal modeling and simulating high-fidelity neck models and motions.
2. how head-supported mass influences muscle excitations, and how to compare simulated results with experimental data.

[363] GZ LOADING RESPONSES OF INDEX AND ADJACENT CERVICAL SPINE SEGMENTS WITH ANTERIOR CERVICAL DISCECTOMY AND FUSION

Narayan Yoganandan[1], Balaji Harinathan[1], Aditya Vedantam[1], Brian Stemper[1], Hoon Choi[2], Rick Lang[3], Paul Porensky[3]
[1]*Medical College of Wisconsin, Milwaukee, WI, United States;* [2]*Cleveland Clinic, Weston, FL, United States;* [3]*Naval Health Research Center, San Diego, CA, United States*

(Original Research)

INTRODUCTION: Studies including those from the NATO working group and others have reported that cervical spondylosis and neck pain are prevalent and occur earlier in military. Dynamic/high-g scenarios such as ejection and use of head supported mass are attributed as causes for these disorders. Surgical options include anterior cervical discectomy and fusion (ACDF) and/or total disc replacement (CTDR). Almost all studies determining the response of the ACDF/CTDR spines have focused on quasi-static physiological scenarios. Studies are limited with dynamic loading and that include head supported mass conditions. The objective of this study is to evaluate the responses of different spine segments of the ACDF spine under high-g forces. **METHODS:** An intact global human body consortium finite element model was seated upright, Frankfort plane was maintained horizontal (head-neck facing forward in the neutral posture), restrained with five-point restraint system, and donned with a 1.5 kg military helmet. A Gz pulse of peak 6g was applied, and the intact model was validated with human cadaver experimental results. After model validation, ACDF was simulated at C5-C6 (most common level used in military patients), and the spine surgeon author(s) were involved to ensure clinical applicability. The range of motion and facet loads at the index and adjacent segments, and disc pressures at adjacent segments of the ACDF spine were normalized with respect to the intact spine. **RESULTS:** The range of motion and facet force metrics at the index level decreased by two-third and one-third. At the cranial level, disc pressures, motions, and facet force metrics increased marginally (<10%), while the increase was up to 38% at the inferior level. **DISCUSSION:** The is the first study to simulate dynamic high-g Gz loading with intact and ACDF spines. It is known that dynamic and physiological loading induces different intrinsic spinal load-sharing. Results from the experimentally validated finite element model indicate that the patterns of motions, and anterior (disc pressures) and posterior (facet forces) column load-sharing are level dependent and vary inconsistently. The quantified metrics will assist in an improved understanding of this surgical procedure and may assist in evaluating the performance of cervical arthroplasty devices.

Learning Objectives

1. Knowledge about computational modeling of cervical spine as applied to military personnel and loading scenarios.

2. Knowledge about surgical procedures for treating neck pain/disorders in military personnel.
3. Knowledge about performance of spines with anterior cervical discectomy and fusion under military loading scenarios such as high-Gz forces.

[364] PHASE III TRIAL TO INVESTIGATE THE FEASIBILITY AND FIDELITY OF THE ROYAL CANADIAN AIR FORCE AIRCREW CONDITIONING PROGRAM

Erin Smith[1], Tara Reilly[2], Thomas Karakolis[3], Emilie Miller[2]
[1]*Canadian Forces Environmental Medicine Establishment, Toronto, ON, Canada;* [2]*Canadian Forces Morale & Welfare Services, Ottawa, ON, Canada;* [3]*Defence Research and Development Canada, Toronto, ON, Canada*

(Original Research)

INTRODUCTION: More than 90% of RCAF aircrew report significant flight-related neck pain (Smith, 2021). As recommended by the NATO HFM RTG 252 (Farrell, 2020) and demonstrated by the RAF and RAAF, the RCAF Aircrew Conditioning Program (ACP) effectively reduces/prevents neck injury, reduces time away from flying and improves performance (Slungaard, 2018 Slungaard, 2019 Wallace, 2019). Building on the results and lessons learned from the Phase II Trial (Smith, 2022), the revised RCAF ACP was implemented at 12 Wing Shearwater (Maritime Rotary Wing), 4 Wing Cold Lake (Fighters) and 3 Canadian Forces Flying Training School (CFFTS FW and RW Training). Implementation required a dedicated Physical Exercise Specialist (PES) and commitment from RCAF leadership to mandate that all aircrew complete a minimum of two RCAF ACP training sessions per week. **METHODS:** Feasibility was evaluated by participation. Fidelity (effectiveness) was measured by a review of physical performance tests, surveys and health record information at baseline, 3, 6, 9 and 12 months. Phase III will also determine optimal means to quantify program effectiveness, by comparing survey results to other means of collecting similar information: individual electronic health record review, physiotherapy referral forms, Monitor Mass and Unit Flying Program Schedules. **RESULTS:** From baseline to 9-months, 12 Wing (Maritime Rotary Wing) aircrew who attended a minimum of 50% of training sessions demonstrated 40% improved deep neck flexor endurance. This group also demonstrated an improvement in core endurance (side plank) of 50% (Right side) and 30% (Left side). There was also a positive correlation (r=0.54, p=0.007) between compliance and performance (cervical spine strength in flexion) after 3 months in this group. The compliant group (>50% sessions attended) were observed to report fewer neck injuries (0%) at 3 months compared to the non-compliant (<50% attended) group (29%). **DISCUSSION:** Objective testing suggests that with compliance, the RCAF ACP significantly improves performance reduction in neck injury was also observed. Further, improved performance is positively correlated with compliance. However, operational tempo, scheduling and compliance continue to be the biggest barriers to success. Chain of Command support is the biggest contributor to success. Future work must include additional efforts to identify/remove barriers in the respective populations, maximizing participation.

Learning Objectives

1. The audience will learn about the revised RCAF ACP and implementation of this program within the RCAF Fast Jet and Maritime Rotary Wing Communities.
2. The audience will learn about the results of the Phase III Trial of the RCAF ACP, the effectiveness and feasibility of the program and future proposed work.

[365] CASE OF MYASTHENIA GRAVIS IN CIVILIAN PILOT

Dragana Dragic Ranisavljevic
Emirates Airline, Dubai, United Arab Emirates

(Education - Case Study)

INTRODUCTION: This is an uncommon report of a civilian pilot who experienced mild distal limb muscular weakness and nonspecific fatigue due to underlying myasthenia gravis (MG). **BACKGROUND:** Fatigue is a common presentation among pilots in commercial aviation and, along with muscle weakness, is not a specific presentation of MG. Therefore, pilots usually ignore fatigue as a part of the job or rostering issue before presenting the problem to medical professionals. This time can be crucial for detecting other underlying causes of fatigue. Consequently, this delay in diagnosis can worsen the outcome of the timely treatment of conditions such as MG. Additionally, the same delay poses the risk of medical conditions negatively affecting human performance, and, on the contrary, the effect of the aviation environment might negatively affect the condition. Finally, early detection of MG symptoms may lessen symptom severity and improve outcomes. **CASE PRESENTATION:** This is a case of a 39-year-old commercial pilot from the USA with an Indian background. Total flying hours are 8000, about 600 hours yearly, a first officer on an Airbus 380. He gave about a 6-month history of increasing muscle weakness in his lower legs, nonspecific tiredness, and some gastrointestinal issues before he was diagnosed with MG. Removal of his mediastinal mass confirmed a thymoma, followed by plasmapheresis, which eradicated his symptoms. However, neurologists debated to what extent further treatment was necessary and not an obstacle to pilot re-certification and return to the aviation work environment. **DISCUSSION:** This presentation highlights possible risks of prolonged fatigue and weakness in pilots that have not been investigated, as well as the challenges of treatment of MG in pilots. It also raises awareness of MG as "the snowflake disease" and difficulties in diagnosing it due to the variety of its presentation and disappearing symptoms. Finally, it improves awareness that MG has rare and various presentations, potentially reducing diagnosing time.

Learning Objectives

1. The audience will learn about the importance of early detection of myasthenia gravis and how fatigue can masquerade its presence.
2. The audience will learn how the treatment with surgery or medications can support aviators in returning to their duties and re-certification.

Thursday, 06/05/2025 ***1:30 PM***
Regency V

[S-66] PANEL: AVIATION MEDICINE IN THE NEW NORDIC NATO FRAMEWORK

Chair: Bobbie Ray-Sannerud
Co-Chair: Karsten Lindgaard

Panel Overview: *The Nordic nations have significantly strengthened their defence collaboration, particularly in military aviation. This panel session will explore the evolving role of aviation medicine within this new defence landscape, focusing on the integration of Finland and Sweden into the NATO Alliance and the unified Nordic approach to air defence. As we adapt to shared responsibilities within NATO, ensuring the health, safety, and performance of aircrews has become a vital component of operational readiness. On March 25th, 2023, the Royal Danish Air Force, the Finnish Air Force, the Royal Norwegian Air Force, and the Swedish Air Force signed an agreement to establish a Nordic air defense alliance. This collaboration has set the stage for a new era of unified defense efforts in the region. As part of this closer cooperation, these nations have formed the NATO Nordic Aeromedical Group (NNAMG), a specialized initiative aimed at advancing aviation medicine and enhancing their joint operational capabilities. This panel session will feature five presentations, each highlighting key aspects of aviation medicine within the Nordic NATO framework: 1. Royal Danish Air Force: Highlighting innovations in pilot adaptation to 5th generation aircraft helmets, focusing on vision challenges with helmet-mounted displays. 2. Finnish Air Force: Discussing aeromedical challenges related to the dual transition of introducing the F-35A in 2025 and integrating Finland's military and aeromedical systems into NATO. 3. Royal Norwegian Air Force: Presenting two key initiatives—Pilot in the Loop and Human Performance Optimization—focused on enhancing aircrew well-being, performance, and*

mission readiness. 4. Swedish Air Force: Addressing the impact of Sweden joining NATO on aviation medicine, including new demands for medical screenings such as cardiovascular evaluations for aging pilots. 5. Nordic NATO Aeromedical Collaboration: Exploring the NATO Nordic Aeromedical Group (NNAMG), its strategic benefits, current initiatives, and future goals for collaborative aeromedical practices. Together, these presentations will provide a comprehensive view of how aviation medicine is evolving to meet the needs of a rapidly changing defense environment. As these nations continue to deepen their cooperation, aviation medicine will play a critical role in ensuring the resilience, health, and performance of their aircrews, ultimately strengthening the collective air defense of the Nordic NATO Alliance.

[366] NORWAY'S APPROACH: PUTTING PILOTS AT THE CENTER OF CARE

Bobbie Ray-Sannerud
Norwegian Royal Air Force, Oslo, Norway

(Education - Program / Process Review)

BACKGROUND: The Norwegian Armed Forces Joint Medical Services, through the Institute of Aviation Medicine (IAM), provides comprehensive aeromedical services, including education, training, and research, to the Royal Norwegian Air Force (RNoAF). This presentation will focus on IAM´s multidisciplinary approach to improve performance by maintaining and enhancing both the psychological and physical health of aircrew, with an emphasis on placing aircrew at the center of care. Two key programs—Pilot in the Loop and the Human Performance Optimization Program—will be highlighted, illustrating how these initiatives are designed to put aircrew at the center of care to support their well-being, performance, and mission readiness. The approach is inspired by the well-researched principals of person-centered care, which have shown to improve engagement, trust, and resilience by focusing on individual needs and empowering patients to effectively manage challenges. **OVERVIEW:** Aviation medicine at the IAM in the RNoAF integrates prevention, occupational, environmental, and clinical medicine with physiology and psychology to support military aircrew. The Royal Norwegian Air Force (RNoAF), with about 2,500 personnel, operates modern aircraft such as the F-35, P-8, and AW101 in challenging Arctic conditions. NATO's rapidly changing landscape in threat, security, and technology has increased the operational pace for aircrew in Norway. The Institute of Aviation Medicine (IAM) provides medical certification, aeromedical training, policy development, education, and research to enhance flight safety and performance. This presentation will review two aircrew-centered programs at IAM, PIL and HPOP, highlighting their unique approach by 1) integrating specialists in aviation medicine and psychology through a multidisciplinary team, and 2) placing aircrew at the center of care with tailored medical and psychological interventions based on their unique needs and circumstances. This approach enhances engagement, improves treatment adherence, and motivates aircrew toward mission readiness while fostering trust between aircrew and their aeromedical providers. Ultimately, it leads to better health outcomes, reduces stigma and healthcare avoidance, increases satisfaction, and facilitates a more efficient return to flying status. **DISCUSSION:** Like person-centered care, placing aircrew at the center of care in aviation medicine offers a promising approach to improving military aircrew retention, safety, and ensuring a smoother return to flight status. In Norway, the PIL and HPOP programs have been evaluated by medical staff, operational leaders, and aircrew, demonstrating their effectiveness in enhancing well-being, performance, and overall mission readiness.

Learning Objectives

1. Attendees will learn how the Institute of Aviation Medicine (IAM) integrates aviation medicine, psychology, and other disciplines to enhance both the psychological and physical health of militar.
2. Participants will explore the Pilot in the Loop (PIL) and Human Performance Optimization Program (HPOP), gaining insight into how these initiatives are designed to place aircrew at the center of care, addressing their unique needs to improve health outcomes, treatment adherence, and mission readiness.
3. The session will highlight how adopting principles of person-centered care fosters engagement, trust, and resilience in aircrew, leading to improved retention, faster return to flight status, and enhanced overall safety and performance in the Royal Norwegian Air Force.

[367] STRENGTHENING NORDIC AIR DEFENSE: A UNIFIED APPROACH TO AEROMEDICAL COLLABORATION

Anthony Wagstaff
Institute of Aviation Medicine, Oslo, Norway

(Education - Program / Process Review)

BACKGROUND: The Nordic countries' Air Forces—comprising the Royal Danish Air Force, the Finnish Air Force, the Royal Norwegian Air Force, and the Swedish Air Force—have recently strengthened their collaboration in military aviation. With Sweden and Finland joining the NATO Alliance, the Nordic countries have come closer together in their defense initiatives. On March 25th, 2023, the four nations signed an agreement to form a unified Nordic air defense alliance. As part of this closer cooperation, they have established the NATO Aeromedical Group (NNAMG), specifically focused on advancing the field of aviation medicine to enhance their joint operational capabilities. **OVERVIEW:** The Nordic Countries have longstanding tradition of cooperation between their air forces and aeromedical communities, even before Sweden and Finland´s pursuant to NATO membership. While the cultures are closely related and languages similar (except for Finnish), this cooperation, although consistently friendly, has always been limited in scope. With the new Nordic NATO alliance, there is not a renewed focus on collaboration at a far more direct and practical level. Our future plans include regular seminars hosted across the four countries, along with the development of a joint, modular training course for flight surgeons, leveraging shared resources for physiological training, specialist aeromedical assessment, research and operational experience. We also aim to establish standardized procedures for aeromedical support, enhancing interoperability across the Nordic nations within the aeromedical domain. **DISCUSSION:** Despite the differences in aeromedical resources among the Nordic countries' Air Forces, many of the challenges they face are similar. The unique conditions of the High North – characterized by extreme cold, harsh weather, challenging terrain and variable light – demand specialized aeromedical procedures, training, equipment and precautions. Addressing these shared challenges offers an opportunity to strengthen aeromedical capabilities through collective knowledge, research, and resource sharing. Being unified within NATO further amplifies the potential for significant advancements in Nordic aviation medicine, in parallel to the impact of of the joint air forces in an air defense alliance. The progress so fart and the promising outcomes of this cooperation will be explored in greater detail.

Learning Objectives

1. Gain insight into the structure, purpose, and operational goals of the newly established Nordic NATO Aeromedical Group (NNAMG) and how it enhances Nordic air defence.
2. Recognize the specific challenges posed by extreme weather, variable light, and terrain in the North, and learn how collaborative aeromedical procedures and training address these unique conditions.
3. Understand the importance of standardized procedures, modular training, and shared resources to improve interoperability and operational readiness across Nordic air forces within NATO.

[368] DANISH MILITARY AVIATION MEDICINE: CURRENT RESEARCH AND NORDIC COLLABORATION

Karsten Lindgaard
Danish Defence Medical Command, Syddanmark, Denmark

(Education - Program / Process Review)

BACKGROUND: The Danish Military aeromedical organization faces unique challenges as a small branch neutral organization tasked with providing aeromedical services to the diverse branches of the military: Air Force, Navy, and Army. The small size of the organization has strength when it comes to communication and the possibility of fast track case management. On the downside the limited organization size does not

leave room for medical staff to have full time research or development positions. This fact drives the organization to be engaged with NATO partners for knowledge development and exchange. It would simply not be possible to deliver a sufficient service to aircrews without this network and therefore it is crucial to the daily work. As being a part of Scandinavia, Denmark has a strong connection with the closest neighbors and this being reinforced even more with Sweden and Finland joining NATO in the near future. This presentation will give an introduction to the organization, challenges and current research in the Danish military aeromedical community. **OVERVIEW:** The presentation will cover a brief organizational introduction to the Danish military aeromedical community. The growing collaboration between the Scandinavian countries is to a mutual benefit which has been shown in exchange of flight physiology education, training curriculum and knowledge of prevention of altitude induced decompression sickness. Recent research has focused on potential pilot adaptation issues associated with 5th generation aircraft helmets, particularly concerning vision issues related to the extensive use of helmet mounted displays. During the F-35 transition training, a group of 20 pilots were monitored using questionnaires to assess their adaptation experience. In collaboration with the USAF Operational Based Vision Assessment (OBVA) laboratory, a follow-up evaluation was conducted to assess the precision of individual helmet alignment. A brief overview of this study and findings will be presented. **DISCUSSION:** Perhaps now more than ever the NATO community is important for strengthening knowledge and development of interoperability between our nations. Especially with Sweden and Finland as future new NATO members. This calls for a further development of our existing Nordic collaboration, particularly in regards to flight surgeon training, flight physiology training and general knowledge exchange.

Learning Objectives

1. The audience will get insight into pilot reported issues with extensive use of helmet mounted displays.
2. The audience will get an organizational insight into smaller nations aviation medicine structure.

[369] AEROMEDICAL ORGANIZATION IN THE SWEDISH AIR FORCE: GROWTH, CHALLANGES AND POSSIBILITEIS

Patrik Gustafsson
Swedish Armed Forces, Umeå, Sweden

(Education - Program / Process Review)

BACKGROUND: The military aeromedical organization in Sweden has undergone structural changes over the last decades, and more recently since Sweden's integration into NATO. An emerging and well publicized challenge is military pilot shortage in a growing air force. This presentation will introduce aviation medicine and operations in Sweden as well as the challenges and possibilities faced in the new context of joining NATO. **OVERVIEW:** Sweden's central aeromedical section leads all the aeromedical operations in the air force including implementing aeromedical rules, medical board, medevac, research, education. The Medical Examination Department (MedUA) includes first time medical for all flying duties and training of active air force pilots (high-G in the dynamic flight simulator, hypoxia recognition training, parachute landing training and sea survival training). The changing geopolitical landscape has increased security needs requiring more flying duties in a growing air force. However, meeting this demand presents real challenges due to pilot, other flight crew and combat leader shortages. One way this challenge is being met is synergy within NATO, especially our nordic allies, but also retention of elderly pilots who may remain in active flying duty past the age of retirement. This results in new demands for medical evaluation, such as increased requirements for cardiovascular disease evaluations and other screening tools for an aging pilot population. **DISCUSSION:** Sweden's move into NATO and its increasing aviation medicine operational demands facing an aging pilot population demands careful aeromedical considerations. We want to highlight our multidisciplinary approach to our aeromedical organization, research projects and policies, meeting both the medical and psychological aspects of each pilot and other air crew. Ongoing projects to include hypoxia, spatial disorientation and decompression sickness will be highlighted. As an example, recent research of decompression sickness that resulted in a change of routines with pre oxygenation. Recent Nordic collaborations within NATO creates a platform for connecting aviation medicine specialists thus extending the possibility for solving problems for common goals.

Learning Objectives

1. Identify the key responsibilities of Sweden's central aeromedical section in supporting air force operations, including aeromedical regulations, medical evaluations, training, and medevac services.
2. Describe the current challenges in Swedish military aviation medicine due to pilot shortages, increased security needs, and the aging pilot population, as well as strategies for addressing these challenges, such as collaboration with NATO allies and retention of experienced pilots.
3. Discuss recent aeromedical research and multidisciplinary approaches addressing issues like hypoxia, spatial disorientation, and decompression sickness in Sweden's air force.

[370] MILITARY AEROSPACE MEDICINE IN FINLAND

Roope Sovelius[1], Taija Lahtinen[2], Tuomo Leino[3]
[1]*Finnish Defence Forces, Helsinki, Finland;* [2]*Finnish Defence Forces, Rovaniemi, Finland;* [3]*Finnish Defence Forces, Tikkakoski, Finland*

(Education - Program / Process Review)

BACKGROUND: In Finland, aeromedical Centre in Helsinki and health centres in air bases belong to joint medical corps (Centre for Military Medicine). Air Force Command Finland is military aeromedical authority and responsible for aeromedical standards and waiver decisions. Aeromedical Centre is responsible for military aircrew annual flight physicals, and the selection process of military pilots. Health centres are responsible for daily aeromedical concerns, and annual fitness tests as a part of aeromedical qualification. Current aeromedical matters in Finland include dealing with two big transitions taking place almost simultaneously: introduction of a new platform, F-35A in 2025 and integrating the nation, its military and aeromedical system to NATO. 5th gen aircraft has new human factors elements and our aeromedical professionals need to be prepared for the change. On the other hand, this also brings new possibilities for scientific and operational co-operation in military aerospace medicine. **OVERVIEW:** In international and Nordic co-operation, several new sectors are evolving. A national shortage of military medical personnel in Finland highlights the need of common aeromedical training in blocks in Nordic countries. In pilot training, basic flight training is fully given in Finland. Finland has recently opened phase 3 and 4 flight training with Hawk also for Royal Norwegian Air Force student pilots. Main aeromedical research work consists of prospective long-term follow-up of discus degeneration (DD), 5 gen fighter pilots vision studies and comprehensive research of hypoxia training in flight simulators as well as fatigue management and human factors research. On-going programs are presented in more detail in the panel. Also, lessons learned from Ukraine war need to be at highest priority. In Finland, these lessons include prioritizing the training of Tactical Combat Casualty Care (TCCC), developing walking blood banks, and improving Role 2 Forward capabilities with damage control surgery capability. High North operation area provides international challenge for aeromedical evacuation. **DISCUSSION:** Nordic aeromedical community has new challenges due to increasing importance on Arctic region. Finnish Air Force has been developing and emphasizing the elements needed for Agile Combat Employment (ACE) in training and exercises, and this provides another possibility for future co-operation.

Learning Objectives

1. The participant will understand the structure and responsibilities of Finland's military aeromedical system, including the roles of the Aeromedical Centre, Air Force Command, and health centers on air bases.
2. The participant will understand the specific challenges and changes in Finnish aeromedical practices related to the introduction of the F-35A platform, NATO integration, and collaborative training needs with Nordic allies.

3. The participant will understand ongoing Finnish aeromedical research efforts, including studies on fighter pilot vision, hypoxia training, fatigue management, and their practical applications in military aerospace medicine and tactical combat casualty care.

Thursday, 06/05/2025 ***1:30 PM***
Regency VII

[S-67] PANEL: APPLICATIONS OF ARTIFICIAL INTELLIGENCE (AI) TO COMBAT AVIATION MISHAPS

Chair: G. Merrill Rice

Panel Overview: 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. 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 investigators may follow to identify cognitive performance decrements stemming from common aeromedical hazards such as hypoxia, spatial disorientation, and fatigue and then transition the technology to the operational environment . Our second presentation will explore applications of AI with regards to identifying Spatial Disorientation by monitoring real time cockpit control inputs. Our third presentation will evaluate the effects of emotions on performance and the potential for mitigating negative emotional effects by AI enhanced neuromodulation. Finally, we will provide methodologies for using deep learning to systematically evaluate aircraft environmental control systems data to identify conditions which may result in physiologic events or mishaps. Attendees will garner an understanding of the current methodologies in machine learning employed by aeromedical researchers to improve human performance and mitigate mishaps in aviation environments.*

[371] METHODOLOGIES TO UTILIZE AI TO COMBAT AVIATION MISHAPS - A CRITICAL REVIEW

G. Merrill Rice[1], Steven Linnville[2], Dallas Snider[3]
[1]*Naval Safety Command, Norfolk, VA, United States;* [2]*Naval Aerospace Medicine Research Laboratory - Dayton, Dayton, OH, United States;* [3]*University of West Florida, Pensacola, FL, United States*

(Original Research)

INTRODUCTION: Despite significant advancements in aerospace engineering and safety protocols over the last decade, U.S. naval mishap rates have remained essentially unchanged. This presentation explores how researchers may leverage current Artificial Intelligence (AI) technologies to enhance aviation safety. **METHODS:** A critical review was performed identifying aviation research protocols which have incorporated machine learning (ML) to enhance the accuracy of detecting common aviation hazards leading to cognitive decrements. The review proposes a three-step methodology for creating protocols to identify cognitive decrements in aviators: 1) sensor selection 2) pre-processing techniques, and 3) ML algorithm development. **RESULTS:** Several psychophysiological biosensors, enhanced by ML modeling, show promise in identifying cognitive deficits secondary to fatigue, hypoxia and spatial disorientation. The most cited biosensors integrated with ML models include electroencephalographic, electrocardiographic, and eye tracking devices. The application of pre-processing techniques to biosensor data is a critical methodological step prior to applying ML algorithms for data training and classification. ML algorithms utilized were categorized into supervised, unsupervised, and semi-supervised types, often used in combination for more accurate predictions. **DISCUSSION:** Current literature suggests that AI, when used in conjunction with various psychophysiologic sensors, can predict and potentially mitigate common aeromedical hazards such as fatigue, spatial disorientation, and hypoxia in simulated settings. The miniaturization of pre-processing and ML algorithmic hardware is the next phase of transitioning AI to operational environments for real-time continuous monitoring.

Learning Objectives

1. Participants will learn the basic methodologies employed from recent literature to utilize AI to identify cognitive decrements in the cockpit.
2. Participants will be able to identify the primary psychophysiologic sensors utilized, pre-processing techniques and machine learning algorithms applied in existing aeromedical protocols.

[372] ARTIFICIAL INTELLIGENCE AS A COUNTERMEASURE FOR SPATIAL DISORIENTATION

Vimal Vivekanand, Yonglin Wang, James Lackner, Paul DiZio, Pengyu Hong
Brandeis University, Waltham, MA, United States

(Original Research)

INTRODUCTION: Spatial disorientation (SD) is a major contributor to fatal aircraft accidents. Previously, from the same disorienting profile, we found a surprisingly wide range of individual differences in the perception of self-orientation which, to our knowledge, no vestibular model can predict. Could an AI model help? **METHODS:** Blindfolded participants (n=37) were secured into a Multi-Axis Rotation System device that was programmed to behave like an inverted pendulum in the horizontal roll plane, where participants could not use gravitational cues to determine their position because they did not tilt relative to the gravitational vertical. They used a joystick to stabilize themselves about the balance point. All participants exhibited spatial disorientation, poor performance and high rates of crashing (reaching ±60 deg). In a first study, to predict individual differences in performance while disoriented, we used a Bayesian Gaussian Mixture method to cluster participants into three statistically distinct performance groups and then used a Gaussian Naive Bayes method to create predictive classifiers of performance. In a second study, we used stacked gated recurrent units (GRU) to predict impending crashes before they happened. **RESULTS:** In the first study, we could predict a participant's final performance group with 80% accuracy within the first 13 minutes. We also identified a suboptimal strategy that all participants used in the least proficient category. In the second study, we were able to predict crash events 800 ms in advance with an AUC (area under the curve) value of 99%. When we prioritized reducing false negatives we found it resulted in more false positives. We found that false negatives occurred when participants made destabilizing joystick deflections that rapidly moved the MARS away from the balance point. These unpredictable destabilizing joystick deflections were a result of SD. **DISCUSSION:** If our model could work in real time, immediate human action would result in the prevention of 80.7% of crashes. However, accounting for human reaction times (~400 ms), only 30.3% of crashes could be prevented. Therefore, while AI could be helpful, our implementation was limited by the huge variability and unpredictability of individual differences in perception of self-orientation caused by SD

Learning Objectives

1. How did we create a spaceflight analog condition that led reliably to spatial disorientation?
2. How metrics such as the AUC (area underneath the curve) are not always the best way to access the success of the AI model.

[373] IMPROVEMENT OF COGNITIVE PERFORMANCE UNDER NEGATIVE EMOTIONS IN COMPLEX ENVIRONMENTS UTILIZING TDCS AND ARTIFICIAL INTELLIGENCE

Fabre Ludovic, Olivier Bartheye, Tristan Feutren
École de l'air et de l'Espace, Salon-de-Provence, France

(Original Research)

INTRODUCTION: Considering the emotional impact on decision-making processes during aerospace operations is essential to avoid

negative outcomes and biases, the aim of the present experiment was twofold: (1) to monitor the cognitive state of operators in real-time and assess the impact of emotions on performance and (2) mitigate emotionally induced performance decrements with neuromodulation and explainable artificial intelligence (AI). AI was used to monitor participants in real-time and adapt neurostimulation to each participant. **METHODS:** A single-blind, within-subjects, sham-controlled design was employed. Thirty participants performed three laboratory tasks, each specifically assessing a cognitive control process: the Go/No-Go task (inhibition), the 2-back task (updating), and the set-switching task (shifting). They engaged in a video game used in psychological research, Space Fortress, which simulates a multitasking environment. Emotions were manipulated using the IAPS pictures or the Trier Social Stress Test. Half of the participants received transcranial direct current stimulation (tDCS) over the left dorsolateral prefrontal cortex (DLPFC) for 30 minutes at 2mA, while the other half received a sham stimulation at the beginning and end of the tasks. EEG data were recorded using a 32-channel active electrode cap. **RESULTS:** Behavioral results replicated previous findings, revealing that negative emotions impaired performance in the 2-back task ($p = 0.002$) and switching tasks ($p < .001$). Interestingly, tDCS stimulation interacted with emotions, leading participants to improve their performance under negative and neutral emotional conditions ($p < .001$). For the 2-back task, participants responded faster and made fewer errors in the active stimulation condition compared to the sham condition. ($p = 0.03$). The effect of tDCS on Go trials was not significant for both active and sham stimulation. tDCS reduced the switching cost, resulting in faster response times after the switch. ($p = 0.04$). **DISCUSSION:** The present study examined how a single session of tDCS influenced the effects of negative emotions on cognitive control processes. These findings have important implications for understanding the influence of emotions on cognitive control and multitasking. Moreover, the use of OpenViBE software is promising in designing and implementing Brain-Computer Interfaces (BCIs) that provide real-time feedback and adapt tDCS protocols to individual participants.

Learning Objectives

1. The participant will be able to understand how negative emotions influence the processes of cognitive control.
2. The participant will understand the potential use of BCI, enabling neurostimulation to be adapted to each participant to offset the deleterious effects of emotions on cognitive performance.

[374] DETECTING PRESSURE-RELATED PHYSIOLOGICAL EVENTS WITH DEEP LEARNING

Lucas Haberkamp[1], Stephanie Warner[1], Dain Horning[1], Roy Allen Hoffman[2]

[1]*Naval Medical Research Unit-Dayton, Wright-Patterson AFB, OH, United States;* [2]*Engineering Systems Inc, Peachtree Corners, GA, United States*

(Education - Tutorial / Review)

INTRODUCTION: Physiological events (PEs) resulting from fluctuating cockpit pressure are a significant concern in tactical jet aircraft, particularly in the F/A-18. The specific cockpit pressure features contributing to aircrew symptoms remain unclear. Cockpit pressure dynamics are complex and time-dependent, making them difficult to capture with scalar values. Therefore, researchers should leverage deep learning approaches that automatically extract meaningful features from raw data and achieve state-of-the-art classification performance across several domains. **TOPIC:** Since 2017, the U.S. Navy has collected cockpit pressure data from F/A-18 flights, providing a robust dataset for studying normal cockpit pressure dynamics. Prior analyses relied on thresholds for the rate of cockpit pressure change, with the best performing ±0.6 PSI/sec threshold yielding poor precision (19%) and moderate recall (64%). To date, no deep learning models have been developed to distinguish PE from non-PE flights. However, three promising approaches for this task include unsupervised autoencoders, supervised contrastive learning, and traditional supervised learning with focal loss. Autoencoders compress non-PE data into a lower-dimensional space, capturing key features of normal pressure dynamics. By reconstructing the input data, autoencoders produce low error for normal fluctuations but high error for anomalies, thereby detecting potential PE flights. Supervised contrastive learning identifies discriminative features by projecting time-series data into a representation space where non-PE flights cluster tightly and PE flights are distinctly separated. It handles imbalanced data well by leveraging many unique comparisons between PE and non-PE examples, allowing the model to learn effective representations even with limited PE examples. Traditional supervised learning with focal loss also addresses the class imbalance problem. Focal loss adjusts the contribution of each example dynamically, focusing on hard-to-classify examples and reducing bias towards non-PE flights. **APPLICATION:** These deep learning approaches are expected to significantly improve the precision and recall of pressure-related PE detection. They will serve as benchmarks for developing interpretable machine learning models requiring manual feature engineering. Ultimately, the best performing deep learning model may enhance PE investigations by reliably predicting the likelihood of a pressure-related PE.

Learning Objectives

1. Understand how deep learning models can recognize patterns and automatically learn important features from F/A-18 cockpit pressure data.
2. Provide insights into which deep learning approaches are suitable for datasets with severe class imbalance (i.e., anomaly detection).

Thursday, 06/05/2025 ***1:30 PM***
Hanover C/D/E

[S-68] PANEL: AEROMEDICAL ETHICS PANEL: SPONSORED BY THE AMERICAN SOCIETY OF AEROSPACE MEDICINE SPECIALISTS

Chair: Mark Mavity

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 value conflicts in the current practice of aerospace medicine.*

[375] AEROMEDICAL ETHICS PANEL: SPONSORED BY THE AMERICAN SOCIETY OF AEROSPACE MEDICINE SPECIALISTS

Mark Mavity

EHE Health and Acuity International, 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 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, 06/05/2025 ***1:30 PM***
Grand Hall East Corridor - Posters Only

[S-70] POSTER : HEAD, SHOULDERS, KNEES & TOES FOR SPACE

Chair: Barrett Campbell
Co-Chair: Jan Stepanek

[379] SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME (SANS) OPTICAL COHERENCE TOMOGRAPHY (OCT) CLINICAL GUIDELINES: TRANSITION FROM OCT1 TO OCT2

Sambit Pattanaik[1], Lenexa Morais[2], Carlo Canepa[3], Sara Mason[4], Nimesh Patel[5], Tyson Brunstetter[6]
[1]*Cooper University Hospital, Camden, NJ, United States;* [2]*University of Florida, Gainesville, FL, United States;* [3]*Baylor College of Medicine, Houston, TX, United States;* [4]*Aegis Aerospace Inc, Webster, TX, United States;* [5]*University of Houston, Houston, TX, United States;* [6]*NASA JSC, Houston, TX, United States*

(Education - Program / Process Review)

BACKGROUND: Optical Coherence Tomography (OCT) is the primary modality for monitoring and measuring ocular anatomical changes that are associated with Spaceflight Associated Neuro-ocular Syndrome (SANS) in long- and extended-duration spaceflight. The latest generation Spectralis OCT-2 diagnostic device (Heidelberg Engineering) is currently used onboard the International Space Station (ISS), allowing for improved data collection and diagnostic value compared to the previous generation OCT1 device. As part of a National Aeronautics and Space Administration (NASA) Aerospace Medicine Clerkship project in April 2024, the authors updated the clinical guidelines for OCT-2 for the NASA Flight Surgeons and International Partners. **METHODS:** Literature review of the prior OCT-1 clinical guidelines (NASA internal document) was updated with information obtained from a broad, open-source literature review of current SANS-related journal articles, Heidelberg Engineering technical specifications, and discussion/interviews with SANS Subject Matter Experts (SMEs). Comparison of OCT-1 and OCT-2 protocol demonstrated significant improvements in clinical capability of the OCT-2 device, including higher scan density, increased resolution, deeper tissue penetration, faster scan times, and the new feature MultiColor Imaging (MCI). **DISCUSSION:** OCT-2 is the most critical ocular diagnostic device and primary tool to detect and grade SANS optic disc edema (by measurement of pre- to in-flight change in peripapillary total retinal thickness, ΔTRT). Upgrading from OCT1 to a higher density and faster OCT2 protocol has saved valuable astronaut time, streamlined scans and user capability, and improved data resolution. Additionally, OCT-2 MCI capability has replaced on-orbit fundoscopy for nominal operations, which has saved over 14 hours of crewtime per increment. By summarizing the OCT2 Clinical Guidelines, we hope to demonstrate why OCT is a valuable and clinically relevant data collection and diagnostic tool, and why it should continue being utilized onboard the ISS and beyond. With the increasing extended duration missions on the horizon, a new, mini-OCT device that retains or exceeds the OCT2 capabilities will be needed.

Learning Objectives

1. The audience will better understand the role of OCT in detecting, monitoring, and objectively quantifying the clinical features associated with SANS.
2. The audience will gain a greater appreciation for the increased speed and capability of OCT-2 compared to OCT-1, which will emphasize the importance of continuing to develop OCT devices for use beyond low Earth orbit (LEO).

[380] ASSESSMENT OF RISK FACTORS FOR OPTIC DISC EDEMA IN A SPACEFLIGHT ANALOG

Sarah Ditelberg[1], Sara Zwart[2], Scott Smith[2], Millennia Young[2], Alex Huang[3], Brandon Macias[2], Steven Laurie[2]
[1]*Loyola University Chicago Stritch School of Medicine, Maywood, IL, United States;* [2]*NASA JSC, Houston, TX, United States;* [3]*University of California San Diego, San Diego, CA, United States*

(Original Research)

INTRODUCTION: While ~60% of astronauts develop mild optic disc edema (ODE) during spaceflight, and ~18% develop more concerning ODE, there are likely modifying factors that explain the variability in the magnitude of its presentation. Prior studies involving astronauts during spaceflight and participants exposed to strict head-down tilt bed rest (HDTBR) have focused on optic cup volume, sleep duration, and genetics as single factors to explain the variability in ODE presentation. The purpose of this study was to determine if combining data from all of these factors can improve the ability to predict the severity of ODE. **METHODS:** At the German Aerospace Center, 47 participants (27 males, 20 females) were exposed to 30 days of strict 6° HDTBR. Optic cup volume was quantified from optical coherence tomography (OCT) images, sleep duration from polysomnography, and single nucleotide polymorphisms (SNPs) from blood samples. Change in total retinal thickness (ΔTRT) was quantified from OCT images to assess ODE; ΔTRT >19.4 µm indicates its earliest signs. This project was approved by the NASA JSC IRB and the North Rhine Ethics Committee in Germany. **RESULTS:** HDTBR led to ODE in 37/47 individuals (ΔTRT 19.6 to 193 µm). No individuals with optic cup volumes > 0.4 mm3 developed ODE. One individual with a moderate sized cup volume (0.3 mm3) and ΔTRT > 50 µm had < 5 hours of sleep and possessed 3 of 4 "risk" alleles based on SNPs identified in previous research. The individual with the greatest ΔTRT had normal sleep (~7 hours), but a small cup volume (0.02 mm3) and possessed 2 "risk" alleles. **DISCUSSION:** Evaluation of all three factors together represents a more comprehensive approach to determining the degree of ODE severity. These data highlight that different factors may influence ODE development in different individuals and reveal that combining multiple factors improves our ability to predict ODE development. This more comprehensive understanding of multiple risk factors will allow for targeted approaches in utilizing SANS countermeasures.

Learning Objectives

1. The audience will be able to describe three hypothesized risk factors for SANS.
2. The audience will be able to understand how these factors are being used to identify those at risk for SANS.

[381] WITHDRAWN

[382] REHASHING REHABBING: HOW PRIVATE SPACEFLIGHT COULD CHANGE THE FUTURE OF REHABILITATION IN MICROGRAVITY.

Hamaad Khan, Emily Gansert, Tyler Mistretta
Mayo Clinic, Jacksonville, FL, United States

(Education - Tutorial / Review)

INTRODUCTION: Commercial spaceflight companies like Axiom, Virgin Galactic, and SpaceX are increasing private citizens' access to spaceflight. As this demand grows, the physical conditioning process for the average space traveler will become increasingly difficult. Maintaining bone density and muscle mass in microgravity proves difficult even for highly trained astronauts, many of whom are former military personnel. It is clear that average citizens, often with minimal training and potential comorbidities, will face even greater physical challenges. A thorough review of the current spaceflight rehabilitation regimen is critical to understanding how these methods can be adapted and optimized for future space travel. **TOPIC:** Rehabilitation for space flight currently

involves three key phases: preflight, in-flight, and post-flight. Preflight focuses on preparing the body for microgravity, with an emphasis on strength, cardiovascular conditioning, and flexibility exercises to build a strong foundation. In-flight exercises work to mitigate the rapid muscle atrophy and bone density loss caused by microgravity with carefully crafted exercise regimens. Post-flight rehabilitation shifts the focus to readapting the body to Earth's gravity, addressing balance, coordination, and overall physical strength after prolonged weightlessness. These regimens have all been designed with career astronauts in mind, and many components will require restructuring for the unique needs of the civilian population. **APPLICATION:** With a rise in the number of private individuals venturing into space, training protocols must become more personalized, accounting for the physical diversity and health variations of private astronauts. Focus on lower body and core muscle groups to strengthen load-bearing bones is crucial, especially in elderly travelers. Progressive loading and joint stabilization exercises will be paramount on Earth to prevent connective tissue injury in microgravity. Additionally, in-flight rehabilitation should incorporate wearable biosensors to provide real-time health monitoring and enable detailed tracking of functional changes throughout the mission. The post-flight phase will need greater support from specialists and experts to address the varied physical responses and potentially slower recovery rates of civilians as they readjust to Earth's gravity. By integrating adaptive and personalized methods, we can create a safer, more inclusive future for human space travel.

Learning Objectives

1. The audience will be able to identify current rehabilitation strategies employed by governmental space agencies to mitigate microgravity changes in astronauts.
2. The audience will acknowledge the challenges faced by private space agencies when employing private citizens.
3. The audience will understand how traditional rehabilitation strategies will be adapted for civilian space travelers for preflight, in-flight, and post flight conditioning.

[383] WITHDRAWN

[384] VOLUME OF INJURIES: A REVIEW OF MSK INJURY INCIDENCE RELATIVE TO SPACECRAFT HABITABLE VOLUME

Ari Epstein
University of Rochester, Rochester, NY, United States

(Education - Program / Process Review)

BACKGROUND: With the anticipated retirement of the ISS (International Space Station) by 2030 and transition back to flights beyond Low Earth Orbit (LEO) via NASA's Artemis Program, future non-commercial spaceflights will expose crew to new operational environments that may increase the risk of MSK injuries. One such change is the decreased habital volume of the spacecraft. Presently, NASA crew fly in capsular craft (Soyuz or Crew Dragon) for limited intervals (i.e. 4-16 hours) in transit to the ISS, but the planned early Artemis missions will require crew to remain in the capsular Orion MPVC for the duration of the flight, like 10 days for all crew on Artemis II or approximately 30 days for half the crew on Artemis III. **OVERVIEW:** This literature review summarizes the Aerospace Medicine literature to identify existing knowledge gaps specific to in-flight musculoskeletal (MSK) injury mechanisms and injury rates relative to spacecraft design or habital volume. A review utilizing select databases (MEDLINE, NASA Technical Report Server, and PubMed) was performed to identify both the mechanisms for and locations of in-flight MSK injuries that occurred on flights between 1959 and 2023. A literature search of original research, technical reports, and conference media (poster/podium presentations and papers) was performed with a combination of keywords: musculoskeletal, MSK, capsule, spacecraft design, and injury[ies]. **DISCUSSION:** MSK injury rates localized to specific mission activities, like extravehicular activity (EVA), translation through modular spacecraft, equipment stowing, and in-flight exercise. However, unpublished data from early, capsule-only programs (maximum mission duration 14 days) demonstrated higher MSK injury rates independent of the latter mission activities. Despite this difference, none of the sources in this literature review specified the mechanisms of the reported MSK injuries in those early programs. Future research may address this operational knowledge gap to better understand if capuslar vehicles with much smaller habital volumes than current, large-volume operating environments (i.e. ISS), may increase the risk of MSK injury independent of in-flight activities, like exercise or EVA.

Learning Objectives

1. The audience will learn about the most common mechanisms for MSK injuries on larger habital volume spacecraft, like the ISS. Specifically, the audience will gain a more nuanced understanding of MSK injury risks to crew from 1) operating both aerobic and resistive exercise devices and 2) EVA suit components.
2. The audience will learn about the capsular design of earlier NASA programs (Gemini X-XII, Apollo, and the Apollo/Soyuz Test Project).
3. The audience will learn about how crew translate about the habital volume of capsules and which countermeasures were implemented to enhance crew safety.

[385] TUTORIAL: REVIEW & PROPOSED MANAGEMENT OF SPACEFLIGHT DERMATOSES

Julian Henke[1], Sana Kamboj[1], Jacob Asmuth[2], Ameya Gangal[1], Justin Cheeley[1], Travis Blalock[1]
[1]*Emory University School of Medicine, Atlanta, GA, United States;* [2]*Johns Hopkins, Baltimore, MD, United States*

(Education - Tutorial / Review)

INTRODUCTION: While multiple reviews of dermatologic conditions associated with spaceflight have been published over the past decade, they often lack standards for managing these conditions in space. Transcriptomic studies have revealed key biological changes including those related to skin health, DNA damage, and repair. This tutorial bridges that gap by focusing on the identification and practical management of dermatologic sequelae of spaceflight, including microgravity-induced skin thinning, xerosis, and contact dermatitis, with specific, evidence-based treatment recommendations and potentially promising management techniques. **TOPIC:** Space missions pose unique challenges to skin health due to microgravity, low humidity, and limited hygiene, leading to issues such as skin thinning, dermal atrophy, and increased incidence of dermatologic symptoms. Skin abrasion and rash are among the most common medical conditions reported in space, as noted by the NASA Human Research Program's Integrated Medical Model. Microgravity also downregulates fibroblast and keratinocyte function, which contribute alongside extracellular matrix composition changes to lead to impaired skin healing and dermal atrophy. **APPLICATION:** To counter these effects, targeted interventions such as retinoids and vitamin A derivatives should be considered to increase collagen synthesis and enhance epidermal turnover. In recent causal gene expression relationship studies, calcitriol and L-asparaginase have been identified as a significant potential countermeasure for targeting skin spaceflight dysfunction. While emollients, barrier creams, corticosteroids, and anti-inflammatory agents have been used for xerosis and contact dermatitis, occlusive dressings may combat the established low efficacy of treatments during missions. Additionally, hydrogels and negative pressure wound dressings are proposed as effective options to mitigate decreased wound healing by promoting a diffusive environment enhanced for tissue regeneration.

Learning Objectives

1. Identify and understand the unique dermatologic challenges posed by spaceflight.
2. Evaluate and apply evidence-based treatment strategies for dermatologic conditions in space.
3. Incorporate new research findings into dermatologic care for spaceflight.

[386] WITHDRAWN

[387] EVALUATION OF ACUTE AIRWAY CHANGES DURING SHORT-DURATION SPACEFLIGHT

Taania Girgla[1], Amran Asadi[2], Kaleigh Stabenau[2], Marissa Rosenberg[2], Brita Mittal[3]
[1]*Mass General Brigham, Boston, MA, United States;* [2]*SpaceX, Hawthorne, CA, United States;* [3]*Stanford University, Palo Alto, CA, United States*

(Original Research)

INTRODUCTION: It is theorized that microgravity-induced fluid shifts may cause airway edema, however, no direct observations have been published. This poses major challenges for developing protocols, training, and medical systems capable of supporting airway emergencies in spaceflight. This study aims to characterize acute airway changes during short-duration spaceflight via in-flight transnasal endoscopy, front-of-neck ultrasound (U/S), Mallampati scores, and voice recordings. **METHODS:** This is an IRB approved, prospective, observational pilot study of commercial astronauts in orbital spaceflight. Four subjects underwent a longitudinal training protocol consisting of didactics, hands-on skills sessions, and just-in-time training. In flight, procedures were self-administered under remote supervision. Endoscopic video of 10 key airway structures were assessed, including tongue, hypopharynx, vallecula, epiglottis, subglottis, aryepiglottic folds, arytenoid complex, posterior commissure, true vocal cords, and false vocal cords. Front-of-neck U/S included laryngeal, supraglottic, subglottic, submental, and hyoid views. Mallampati scores and voice were recorded. Data was acquired pre-flight (L-30), in-flight (FD 2, 4, and 5), and 24h after return to 1G (R+1). **RESULTS:** A one-point increase in Mallampati score was noted on FD2 (N=2) but resolved by FD4 (N=2). Preliminary review via paired T-tests of the U/S data revealed an increase in tongue thickness from FD4/5 to R+1 (N=3), a decrease in pre-epiglottic space depth from L-30 to R+1 (N=4), and a decrease in skin to cricothyroid membrane distance from L-30 to R+1 (N=4) and FD4/5 to R+1 (N=3). Endoscopic video was assessed for airway edema, erythema, dynamic function, and laryngeal inlet positioning (N=2). Voice recordings will be evaluated with the Consensus Auditory-Perceptual Evaluation of Voice (CAPE-V) protocol. Completion of analysis is expected by early 2025. **DISCUSSION:** Understanding microgravity-induced airway changes is needed to prepare for airway emergencies in spaceflight. Our results show that Mallampati scores increased in the acute inflight period but appeared to normalize by FD4. The preliminary U/S results show that the dimensions of airway structures typically associated with difficult airway management did not increase on FD4 compared to preflight baseline. This study also reports the first successful use of transnasal endoscopy and advanced airway U/S by a non-physician crew in spaceflight.

Learning Objectives

1. The audience will learn about our longitudinal training protocol to conduct remote just-in-time guided advanced airway ultrasound and endoscopy in spaceflight.
2. The participant will be able to understand the changes and resolution of microgravity-induced acute airway changes during spaceflight compared to pre-flight baseline.
3. The participant will be able to understand the changes and resolution in auditory-perceptual assessment of voice during spaceflight compared to pre-flight baseline.

[388] SUBORBITAL DEPLOYABLE TROOPS AND FLIGHT RISKS AND COMPLICATIONS IN CARDIOVASCULAR, NEUROVESTIBULAR, AND NEUROMUSCULOSKELETAL SYSTEMS, AND FLUID SHIFT

Gavin Ward[1], Danielle Anderson[2], Richard Scheuring[2]
[1]*Mayo Clinic, Rochester, MN, United States;* [2]*NASA JSC, Houston, TX, United States*

(Original Research)

INTRODUCTION: There is an increasing demand to rapidly deploy US service members in case of a crisis. Suborbital flight may serve as a useful strategy to address this demand. It is critical to understand physiological and mechanical risks and complications to evaluate time to operational readiness after landing. Therefore, the aim of our review was to evaluate suborbital flight risks and complications associated with cardiovascular (CVS), neurovestibular, and neuromusculoskeletal (NMSK) systems, and fluid shift, to discuss their relationship to deployable troops. **METHODS:** A systematic review using PubMed, Scopus, and NASA Technical Report Server Publicly Available Content was performed to identify original research containing suborbital flight risks and complications associated with CVS, neurovestibular, and NMSK systems, and fluid shift. Articles discussing centrifuge simulated suborbital flight were also evaluated. **RESULTS:** Seven suborbital flight and 6 centrifuge simulated suborbital flight articles were included in the review. In suborbital flights, astronauts demonstrate increased risk to elevated CO2 levels of 15 mmHg and 10 mmHg at 1 hour and 24 hours in-flight, respectively, where terrestrial research indicates cognitive decline starts at 1.9 mmHg; elevated orthostatic rise in heart rate and drop in systemic blood pressure post-flight with symptoms lasting 7-19 hours; and fatigue peaking at 12 hours post-flight. There is negligible risk to NMSK and neurovestibular systems. In centrifuge simulated suborbital flights, there are significant increases in post-flight vertigo in up to 34% of flyers, causing significant ($p \leq 0.002$) imbalance and unsteadiness, after undergoing up to 6 flights in short periods of time. **DISCUSSION:** Deployable troops may be at greatest risk for minor CVS symptoms, elevated CO2 levels resulting in impaired decision-making capacity and decrease in performance for mission objectives, significant vertigo after undergoing multiple suborbital flights in a short period of time, and fatigue. Overall, there is little risk to CVS and NMSK systems, but precautions should be taken for the neurovestibular system and fluid shift. There is a paucity of literature characterizing suborbital risks and complications. Future research should place greater emphasis on evaluating suborbital flights. Current data suggests suborbital flights for deployable troops is feasible with symptoms resolving in 24 hours or less.

Learning Objectives

1. The audience will learn about the risks and complications affecting the cardiovascular, neurovestibular, and neuromusculoskeletal systems, as well as fluid shifts, in astronauts undergoing suborbital flights.
2. The audience will understand the increasing demand for rapid deployment of U.S. service members.
3. The audience will explore the connection between suborbital flight risks and the readiness of deployable troops, emphasizing the need for more focused suborbital flight data in future research.

[389] REVEALING NON-TECHNICAL SKILLS THROUGH SIMULATION FOR HIGH-STAKES SELECTION

Dana Herrigel[1], Diego Garcia[2], Teo Dagi[3], Leigh Speicher[1]
[1]*Mayo Clinic, Jacksonville, FL, United States;* [2]*Embry-Riddle Aeronautical University, Daytona Beach, FL, United States;* [3]*Mayo Clinic, Rochester, MN, United States*

(Education - Program / Process Review)

BACKGROUND: Selecting high-performing individuals, like astronauts, for high-stakes missions requires a robust understanding of behavioral attributes such as resilience and anti-fragility under stress. Non-technical skills (NTS) are essential for safety-critical, high-consequence teams, and present significant assessment challenges, especially in non-operational settings. Existing approaches lack the unobtrusive, real-time observational fidelity necessary to evaluate these skills accurately. This is a growing concern, as the operational demands for commercial and international astronauts increase. **OVERVIEW:** We developed an immersive simulation method for observing and assessing key non-technical skills required for astronaut candidates. This approach focuses on eight NTS domains identified by NASA for commercial astronaut roles. We adapted validated behavioral

anchors from an inter-professional assessment tool to create a point-of-care interface that captures real-time behaviors using a Likert scale, and we propose scoring criteria. This methodology was tested with 18 trainees enrolled in an aerospace medicine course. Subjects participated in a structured, group-based problem-solving simulation designed to elicit behaviors in domains such as Self-Management, Teamwork, Decision-Making, Communication, Leadership-Followership, and Conflict Management. The simulation's stressors—time pressure, social observation, ambiguity, task saturation, and communication challenges—were designed to replicate conditions of operational complexity. **DISCUSSION:** This simulation-based platform advances human performance assessment by providing operationally relevant insights into candidates' NTS in a controlled, observable setting. This methodology can facilitate comparisons across disciplines where conventional subjective measures may be insufficient. By incorporating biometric monitoring (heart rate variability) and self-assessment tools, such as the IPI-NEO-120 personality inventory and the NASA task load index, the methodology captures a holistic view of both perceived and physiologic responses to stress. This initiative supports cross-sector applications, including military-civilian and international astronaut selection frameworks. The promising results from this index simulation will inform next steps, aiming to correlate behavioral observations with physiologic markers, and refine selection processes across high-stakes, safety-critical professions.

Learning Objectives

1. Describe the advantages and applications of group interactive simulation in the context of high-stakes candidate selection.
2. Apply NASA non-technical skills standards to create group problem solving exercises.
3. Evaluate candidates' non-technical skills (NTS) performance revealed by direct observation.

Thursday, 06/05/2025 ***3:30 PM***
Centennial Ballroom II

[S-72] PANEL: MAKING SENSE OF SPECIAL SENSES IV: SENSORY CHALLENGES

Chair: Harriet Lester
Co-Chair: Benisse Lester

Panel Overview: *Making Sense of Special Senses IV: Sensory Challenges Vision, equilibrium, and hearing are special senses processed by the cranial nerves, thus intertwined with the brain and human factors. Critical and vulnerable, these special senses mitigate aviation safety risk when functioning well. When malfunctioning or challenged, they contribute to safety risk. Intact visual, vestibular, and auditory perception; and accurate interpretation of these inputs, enable aviators to fly and survive. Adaptations through training and technology help over-ride sensory misperceptions and compensate for gaps in perception. Perceptual gaps are worsened by sensory pathology. Aeromedical standards enable regulators to identify critical sensory deficiencies, in order to reduce accident risk. New generations of medications enable some pilots to fly who would previously have been grounded permanently. However, medical conditions can cause sensory deficits that cannot be rectified, and when significant, the pilot does not meet medical standards as pilot in command. We will discuss laser strikes, which interfere with vision, can cause injury, and are a worsening aviation nuisance and potential hazard. We will present binocular visual field loss and monocular acuity loss in a commercial balloon pilot, in the context of the new FAA rule, RIN 2120–AL51. We will review the treatment of retinal vascular pathology with anti-VEGF injections in USAF pilots. We will discuss UAV sensory human factors challenges and a proposed way to better understand these challenges. Beyond the medical and technical, there is human judgment. Prohibited substances exacerbate sensory challenges. We will report research findings for toxicology in fatal general aviation spatial disorientation fixed wing accidents. Pilots with intact sensory apparatus can have misperceptions, and pilots with abnormal sensory apparatus can sometimes be well adapted. Failure and deficiencies of the special senses can be lethal. Aeromedical standards help mitigate risk but are not absolute. Judgment and adaptations are important. Safe flight depends upon intact special sensory systems, correct sensory interpretation and judgment, training, experience, technology, and compliance with regulatory requirements designed to mitigate safety risk. Special Senses are an inextricable part of the Human Factors aviation puzzle.*

[396] THE EXPANDING AND OMNIPRESENT LASER BEAM THREAT TO AIRCRAFT OPERATIONS AND THE EYE

Douglas Ivan[1], Harriet Lester[2]
[1]*ADI Consultants, San Antonio, TX, United States;* [2]*FAA, Jamaica, NY, United States*

(Education - Tutorial / Review)

INTRODUCTION: Lasers remain one of the most remarkable technological achievements of the modern era with a broad and ever-growing range of applications in medicine and industry. Reduced system costs, design improvements, expanded wavelength options, portability and increasing beam power have not only broadened their accessibility and capabilities, but have increased the risks associated with their use. Whether pointed indiscriminately by naïve users or deployed with sinister intent by bad-actors, laser beams have the potential to be a disruptive threat across the spectrum of civil, commercial, and military air operations, as well as being a significant hazard to the eye. **TOPIC:** This tutorial will review pertinent historical events, potential bioeffects, and update applicable developments related to lasers in the modern aviation environment, especially the threat they pose to vision and visual performance. It will present FAA data regarding current exposure incidents involving civil and commercial aviation and some example cases involving military aircraft. **APPLICATION:** The issues addressed in the tutorial will heighten awareness of the current laser threat impacting worldwide air operations and existing defensive strategies available to aircrew to mitigate the impact of an exposure on flight safety.

Learning Objectives

1. Update attendees on the nature of the laser threat and its potential to disrupt air operations.
2. Familiarize attendees on the potential bioeffects of laser beams to the eye.

[397] BINOCULAR VISUAL FIELD LOSS IN A COMMERCIAL BALLOON PILOT: A CASE REPORT

Harriet Lester[1], Doug Ivan[2], Benisse Lester[3], Leo Hattrup[4]
[1]*FAA, Jamaica, NY, United States;* [2]*Retired, San Antonio, TX, United States;* [3]*Retired, Washington, DC, United States;* [4]*No institution, Alexandria, VA, United States*

(Education - Case Study)

INTRODUCTION: This report describes a balloon pilot with dense binocular visual field defects subject to the FAA rule signed 11/16/22 mandating that airmen must hold at least second class medical to exercise the privileges of a commercial pilot certificate in a balloon for non-instructional flight. **BACKGROUND:** NTSB DCA16MA204 involved a hot air balloon that struck power lines near Lockhart, TX on 7/30/16, resulting in 16 deaths. The pilot was exercising the privileges of a commercial pilot on this part 91 flight. NTSB concluded that impairing medical conditions and medications; and no FAA requirement for a medical certificate for commercial balloon pilots, were contributing factors. Prior to this accident, no commercial balloon accidents in the United States were specifically attributed to medical deficiencies. Following implementation of the new FAA rule, this pilot was no longer eligible to fly due to dense binocular visual field defects and monocular loss of visual acuity. Literature review indicates that balloon accidents are most commonly associated with ground impact and collision with objects, including power lines—these risks would be exacerbated by the pilot's deficits. **CASE PRESENTATION:** A 63 year old pilot with approximately 2000 hours, and over 35 years of flight experience without

accidents, applied for an FAA Class 2 medical certificate in compliance with the new FAA rule. He lost visual field in both eyes and central acuity in the left eye approximately 20 years prior, attributed to non-arteritic ischemic optic neuropathy (NAION). The right eye was 20/20 uncorrected, the left eye corrected to 20/400. The right eye had a dense inferior defect, and the left eye had three quadrants of field loss, also involving inferior field. Optic nerve findings were consistent with field defects. **DISCUSSION:** Review of balloon related case fatalities in the FAA database revealed a single fatal accident subsequent to the new rule requiring Class 2 medical certificate, and the preliminary NTSB report did not suggest medical attribution. NAION causes permanent visual loss, which can be bilateral, as in this case. Notwithstanding his successful balloon flying history and apparent adaptation to his significant deficits, the loss of useful visual acuity in one eye, combined with dense overlapping binocular inferior field defects, were deemed incompatible with aviation safety. The airman was issued a final denial.

Learning Objectives

1. Have knowledge of the FAA rule signed November 16, 2022 mandating that airmen must hold at least second class medical to exercise the privileges of a commercial pilot certificate in a balloon for non-instructional flight.
2. Understand the need for visual field functionality in aviators, including balloon pilots.
3. Be aware of the 2016 fatal accident that led to the FAA rule mandating that airmen must hold at least a second class medical to exercise the privileges of a commercial pilot certificate in a balloon for non-instructional flight.

[398] ANTI-VEGF INJECTIONS IN USAF AIRCREW: IT'S WORTH A SHOT!

Michael Parsons
FAA, Beavercreek, OH, United States

(Education - Tutorial / Review)

INTRODUCTION: Manned aviation has from its inception required excellent visual perception. While there have been many advances in aiding the human weapon system when it comes to flight, the human sense of vision remains essential to safe, efficient and effective functioning. When vision is compromised or challenged, this impaired special sense contributes to safety risk. **TOPIC:** Retinal vascular disease is a common cause of decreased vision in the United States and around the World. In the population of US Air force aviators it is relatively uncommon, however when it happens, it threatens mission success and it threatens permanent vision loss. While there have been medical interventions for this problem for decades, it only relatively recently that carefully engineered medications called anti-vascular endothelial growth factor (VEGF) can be delivered to the site of pathology and alter the course of disease for the better. These medications directly bind the growth factors that cause new and leaky blood vessels to form in the aftermath of ischemic disease, preventing retinal bleeding, fluid leaking, retinal scarring and retinal detachment. As the sensory tissue of the eye, the human retina does not often heal well from scarring. These medications aim to minimize this damage and preserve the eye's ability to help turn light into vision. **APPLICATION:** Discuss the use of anti-VEGF therapy for retinal vascular diseases and potential sensory challenges for duties in the aviation environment.

Learning Objectives

1. The participant will learn about the unique visual challenges associated with retinal vascular disease in its relationship to the unique demands of manned flight.
2. The participant will be able to describe several ways to manage retinal vascular disease, along with their relative risks, benefits and shortcomings.
3. The participant with leave with a better understanding of the role of anti-VEGF in the treatment of retinal vascular disease.

[399] BALANCE, HEARING AND UNMANNED AERIAL VEHICLE OPERATIONS

John Allen[1], Harriet Lester[2]
[1]*Star Harbor, Dagsboro, DE, United States;* [2]*FAA, Jamaica, NY, United States*

(Education - Program / Process Review)

BACKGROUND: The use of Unmanned Aerial Vehicles (UAV) is growing exponentially in the US and around the globe. The safe operation of UAVs may be impacted by health conditions, but are hearing and balance among those concerns? The USAF requires UAV operators to meet the requirements of AFI 48-123, which spells out hearing standards, while the FAA has no specific medical requirements for UAV operations. **OVERVIEW:** Statistics show a rapid increase in UAV demand, both in the military and for civilian/commercial purposes. Civilian/commercial applications may be conducted in open field conditions, with virtual reality headsets, or with video screen displays. Military applications typically employ video screen displays. Traditional aviation piloting includes the entirety of sensory modalities (visual, auditory, vestibular, kinesthetic, proprioceptive) which contribute to situational awareness in flight. However, piloting a UAV is dependent largely on just the visual system. This raises the question of to what degree will the absence of these other stimuli impact performance and overall safety of flight. There is significant literature that addresses the impact of UAV operations on behavioral health, but not on hearing or balance. Anecdotal reports suggest that UAV operation results in "dizziness" which adversely impacts operations. These reports are from individuals operating their own drones, largely for entertainment purposes. There is an absence of rigorous studies of vestibular impacts by commercial and military operators. Additionally, there is no evidence that hearing loss impacts UAV operations. **DISCUSSION:** The absence of literature indicating the potential negative impact of UAV operations on vestibular or auditory function should not suggest that these impacts do not occur. The presence of Menier's Syndrome may have significant challenges in or concerns about drone operation. Nor should the absence of data suggesting that degraded auditory function adversely impacts the ability to pilot UAVs. In fact, significant hearing loss may be present in an individual who very effectively controls UAV operations. Of course, in a military operational environment this would not be acceptable. In addition, there are several reports suggesting the potential impact of drone noise on hearing and on annoyance to communities where they are used. These will be reviewed. In addition, a proposed survey of UAV operators focused specifically on individual sensory systems (auditory, vestibular, visual) will be presented. Recommendations where further investigation is needed will also be discussed.

Learning Objectives

1. Participants will understand the breadth of UAV use in the US and across the globe.
2. Participants will understand the impact of hearing and balance problems on drone operations.
3. Participants will understand federal regulations that pertain to UAV operations.

[400] TOXICOLOGY FINDINGS IN FATAL GENERAL AVIATION SPATIAL DISORIENTATION ACCIDENTS

Jason Sigmon, Hannah Baumgartner, Austin Ciesielski, Russell Lewis
FAA, Oklahoma City, OK, United States

(Original Research)

INTRODUCTION: Spatial disorientation (SD) mishaps are a well-documented threat in general aviation (GA) and altered cognitive states due to the use of alcohol or other prohibited drugs (illicit, over the counter, and prescription) may enhance a pilot's susceptibility to SD in flight. A retrospective review of toxicology findings in fatal SD accidents was undertaken to begin to document the link between these potentially altered mental states and the incidence of SD accidents. **METHODS:** The National Transportation Safety Board's CAROL database was queried for final accident reports in GA fixed-wing operations from 2003-2021

that contained the term "spatial disorientation" in the factual narrative, probable cause, or finding text. Final accidents reports meeting this criterion were evaluated for overall trends across reports, including toxicology findings if available. Ethanol results potentially due to microbial formation were excluded. **RESULTS:** Out of 367 final reports that involved fatal GA accidents with SD, 30% (n = 109) included positive toxicology findings for the pilot. The most frequently identified drug classes included sedative antihistamines (n = 28), antidepressants (n = 22), and tetrahydrocannabinol (n = 14). Out of 33 positive ethanol cases, 4 were consistent with antemortem consumption of alcohol. There was a slight increase in positive toxicology findings over the 18-year period, with a peak of 9 accidents in 2021. While most pilots had valid FAA medicals on file, the majority of pilots without valid FAA medicals or BasicMed requirements had positive toxicology results (n = 10 of 13). **DISCUSSION:** Determining the current incidence between positive toxicology findings for potentially impairing substances in SD fatal accidents in GA is a critical to understanding SD vulnerabilities. Nearly a third of all fatal SD accidents in GA were associated with positive toxicology results, some of which, such as antidepressants, suggested a non-reported, potentially impairing condition. However, the presence of these positive toxicology findings does not necessarily imply impairment at the time of the SD accident. Future research should further examine the link between the use of prohibited substances and how that may impact the risk of SD.

Learning Objectives

1. The participant will learn about the findings for this original research and the NTSB Safety Research Report on Drug Use Trends in Aviation.
2. The participant will learn about the current trends in general aviation accidents involving fatality and post-mortem toxicology for potentially impairing medications, illicit drugs and alcohol.
3. The participant will learn about current incidence and highest injury level in fixed wing general aviation accidents involving a probable cause of spatial disorientation.

Thursday, 06/05/2025 ***3:30 PM***
Centennial Ballroom III

[S-73] SLIDE : SUPER MODELS: PREDICTING RESPONSES TO SPACE

Chair: Kristian Mears
Co-Chair: Michael Harrison

[401] IMMEDIATE MEDICAL EMERGENCY MANAGEMENT IN SPACE: A SYSTEMATIC REVIEW OF STRATEGIES AND PRACTICES

Susana Alves, Mariana Peyroteo, Luís Lapão
NOVA School of Science and Technology, Almada, Portugal

(Original Research)

INTRODUCTION: With plans to return to the Moon and explore Mars, long-duration missions beyond Low Earth Orbit (LEO) will soon become a reality. Medical self-sufficiency will be vital as astronauts operate far from Earth, where crews can't depend upon reliable logistic depots, and early return might not be feasible. While studies have discussed medical autonomy, no prior research has analysed the current strategies for the immediate management of medical emergencies in space missions in LEO and beyond, specifically examining preparedness and response strategies as defined by the Federal Emergency Management Agency. **METHODS:** This systematic review adheres to Joanna Briggs Institute and PRISMA guidelines using the PICO framework. To answer the question "How are astronauts' medical emergencies managed during human Spaceflight?" a literature research was conducted across three databases: PubMed, Scopus and Web of Science. Publications from the last 40 years, including journals, conference proceedings, and books, that address any aspect of managing medical emergencies on space missions, were included. Exclusions applied to articles not published in Portuguese or English, those focused on mitigation or recovery phases, and physiological studies. **RESULTS:** Out of 4868 articles, 84 articles met the inclusion criteria. Preparedness was addressed by 61 articles (62.9%), and response by 36 (37.1%), with overlap in some studies. Studies were categorised into personnel, procedures, and equipment. For preparedness, 17 studies (14.3%) explored personnel training, 39 (32.8%) focused on contingency planning, and 44 (36.9%) examined medical kits and diagnostic tools. For response, 12 studies (10.1%) focused on personnel's ability to manage emergencies, 10 (8.4%) on protocols, and 24 (20.2%) on equipment effectiveness. **DISCUSSION:** Preparedness dominated the literature, yet more attention is needed to test decision-making, protocol adequacy, and equipment functionality under realistic, high-stress conditions. Although injuries and fractures are the most probable emergencies in space, future research should prioritize preparedness and response strategies for more critical medical events such as decompression sickness and complex multi-astronaut events. Another finding was the focus on mitigation, leaving gaps in immediate emergency management research. Additionally, advancing medical technologies and decision-support systems will be critical for deep-space exploration.

Learning Objectives

1. Learn the current preparedness and response strategies for managing medical emergencies in space missions.
2. Identify the gaps in research and practical application of immediate emergency management in space.

[402] ARTEMIS II MISSION MEDICAL RISK: A COMPARISON OF THE IMPACT AND IMM MODELING TOOLS

Arian Anderson[1], Ariana Nelson[2], Derek Nusbaum[2], Gina Vega[2]
[1]*University of Colorado School of Medicine, Aurora, CO, United States;* [2]*UTMB, Galveston, TX, United States*

(Original Research)

INTRODUCTION: The Artemis program aims to return astronauts to the Moon to test novel technologies and maintain a long-term presence off planet in preparation for human missions to Mars. NASA has developed modeling tools that predict medical events and outcomes to aid mission planners in the development of medical systems for these complex mission profiles. While the Integrated Medical Model (IMM) tool was operationalized for medical system development on the International Space Station (ISS), it does not have the capability to model lunar surface missions. As a result, NASA recently developed the Informing Mission Planners via Assessment of Complex Tradespaces (IMPACT) tool to meet this need. This presentation aims to compare the IMM and IMPACT results of a simulated Artemis II mission to demonstrate its capabilities. **METHODS:** The IMM and IMPACT tools were used to independently model the Artemis II mission. This mission was composed of 4 crewmembers, 1 female 3 males, on a 9-day mission aboard the Orion capsule with a 13.3kg medical system. Outcome metrics for both tools included medical events, crew mortality, medical evacuation, effects on crew performance, and medical resource requirements. Conditions specific to extravehicular activity (EVA), partial gravity, and long duration flight were removed. Both tools were optimized for crew performance with 500,000 trials performed to reach risk metric convergence. **RESULTS:** IMM and IMPACT had similar risk profiles for crew mortality (0.0002 vs 0.0001 events/mission) and performance effects (95.64% vs 94.062%), but different rates of medical evacuation (0.003 vs 0.006 events/mission). Outputs from both tools revealed the conditions most likely to impair performance were space adaptation related. Mortality and medical evacuation risk were most influenced by infectious conditions in IMM and environmental exposures in IMPACT.

DISCUSSION: Both tools performed similarly and predicted a very low overall mission medical risk for Artemis II, however both had limitations. IMPACT likely overpredicts conditions for short missions that are typically associated with long duration flight while IMM cannot model more complex profiles. For future missions, the IMPACT tool is anticipated to produce more valuable results for mission planners developing medical systems for missions beyond LEO.

Learning Objectives

1. Understand the utility of medical risk modeling tools applied to human health and performance in spaceflight.
2. Compare and contrast the IMM and IMPACT results and methodology.
3. Understand the limitations of each tool and how they may be used for future human spaceflight missions.

[403] WITHDRAWN

[404] WITHDRAWN

[405] EVALUATING THE USE OF GENERATIVE AI FOR LARGE SCALE LITERATURE SCREENINGS IN SPACE MEDICINE: A COMPARTIVE STUDY OF LLMS AND HUMAN REVIWERS

Satyam Patel[1], Christopher Janssen[2], Johnathan Szeto[3], Krishi Korrapati[4], Cooper Lytle[4], Stephen Kunkel[5], Ghufran Syed[6]

[1]*University of Wolverhampton, Wolverhampton, United Kingdom;* [2]*Texas A&M University College of Medicine, Bryan, TX, United States;* [3]*Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA, United States;* [4]*Chicago Medical School at Rosalind Franklin University, Chicago, IL, United States;* [5]*UTMB, Galveston, TX, United States;* [6]*University of California Los Angeles, Los Angeles, CA, United States*

(Original Research)

INTRODUCTION: The rapid development of commercial spaceflight has created a need for comprehensive medical screening protocols, particularly in fields like immunology, microbiology, and radiation oncology. The AsMA Commercial Spaceflight Ad-hoc Committee's Immunology working group conducted a scoping review of existing literature, assessing over 10,000 abstracts. The high volume led to the exploration of artificial intelligence (AI) and generative Large Language Models (LLMs), Gemini 1.5, LLaMA 3.2, and Claude, to streamline and support the preliminary screening process. This study evaluates the effectiveness of LLMs in facilitating large-scale literature reviews and reducing traditional time and resource demands. **METHODS:** The LLMs were built to classify abstracts into "include," "exclude (do not review)," or "exclude but review for discussion", based on specific criteria related to immune dysregulation, microbiology, and radiation oncology in spaceflight context. A structured prompting framework was utilizing few-shot learning, chain-of-thought reasoning, and self-consistency techniques to guide the decision-making process. Human medical reviewers screened abstracts to establish an accuracy benchmark for comparison. **RESULTS:** Preliminary findings demonstrate that Gemini 1.5 can manage large-scale abstract screenings effectively, offering significant time savings. The models showed varying degrees of accuracy and consistency in comparison to human reviewers. Generative AI models performed well in excluding irrelevant papers, achieving a precision of 99.6% and a recall of 80.3%. However, they exhibited limitations in more nuanced classifications, such as "exclude but review for discussion" (precision: 0.54%) and "include" (precision: 7.69%). The overall accuracy of the LLMs was 79.3%, with a total of 10,200 abstracts reviewed. **DISCUSSION:** When deployed within a structured framework, Generative AI, such as LLMs models can be effective tools for high-volume literature screening. Human oversight remains critical for addressing ambiguities and ensuring accuracy in complex cases. This study supports the feasibility of a hybrid human-AI workflow, where LLMs handle initial screenings, allowing human experts to focus on more intricate classifications. Future research will explore refinements to LLM prompting strategies and assess their adaptability in specialized medical fields, aiming to establish best practices for AI integration in medical literature reviews.

Learning Objectives

1. Understand the Role of LLMs in Literature screening - Explain how generative Large Language Models (LLMs) such as Gemini 1.5, LLaMA 3.2 and Claude can be utilized to assist in large scale medical screening for fields relevant to commercial spaceflight.
2. Identify Workflow Integration Strategies - Describe the benefits and limitations of integrating LLMs into the literature review process, focusing on a hybrid human-Ai workflow where Ai handles the primary screenings and human experts manage complex decisions.
3. Discuss the necessity for human oversight to ensure accuracy and ambiguities in literature screening with using AI tools.

[406] BASELINE MEDICAL SYSTEM TRANSLATION FOR THE IMPACT MEDICAL DATABASE

Eric Kerstman[1], Shane Schwartz[2], Gina Vega[3], John Arellano[4], Binaifer Kadwa[5]

[1]*UTMB, Galveston, TX, United States;* [2]*Geologics Corp, Beverly, MA, United States;* [3]*KBR, Houston, TX, United States;* [4]*Aegis Aerospace, Houston, TX, United States;* [5]*NASA JSC, Houston, TX, United States*

(Original Research)

INTRODUCTION: As a successor to the Integrated Medical Model (IMM), NASA has developed a new evidence-based data-driven probabilistic risk assessment and tradespace analysis tool, known as IMPACT (Informing Mission Planning via Analysis of Complex Tradespaces). Whereas IMM focuses on medical risks and resources associated with International Space Station (ISS) and low earth orbit (LEO) missions, IMPACT estimates the frequency and consequences of medical conditions anticipated on exploration missions. IMM offers a series of baseline medical systems associated with typical mission types or Design Reference Missions (DRMs) as alternatives to optimized medical systems. The unique nature of IMPACT poses challenges to efficiently reproduce baseline medical systems in a compatible format. This effort seeks to define a practical, repeatable process for generating baseline medical systems suitable for typical DRMs within IMPACT, allowing requestors to prioritize questions pertaining to mission parameters independent of the available medical supplies. **METHODS:** While optimized medical systems can be expected to outperform a baseline system, they must be generated and validated for each request. Baseline systems will serve as standard reference points, performing consistently well across variations of an associated DRM, reducing time spent beyond the scope of the request generating medical kits. Prototype baseline systems were translated from ISS medical resources in IMM, and a preexisting medical system designed for the Orion vehicle. In consultation with subject matter experts, the provided resource lists were matched to similarly purposed resources in IMPACT. **RESULTS:** This approach preserved medical system integrity, offering the same treatment capabilities and reconciling differences in the medical resources and medical conditions between IMM and IMPACT. **DISCUSSION:** Demonstrating the practicality of this process and generalizability of the baseline medical systems establishes a framework for future translations. Each baseline system generated expands the scope of DRMs for which mission-focused analyses can be conducted. Previously identified resources can be quickly substituted for established equivalents in IMPACT, expediting the analysis of future NASA and commercial crew medical systems. This initial approach will ease future analysis of unique and proprietary medical systems likely to be proposed by commercial crew space programs.

Learning Objectives

1. The audience will understand the importance of developing baseline medical systems for medical probabilistic risk assessment models.
2. The audience with learn the process used to generate baseline medical systems for the IMPACT (Informing Mission Planning via Analysis of Complex Tradespaces) model from the IMM (Integrated Medical Model) for the ISS (International Space Station) and the Orion vehicle.

Thursday, 06/05/2025 ***3:30 PM***
Regency V

[S-75] PANEL: WHEN AVIATION MEDICINE IS GOING BEYOND CARE MEDICINE

Chair: Olivier Manen
Co-Chair: Jonathan Monin

Panel Overview: *The content and the approach of periodical examinations in aircrew have changed since the application of the European (EASA) regulations, one could say fewer medical considerations but more administrative procedures for the AME and AeMC. In parallel, care medicine has been developing for decades, particularly in terms of diagnostic techniques and therapeutical considerations. However, depending on the country where the aircrew is working or flying, the access to the GMP and/or specialized practitioners may be difficult, all the more as they may not have enough time or they may express few interests for asymptomatic patients because their first task is to treat whereas the AME's first objective is to prevent acute events. Finally, recommendations in care medicine may not be sufficient for aircrew. In that context, we should wonder if the only role of AME is to make assessment of aircrew suffering from pathologies with a diagnostic and treatment performed in care medicine. Couldn't we talk about a "super GMP" who is sometimes going beyond the classical recommendations for the screening, evaluation, treatment and follow-up, in order to improve the medical condition of aircrew and to optimize the fitness decisions? The panel will consist in five presentations: two of them will deal with coronary artery disease and the need to develop a specific protocol of screening in asymptomatic aircrew, including cardiac imaging modalities. The third presentation will be focused on sleep apnea syndrome and the role of AME in the early detection leading to more favourable decisions. A fourth presentation will express the major place of the aviation psychiatrist in the diagnosis and the follow-up of aircrew. As a synthesis, the fifth talk will use many examples in aircrew to explain why aviation medicine is a very exciting mode of modern medicine practice to promote the health and so a long life for patients in aviation.*

[412] THE CALCIUM SCORE : ADDED VALUE FOR THE AEROMEDICAL EXPERT OR FOR THE AIRCREW ?

Nicolas Huiban[1], Mélanie Gehant[1], Sébastien Bisconte[2], Laëtitia Marion[2], Jonathan Monin[3], Olivier Manen[3], François-Xavier Brocq[1]
[1]*French Military Health Service, Toulon, France;* [2]*French Military Health Service, Clamart, France;* [3]*French Military Health Service Academy, Clamart, France*

(Original Research)

INTRODUCTION: The coronary artery calcium score (CACS) is a key test for the risk stratification and an essential screening tool for coronary heart disease (CHD) in asymptomatic patients. In aviation medicine, the benefits could be extended to monitoring methods and determining the flight fitness of aircrews, as well as to optimized primary prevention. **METHODS:** A descriptive single-centre, cross-sectional study with retrospective data collection was carried out between June 2022 and August 2024 in our AeMC. The patients included were civilians and military in renewal visits. The risk factors included age, body mass index, cardiovascular heredity, smoking, diabetes, arterial hypertension and LDL hypercholesterolemia. The overall 10-year risk was estimated using SCORE 2 and MESA models. The CACS results defined the primary outcome. **RESULTS:** During this period, 31 subjects were included, exclusively men with a mean age of 54.4 years (sd 6.9) ranging from 40 to 74 years. Two-thirds were pilots and 61.3% [42.2-78.2] had a SCORE 2 of "high" to "very high". On the basis of the MESA score, mean coronary age was estimated to be 6.9 years older than physiological age and 7.8 years older using CACS. The Agagston score ranged from 0 to 3028, and was greater than 400 in 26.7% [95% CI: 12.3-45.9] of cases. It was above the 75th percentile of the reference population in 50% [95% CI: 31.3-68.7] of cases, leading to lipid-lowering treatment in 11 patients. Following a cardiological opinion, 7 coronary angiographies were performed, resulting 6 times in revascularisation procedures. In univariate statistical analysis, the SCORE 2 and MESA models had a correlation coefficient of 0.86 ($p<10\text{-}8$). For CACS, it was 0.41 with the SCORE 2 model ($p=0.028$) and 0.48 with the MESA one ($p=0.0084$). In the multivariate analysis, no statistically significant association was found between the risk factors tested and the CACS value or thresholds. **DISCUSSION:** The CACS is emerging as a valuable tool for promoting aircrew health and flight safety. In addition to providing a clearer level of cardiovascular risk, it appears to be a genuine screening test with direct consequences for the prevention and treatment of CHD.

Learning Objectives

1. The audience will understand that as part of a personalized approach to cardiovascular risk stratification, the calcium score can be considered as a genuine risk factor in its own right.
2. The audience will learn that, when assessing the fitness to fly of aircrew, the calcium score can be used to reclassify intermediate risk as low or high, and also contributes to raising awareness about the need for preventive measures.

[411] CORODIAG: A CORONARY ARTERY DISEASE SCREENING PROTOCOL FOR AIRCREW BEYOND THE RECOMMENDATIONS

Sébastien Bisconte[1], Gaëtan Guiu[1], Sonia Houssamy[1], Jonathan Monin[2], Erik Rebiere[1], Caroline Brescon[1], Mustapha Khezami[1], Nicolas Huiban[3], Laetitia Marion[1], Eric Perrier[2], Olivier Manen[2]
[1]*French Military Health Service, Clamart, France;* [2]*French Military Health Service Academy, Clamart, France;* [3]*French Military Health Service, Toulon, France*

(Original Research)

INTRODUCTION: Screening for CAD in asymptomatic patients is not standardized. However, many new tools are available, such as the Coronary artery calcium score (CACS). Nevertheless, an early diagnosis and appropriate risk stratification of CAD are essential for aviation safety. The aim of this study was to discuss the role of different cardiovascular assessment techniques (ESC SCORE 2 and CACS) to screen for CAD and predict treatment adjustments. **METHODS:** From October 2023 to April 2024, a prospective, monocentric study was conducted in aircrew with a significant SCORE 2. They underwent a CACS and treadmill stress test and/or CT scan for high cardiovascular risk. **RESULTS:** 241 subjects were included (97% male, mean age: 56.7 yo +/- 6.14, range 39-73 yo, 81.3% civilians). 52.6% had more than one cardiovascular risk factor (10% family history of CAD, 33% HBP, 4.4% diabetes, 7.5% with treated hypercholesterolaemia, 15% smokers). The mean SCORE 2 was 5.56% +/- 1.9 (79% high or very high risk) and the mean CACS was 126 +/- 284 (22% high risk). Investigations included calcium score (90.8%), stress test (83.8%), CT scan (34.4%), MRI or stress scintigraphy (15.3%) and/or coronary angiography (4.6%). We found 29% of coronary lesions or ischaemia. SCORE 2 was only predictive of the presence of a coronary lesion ($p<0.01$). CACS was clearly predictive of a coronary lesion and an impact on treatment and fitness ($p<0.001$). Stress test was not significant for either criterion. The findings have an impact on the aeronautical fitness in 16% of AM. **DISCUSSION:** In asymptomatic aircrew, the AME should play an important role in the screening and diagnosis of CAD. Indeed, coronary lesions may be found at early stage with a direct benefit when a preventive treatment is prescribed as it may avoid acute events, reduce the impact on the flight safety and lead to less disqualifications. Public health medicine could be inspired by this approach.

Learning Objectives

1. To have a clear idea of the hierarchy of screening tests for coronary artery disease in asymptomatic subjects.
2. To understand the distribution of cardiovascular risk factors among pilots.

[413] OBSTRUCTIVE SLEEP APNEA SYNDROME IN AIRCREW MEMBERS: IS OUR ROLE LIMITED TO FITNESS DECISION?

Jonathan Monin[1], Erik Rebiere[2], Gaëtan Guiu[2], Laëtitia Marion[2], Sébastien Bisconte[2], Nicolas Huiban[3], Caroline Brescon[2], Mustapha Khezami[2], Eric Perrier[1], Olivier Manen[1]
[1]*French Military Health Service Academy, Clamart, France;* [2]*French Military Health Service, Clamart, France;* [3]*French Military Health Service, Toulon, France*

(Original Research)

INTRODUCTION: Obstructive sleep apnea syndrome (OSAS) is a major issue in aviation medicine because it is responsible for sleepiness and higher cardiovascular risk, which could jeopardize flight safety. The aim of this study is to describe the management of OSAS in our AeMC, in order to study our role in both diagnosis and aeromedical assessment. **METHODS:** This is a monocentric retrospective study. The included population is composed of all aircrew members (AM) (civilian and military, pilots and others specialties) who had an examination in our AeMC between 2011 and 2024, with a history of treated OSAS. **RESULTS:** Our population consists of 206 AM with OSAS, 99% males, 72% civilians, 77% pilots, mean age 50,6 +/- 9yo. The AeMC prescribed the investigations which posed the diagnosis of OSAS in 42% of cases, especially in atypical situations: when there was no symptom (p=0.023) or only rare ones like nycturia (p=0.014) in comparison to those diagnosed elsewhere. Cardiovascular assessment was performed in 87% of cases, and maintenance of wakefulness tests (MWT) in 66% of cases, particularly in the last 5 years (p<0.01), and when the AM were not already unfit for another disease (p<0.01). MWT were <40min in 15 AM (11%) despite a normal Epworth score in 10 AM and an AHI<10/h in 14 AM. Finally, 86% of them were declared fit with limitations. The main predictive factors of unfitness were residual sleepiness (p<0.001) and psychiatric disease (p<0.001). Being diagnosed thanks to the AeMC seemed to be a protective factor (p=0.036). **DISCUSSION:** AeMC and AME should be involved in the diagnosis of OSAS, with a good knowledge of criteria. Indeed, this diagnosis can be performed before the onset of symptoms or complications, which can lead to more fit decisions. In accordance with the French Sleep Society guidelines, systematic MWT should be prescribed as the rate of residual sleepiness is comparable to the general population.

Learning Objectives

1. To understand the role of AME and AeMC in the diagnosis of OSAS.
2. To understand how to evaluate the risk of sleepiness in aircrew members with OSAS.

[414] THE AVIATION PSYCHIATRIST: AN ASSET FOR FITNESS DECISIONS BUT ALSO A MAJOR ROLE IN THE DIAGNOSIS AND FOLLOW-UP

Laëtitia Marion[1], Erik Rebiere[1], Sébastien Bisconte[1], Nicolas Huiban[2], Jonathan Monin[3], Olivier Manen[3]
[1]*French Military Health Service, Clamart, France;* [2]*French Military Health Service, Toulon, France;* [3]*French Military Health Service Academy, Clamart, France*

(Original Research)

INTRODUCTION: Military aircrews' psychological aspects are assessed, as somatic disorders, by military flight surgeons. Sometimes they must refer aircrews to an aviation psychiatrist. In this study, we focused on the contributions of this specialist for the flight surgeon, the aircrews and the command. **METHODS:** This is a retrospective study of the aircrews referred for the first time to the aviation psychiatrist of our AeMC between January 2022 and September 2024. We were interested in the characteristics of this population, the reasons why they were addressed, the diagnoses adopted, the fitness decisions and the indications of referring to the AeMC multidisciplinary concertation panel (AMCP) or to the French Military Aeromedical Board (FMAB). **RESULTS:** The population was composed of 105 aircrews (81% males, 69% officers, 58% pilots, mean age 35.9 +/-8.5yo). 63% of them were referred by a flight surgeon and 37% by an AeMC, for symptoms (59%), long sick leaves (7.6%), and behavioral disorder as in case of positive drug testing (5.7%). 68% did not have a past psychiatric medical history, and the aviation psychiatrist made 73% of the diagnoses. Adjustment disorders were diagnosed more frequently by the psychiatrist (p<0.001) in contrast to behavior disorders (p<0.01). 69% of the population had a specific follow-up by the aviation psychiatrist. Concerning fitness assessment, 59% of these cases were discussed in the AMCP and 42% were referred to the FMAB. 54% of aircrews were fit for fly. Adjustment disorders (p=0.01), neurodevelopmental disorders (p=0.041), personality disorders (p=0.041) and psychoses were risk factors for unfitness. **DISCUSSION:** We showed that aeronautical psychiatrists have a major role to play in diagnosis in a population that has no past psychiatric history for the most part. They are also important to take an aeromedical decision and provide psychiatric follow-up, which is to underline in this population often described as reluctant by fear of being declared unfit. It appears that follow-up by aviation psychiatrists is not synonymous of unfitness: except in cases of serious psychiatric disorders, it may help military aircrews to fly again after a psychiatric issue, always in concertation with the AeMC.

Learning Objectives

1. To highlight the importance of the aeronautical psychiatrist in terms of diagnosis, follow-up and aviation fitness.
2. To describe the population of aircrew addressed by flight surgeons and experts in aviation medicine to the aeronautical psychiatrist.

[415] SCREENING, PREVENTION, DIAGNOSTIC PROCESS, FOLLOW-UP… WHEN THE AEROMEDICAL EXPERT BECOMES A SUPER GMP

Olivier Manen[1], Sébastien Bisconte[2], Erik Rebiere[2], Gaëtan Guiu[2], Laetitia Marion[2], Nicolas Huiban[3], Mustapha Khezami[2], Caroline Brescon[2], Jonathan Monin[4], Eric Perrier[4]
[1]*French Military Health Service Academy, Clamart, Hauts-de-Seine, France;* [2]*French Military Health Service, Clamart, France;* [3]*French Military Health Service, Toulon, France;* [4]*French Military Health Service Academy, Clamart, France*

(Education - Program / Process Review)

BACKGROUND: In consideration of the periodicity and content of the aeromedical examinations, screening and prevention have not been considered very much by EASA. In some countries including France, the demographic medical population has led to difficulties to consult some specialized practitioners who sometimes have not time for asymptomatic patients. The cost of modern technologies can be a bar for GMP to prescribe investigations when firstly indicated by aeromedical concerns. Besides, medical recommendations frequently give the opportunity to the patient or practitioner to adopt an expectative attitude. Finally, many patients are far from the expected therapeutical objectives (diabetes, high blood pressure, CAD). In that context, we should question about the correct place of AME within the medical team of aircrew. **OVERVIEW:** In many medical situations, the AME will have to interfere with the GMP or to act as a medical expert to prescribe, check, explain, advise and perform the follow-up of aircrew as a potential or confirmed patient. In cardiology excluding CAD, asymptomatic atrial fibrillation, ventricular preexcitation and other rhythm or conduction disorders are clearly detected during the periodical examinations, as well as valvular heart diseases, for which investigations will be managed by the AME first. A complete physical exam gives the opportunity to look for clinical signs of (pre-)malignant conditions (skin cancers, lymphomas, thyroid or testicle lesions) but also conditions that lead to an earlier medical or surgical treatment (cardiovascular risk factors, hernia, varicose vein). Investigations that are prescribed for aeromedical reasons first (kidney stones, OSAS, deep veinous thrombosis) will finally have an impact on the health for the aircrew. **DISCUSSION:** AME not only are trying to optimize the flight safety but also have clearly a complementary role of GMP when acting in the following tasks: to promote an earlier or better screening, to push for a more complete checkup,

to advise a medical or surgical treatment, to check for sequelae, to require a perfect respect of the therapeutical objectives, to participate in the optimal follow-up, and finally to make the difficult but essential synthesis of a thick and complicated medical file with many investigations and a wandering diagnosis.

Learning Objectives

1. The audience will be aware of the limits of care medicine to optimize the flight safety and the health of the aircrew.
2. The audience will learn about the different modalities of interaction between the AME and the medical team of the aircrew before and after a medical condition.

Thursday, 06/05/2025 ***3:30 PM***
Hanover C/D/E

[S-69] PANEL: AMERICAN ASSOCIATION OF AEROSPACE MEDICINE SPECIALISTS'- AEROSPACE MEDICINE BOARD REVIEW COURSE

Chair: Jeffrey Jones
Co-Chair: Thomas Jarnot

Workshop Overview: EDUCATION: *Aerospace Medicine Board Review Panel* **INTRODUCTION:** *To assist American Society of Aeromedical Specialists members prepare for 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 to anyone interested in Aerospace and Preventive Medicine, the ASAMS education committee assembles topics for review by knowledgeable invited experts in the field. TOPICs and Speakers: Introduction to the Aerospace Medicine Board Exam- Jeff Jones; The Atmosphere- James Elliott; Hypoxia- Thomas Jarnot; Flight Dynamics- Dwight Holland; Q&A moderator- Jeff Jones* **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 their possible involvement in clinical Aerospace Medicine or AM applied 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*

[376] THE ATMOSPHERE

James Elliott
FAA, Fort Worth, TX, United States

(Education - Tutorial / Review)

This presentation will review the composition and physical properties of the atmosphere, including the common gas laws, altitude physiology, and regulatory guidance for supplemental oxygen use.

Learning Objectives

1. Describe the relationship between the volume, the pressure, and the temperature of a gas per Boyle's and Charles' Laws.
2. Given the atmospheric pressure at a specific altitude, calculate the partial pressure of oxygen at that altitude.
3. List the cabin altitudes where supplemental oxygen is required IAW 14 CFR Part 91.211.

[377] AIRCRAFT CONTROL SURFACES, AERODYNAMICS AND CONSIDERATIONS

Dwight Holland
Human Systems Integration, Roanoke, VA, United States

(Education - Tutorial / Review)

This presentation will review the key topics on theory of flight—aerodynamics for fixed and rotary winged aircraft, and the factors affecting lift, thrust, and drag (different types). Other topics include the physics of producing lift, wing camber, and how lift and angle of attack are related, and what factors can degrade lift. Review will also be offered on how modern aircraft and helicopters are controlled with various control surfaces will be highlighted, and countering torques produced by spinning propellors or rotors, whether single engine, multiengine, or helicopter operations.

Learning Objectives

1. This presentation deals with various aspects of aircraft and helicopter control in three axes. The learner will understand basic aircraft control aspects and surfaces after attending this presentation.
2. This presentation looks at the aerodynamics and basic physics of propellors, control surfaces, and the concepts of lift and different aspects of drag. These basic aerodynamic properties will be covered at the appropriate level for the Aerospace Medicine Board exam.

[378] HYPOXIA

Thomas Jarnot
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Tutorial / Review)

This presentation will review typical categories of hypoxia, associated physiology, common examples with signs and symptoms, and operational significance/considerations for the aerospace medicine practitioner.

Learning Objectives

1. Describe four basic types of hypoxia and associated physiology.
2. Discuss common chronic hypoxia situations with corresponding signs and symptoms.
3. Review the operational significance of hypoxia in the aerospace environment.

FRIDAY, JUNE 06, 2025

Friday, 06/06/2025 ***7:00 AM***
Hotel Lobby

[S-77] WORKSHOP: TROPICAL AND SUBTROPICAL MEDICINE: OPERATION STONE MOUNTAIN

Chair: Brian Pinkston
Co-Chair: Cheryl Lowry

Workshop Overview: INTRODUCTION: *Aerospace Medicine practitioners find themselves in austere environments around the world, from providing critical care patient support to recovering aircraft or spacecraft. Atlanta is considered a subtropical climate which provides a laboratory environment for tropical as well as temperate zone medical topics. Topic: Members of the aerospace medicine community may be called upon to provide travel medicine counseling, conduct medical mission planning, or unexpectedly find themselves in a survival situation in these environments.*