

Learning Objectives:

1. The audience will gain insight on General Aviation pilots' ability to interpret aviation weather products.
2. The audience will understand the implications of recycling traditional aviation weather product symbols and coding in new interactive weather product displays.

5:15 PM

[207] EXPANDING THE FRONTIER OF HUMAN FACTORS DESIGN: USABILITY TESTING COGNITIVE AIDS AND IMPLICATIONS FOR AEROSPACE MEDICINE

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(Education - Program / Process Review Proposal)

BACKGROUND: Critical event cognitive aids are an important tool in medicine and aerospace medicine. Although human factors design can assist with optimizing the functionality of these tools, an evaluation must be performed to ensure that the aid performs as intended. Usability testing provides a method of testing this functionality before the cognitive aid is introduced into real-life situations and may be particularly useful for new modalities such as mobile apps. **DESCRIPTION:** The first step in usability testing is *alpha testing*, which is an initial examination of the aid to find and fix problems. Next, beta testing is performed with subjects who represent those who will actually be using the aid (e.g. clinicians responding to in-flight emergencies). Ideally, beta testing will occur in a realistic environment (e.g. a flight training center) and under a variety of realistic conditions (e.g. low lighting, narrow aisle), but useful information can be gathered even if testing is performed in an empty conference room, with the clinician and the researcher sitting at a desk. Next, training should include time for the clinician to look at the aid, followed by a presentation explaining the features of the aid. Next, the subjects should work through a series of realistic, scripted scenarios, that are derived from real-life cases. These should incorporate a range of situations and can be timed for comparison. Examples include simple scenarios, such as hypoglycemia, and complex scenarios such as two sick passengers at once or a combative patient. The last scenario should require the clinician to pick a recently encountered situation and think through using the aid in that situation. A follow-up survey can ask about which aspects of the aid were useful, which could use improvement, and which could be adapted for that specific environment (e.g. the location of the oxygen tank and medical kit on a given airplane). **DISCUSSION:** Although usability testing originated in the software development domain, it can be successfully applied to medicine and aerospace medicine. Specifically, the design and features of new cognitive aids can benefit from usability testing, which can be performed quickly and with minimal cost.

Learning Objectives:

1. Why usability testing should be considered before introducing a new cognitive aid (such as an aid for in-flight medical emergencies) for aerospace medicine.
2. How to create a step-by-step plan for implementing usability testing for your cognitive aid.

WEDNESDAY, MAY 8, 2019

Wednesday, 05/08/2019
Brasilia 1

8:30 AM

[S-42] PANEL: U.S. NAVY AEROMEDICAL DISPOSITION – CHALLENGING CASES FROM NAVAL AEROSPACE MEDICAL INSTITUTE (NAMI)

Sponsored by Society of US Naval Flight Surgeons

Chair: Kai Yan Cheng

Co-Chair: Michael Adriano

PANEL OVERVIEW: This panel represents selected challenging cases from the Naval Aerospace Medical Institute (NAMI). NAMI is the center of

excellence for U.S. Navy (USN) and Marine Corps (USMC) aerospace medicine and is staffed by flight surgeons, aerospace clinical specialists, and support personnel. All USN and USMC aerospace medicine dispositions are made at NAMI. Annually, NAMI receives approximately 50,000 flight physicals from fleet flight surgeons throughout the world and conducts more than 5,500 clinical encounters in Pensacola, FL. This multi-disciplinary panel will highlight six challenging cases dispositioned by NAMI in the past year. Case 1 highlights the importance of corneal topography and pentacam scans, Case 2 highlights the complexity of aeromedical evaluation for a male to female transgender pilot, Case 3 concerns an aviator with a history of anaphylaxis to fire ants, Case 4 reviews the significance of vertigo and the decision process for a return to flight recommendation, Case 5 describes a pilot with type 1 diabetes mellitus in remission, and Case 6 reviews a case of a pilot with obsessive-compulsive disorder.

[208] NAVAL AEROSPACE MEDICAL INSTITUTE (NAMI) CHALLENGING CASES: LOOK OUT FOR THOSE PECULIAR TOPOGRAPHIES

Kyle Dohm

Naval Aerospace Medical Institute, Pensacola, FL, USA

(Education - Case Study: Clinical / Human Performance)

BACKGROUND: Corneal irregularities such as keratoconus, post-operative ectasia, and scarring from trauma can yield corneal mapping images that are difficult to properly disposition with regards to meeting aviation standards. It is important to be cognizant of the nuances when analyzing corneal maps (i.e. topography, pentacam) in order to successfully disposition a myriad of cases that may present during an initial pilot flight physical. **CASE PRESENTATION:** Two female pilot applicants will be discussed. A 22-year old had previously undergone photorefractive keratectomy (PRK) in both eyes seven months prior. She had a moderate amount of pre-operative astigmatism without signs of corneal ectasia. The post-operative corneal topographies displayed inferior steepening in both eyes but the patient reported no visual symptoms, had excellent uncorrected visual acuity, and no pathological signs on slit lamp examination. A 25-year old had previously undergone phototherapeutic keratectomy (PTK) and PRK in 2015 in her right eye only for a central corneal scar and low refractive error. The right eye scar was due to a contact lens induced corneal ulcer in 2014. Her left eye was emmetropic without any scarring. Post-operatively she had excellent uncorrected visual acuity, but a residual (less dense) scar remained in her right eye. The patient had no visual complaints and no visual decline during glare testing. Both cases presented a challenge for final disposition for aviation duties. In the end, both were given clearance to start Naval flight training from an ophthalmic standpoint, but the 25-year old ultimately was not cleared due to other medical issues. **CLINICAL RELEVANCE:** These cases highlight the importance of thoroughly analyzing corneal map images for aviation duties. It is not enough to simply view the different corneal imaging maps and determine that red is disqualifying and green is qualifying. Nor is it acceptable to assume that if visual acuity is within standards there are no problematic visual entities present. Nuances will be discussed in order to give the clinician a better understanding of corneal topography and pentacam scans. A simplified topography criterion will be given so the non-eyecare provider can better determine when appropriate to consult a specialist for further investigation on indeterminate cases. Improper dispositions can have profound ramifications for safety of flight as well as career implications for those involved.

Learning Objectives:

1. The audience will be able to explain the significance of different corneal topographical indices.
2. The audience will be able to recall the simplified criterion to use for aviation screening when analyzing corneal topography for possible keratoconus or ectasia.
3. The audience will be able to recall that corneal mapping machines, such as the pentacam, do not account for refractive surgery or scarring in the normative database.

[209] TRANSGENDER AND MILITARY AVIATION: TO WAIVE OR NOT TO WAIVE: A CASE REPORT

William Nguyen, Benjamin Childers

Naval Aerospace Medical Institute, Pensacola, FL, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This case report describes a military helicopter pilot who underwent gender confirmation surgeries from male to female and is now seeking to become a military aviator as a transgender.

BACKGROUND: On the 30th of June 2016, the USA military announced a new policy accepting all transgender Service members. Moreover, since January 1st, 2018, the US military began accepting transgender applicants. This highly controversial decision has created significant challenges for military aviation from a medical standpoint. This specialized group of service members have more stringent medical requirements than general duty service members. **CASE PRESENTATION:** The subject is a 43-year-old prior military helicopter pilot, who trained and served as a male, ended his active duty service and subsequently sought treatment for his long-standing history of gender dysphoria. He underwent gender transitioning including sexual reassignment therapy which consisted of a mental health evaluation, medication, and gender confirmation surgeries to become a female. Three years after she completed her transition, having no physical or mental limitations, she applied to return to service as an active duty aviator. She was referred to Navy Aeromedical Institute (NAMI), Pensacola, FL for the following disqualifying conditions: gender dysphoria, unspecified anxiety disorder, gender confirmation surgeries, and maintenance medications associated with this condition. After thorough evaluation by NAMI specialists in Internal Medicine, Obstetrics and Gynecology, and Psychiatry, the member was dispositioned as Not Physically Qualified (NPQ) but multiple waivers of the Naval Aeromedical standards were recommended for the member to return to Duties Involving the Actual Control of Aircraft (DIACA). **DISCUSSION:** The significance of this case cannot be understated as transgender members are now serving in the US military. Each case is uniquely complex and deserves a full evaluation based on established standards for military aviation. The four major components that must be addressed, to determine if the member is physically and mentally fit to perform aviation duties, are mental health, stability of maintenance medication, surgical complications (if any), and ongoing surveillance.

Learning Objective:

1. Understand the medical considerations for the application of a transgender person for military aviation.

[210] USING RAST TO FIND ETIOLOGY OF ANAPHYLACTIC REACTION IN A MILITARY PILOT: A CASE REPORT

Yummy Nguyen, Kai Cheng

Naval Aerospace Medical Institute, Pensacola, FL, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This case report describes a fixed wing military instructor pilot who experienced an anaphylactic reaction to an unknown substance, later diagnosed with an allergy to fire ant venom. **BACKGROUND:** Signs and symptoms of anaphylaxis, such as pruritis, rash, flushing, hypotension, and angioedema of the face and airways, can have rapid onset and significantly impact a pilot's ability to safely operate an aircraft. While a history is anaphylaxis is disqualifying for naval aviation, waivers are considered in cases where triggers are identified and avoidable. **CASE PRESENTATION:** The case involves a 31 y.o. military instructor pilot with approximately 1400 total flying hours. He presented to medical after experiencing coughing and shortness of breath, 30 minutes after completing yard work. After receiving an epinephrine auto injector, breathing treatments, and a brief observation period in an ER, his symptoms resolved without recurrence or need for additional treatments. The pilot did not recall of any exposure to a trigger of anaphylaxis, and his initial allergy evaluation was inconclusive. He was subsequently denied an aeromedical waiver based on a diagnosis of idiopathic anaphylaxis. However, further review of his initial presentation was significant for potential fire ant stings. The suspicion for a venom induced anaphylactic reaction was verified by a high fire ants IgE immunoassay. Based on this new finding the pilot was treated with venom immunotherapy and once stable on maintenance therapy was granted an aeromedical waiver to resume flight duties. **DISCUSSION:** This case highlights the significance of anaphylaxis in aviation and the measures to prevent a recurrence in flight. An aeromedical waiver is on a case-by-case basis and is contingent upon if the trigger for anaphylaxis can be identified and is avoidable. It should also be noted carrying an epinephrine auto injector alone does not sufficiently mitigate the risk of anaphylaxis in flight.

Learning Objectives:

1. Idiopathic anaphylaxis is WNR.
2. Proper medical evaluation can possibly identify etiology of unknown anaphylactic episode.
3. Waivers can be considered once members are stable maintenance immunotherapy.

[211] Vertigo in an Instructor Pilot

Charles Reese

Naval Aerospace Medical Institute, Pensacola, FL, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: A Challenging case seen at the Naval Aerospace Medical Institute was a USAF pilot serving as a Flight Instructor with the Navy who experienced a prolonged episode of vertigo following two training flights that were below 8,000' AGL. These flights occurred two days after two uneventful SCUBA diving evolutions down to approximately 100'. **BACKGROUND:** There is a well-documented increased risk of decompression sickness (DCS) in individuals who fly immediately following significant exposure to a hyperbaric environment. For this reason, there are specific guidelines for how long individuals should remain at site level following SCUBA diving before engaging in flight operations. The onset of vertigo following exposure to hypo- or hyper-baric environments could possibly represent Type II DCS. It could also be a manifestation of inner ear barotrauma or some other unrelated entity. **CASE PRESENTATION:** A 32-year-old active duty USAF pilot went spearfishing down to 100' with 2 uneventful dives following all appropriate SCUBA diving protocols. Two days later he had two aviation training missions that were below 8000' AGL. Approximately 90 minutes after the last flight he experienced significant vertigo. Evaluation by an Undersea Medical Officer identified gait instability, a positive Romberg and spontaneous left beating nystagmus. He was treated with a Treatment Table 6 course of hyperbaric oxygen. There was minimal improvement and no further hyperbaric treatments were performed. Meclizine provided some relief and symptoms diminished but persisted. ENT evaluation was consistent with right peripheral vestibulopathy. Vestibular evaluation identified a 59% reduced vestibular response on the left. Further treatment consisted of an aggressive course of prednisone and his symptoms resolved in approximately 30 days. **DISCUSSION:** Desequilibrium and vertigo significantly degrade performance and constitute a very real threat to safe flight operations. Regardless of cause, individuals with a history of protracted or persistent vertigo should be grounded until an etiology can be determined and they must be symptom free for an appropriate length of time before resuming flight duties. This presentation will discuss appropriate tests/clinical tools for evaluating vertiginous patients in the acute phase and then following recovery, what is required to establish a timeline for safely returning to flight duties.

Learning Objectives:

1. To be able to incorporate a series of physical examination techniques that will enhance the clinical evaluation of the vertiginous patient.
2. Develop a plan of action for evaluating a vertiginous aviator and knowing when it is appropriate to return that individual to flight duties.

[212] THE AEROMEDICAL DISPOSITION OF A MILITARY PILOT WITH TYPE 1 DIABETES MELLITUS IN REMISSION

Phillip Adriano

Naval Aerospace Medical Institute, Pensacola, FL, USA

(Education - Case Study: Clinical / Human Performance)

BACKGROUND / LITERATURE REVIEW: Type 1 diabetes mellitus is the result of insulin deficiency due to the destruction of pancreatic beta cell function, which can be autoimmune-mediated, acquired, or idiopathic. The disease is commonly associated with children or adolescents, but one-fourth of cases are diagnosed in adults. The initial presentation are similar across all ages exhibited by a modest elevation of plasma glucose to diabetic ketoacidosis. The differentiation between type 1 and type 2 diabetes mellitus in adults is more challenging given the increase prevalence of insulin resistance with age. There are no set

criteria and diagnosis is based on clinical characteristic and laboratory testing. Upon initiation of insulin therapy, many patients may temporarily regain endogenous insulin production, a period commonly referred to as the "honeymoon." However, the duration of this phase is highly variable lasting from several weeks to several years. Therefore, close monitoring of blood glucose is critical particularly if not receiving exogenous insulin. This case will highlight a military pilot with type 1 diabetes mellitus currently without an exogenous insulin requirement. **CASE PRESENTATION:** The subject is a 33yo USMC pilot with over 1 600 total flying hours presented to his flight surgeon with unexplained weight loss and polyuria was found to have high urine ketones, a random plasma glucose of 318mg/dL, and a hemoglobin A1c of 10.7%. Additional laboratory work-up was significant for an elevated GAD65 Ab and a normal c-peptide suggestive of type 1 DM. The pilot was initially placed on insulin glargine but was eventually discontinued out of concern for hypoglycemia. His follow-up demonstrates good glycemic control on sitagliptin verified by a repeat A1c of 5.8% **OPERATIONAL / CLINICAL RELEVANCE:** It is universally recognized that the use of exogenous insulin is disqualifying for Naval Aviation. Aviators with type 1 DM who have sufficient pancreatic beta cell function may not require exogenous insulin transiently. However, the duration of remission is unpredictable and highly variable. More importantly, the mechanisms to ensure adequate monitoring may not be conducive in an operational setting. The consequences of poor compliance may result in serious harm to the member and can be catastrophic to safety of flight and mission. Any consideration for an aeromedical waiver should take into account of these risks.

Learning Objective:

1. Review the aeromedical implications of type I diabetes mellitus.

[213] THE AEROMEDICAL DISPOSITION OF A MILITARY PILOT WITH OBSESSIVE-COMPULSIVE DISORDER IN REMISSION

Daniel De Cecchis

NMOTC, Naval Aerospace Medical Institute, Pensacola, FL, USA

(Education - Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This is a case report describing a military fixed-wing pilot with recurrent obsessive-compulsive disorder.

BACKGROUND/LITERATURE REVIEW: The 12-month prevalence of obsessive-compulsive disorder is 1.2% in the USA. It is characterized by the presence of obsession, compulsions, or both. These features are often time-consuming and associated with functional impairment of significant distress. This condition presents a unique challenge for Naval Aerospace Medicine. **CASE PRESENTATION:** The subject is a 42-year-old Navy pilot with over 2,900 total flying hours who first presented for mental health care several years ago and was diagnosed with OCD that developed in the context of a family member's hospitalization for an anaphylactic reaction. Obsessive cleanliness became a focus for this pilot in an attempt to ameliorate the significant anxiety he had regarding potential contamination of his home, car, or person. His ego-dystonic concern was that even a minuscule containment would cause an anaphylactic reaction. After a course of psychotherapy, along with an SSRI, the pilot was asymptomatic for several years. Symptoms re-emerged in the context of familial discord. A repeat course of psychotherapy along with maintenance pharmacotherapy with the SSRI allowed the pilot to achieve durable symptomatic remission; ultimately returning to flight duties.

OPERATIONAL/CLINICAL RELEVANCE: The most significant operational concern associated with most psychiatric conditions is the potential for sudden incapacitation in the context of the psychological and physiological stresses of flight. Maintenance pharmacotherapy allowed the pilot to achieve durable symptomatic resolution. After an extensive evaluation aeromedical evaluation process, the pilot was recommended for a waiver first to be a UAS mission commander for 1 year and then to return to duties involving the actual control of piloted aircraft.

Learning Objective:

1. Review the aeromedical implications of obsessive-compulsive disorder.

Wednesday, 05/08/2019

Brasilia 2

8:30 AM

[S-43] PANEL: A FEW LESSONS LEARNED, SOME CURRENT TRENDS, AND EVOLVING TECHNOLOGIES FOR ENHANCING HUMAN PERFORMANCE IN AEROSPACE SYSTEMS AND EXPLORATION

Chair: Dwight Holland

Co-Chair: Thais Russomano

PANEL OVERVIEW: This set of presentations is mostly focused on space-related issues for enhancing human performance from the perspective of past lessons, important current trends and recent research findings and issues, and evolving technologies that will likely be impactful for current and future space systems development. Topics include presentations on genetics changes in microgravity, how to sustain human life on long missions with food sources, the problems associated with food production in changing acceleration ("gravity") fields, and of course the age-old problem of ionizing radiation in space. Discussion will also include efforts by the analog environments community to evaluate new technologies and develop them for exploration class missions on the moon, to Mars, and perhaps beyond. Lastly, the session ends with a presentation on some evolving technologies that relate to Human System Integration and decision-making from displays to smart systems and robotics. At the end of the session, we will have a planned time for a Guided Panel Discussion among presenters, and a key invited guest or two with the audience questions, hot topics, and various paths forward.

[214] TRANSLATING MULTI-SCALE OMICS DATA FROM SPACE AND SPACE ANALOGS INTO PRECISION MEDICINE APPLICATIONS FOR ASTRONAUTS AND FLIGHT SURGEONS

Michael Schmidt

Sovaris Aerospace, Boulder, CO, USA

(Education - Tutorial Proposal)

INTRODUCTION: In order to prescribe drugs in space that minimize adverse events, optimize efficacy, and optimize mission performance, it is important that mission medical teams begin to adopt precision medicine practices founded on pharmacogenomics. **TOPIC:** Pharmacogenomics is a foundation of precision medicine in astronauts. Multi-scale omics studies such as the NASA Twins Study have provided insight into space-relevant molecular dynamics that represent potential countermeasure targets for flight surgeons. Pharmacogenomics is an application that enables the physician to tailor drug therapeutics to an individual astronaut genotype for the purpose of minimizing drug adverse events and optimizing astronaut performance. By relevant example, CYP450 3A4 is required for the metabolism of zolpidem (Ambien). In this case, zolpidem is the substrate. If circumstances in space also require the administration of clarithromycin (Biaxin; an inhibitor of CYP450 3A4), the co-administration of clarithromycin will diminish zolpidem metabolism and increase its effect. This may result in prolonging the effect of zolpidem into the operational daytime with potential adverse impact on mission execution or safety. Among the many considerations in the precision medicine application of drug prescribing are 1) individual astronaut genotype (governing gene-drug interactions), 2) drug-drug interactions, and 3) the effect of space on gene expression of drug metabolizing enzymes. Included among the relevant drug metabolizing genes (and proteins) in space are CYP4502D6, CYP3A4, CYP2C19, CYP2C9, CYP1A2, CYP2E1, and UGT. These account for the processing of most of the drugs on a mission drug list. Clinically, the critical phenotypes to identify are the poor metabolizers and the rapid metabolizers. **APPLICATION:** The need to collect pharmacogenomic data on all astronauts should be considered for all spaceflight research and clinical countermeasure development. The predictive power of standard pharmacogenomic data can be coupled with the genome, transcriptome, epigenome, and proteome data gathered from the NASA Twins Study in a manner that advances pharmacogenomics toward a standard practice in

human spaceflight. **RESOURCES:** Schmidt, MA, Schmidt, CM, Goodwin, TJ. Pharmacogenomics in Spaceflight: A Foundation of Personalized Medicine in Astronauts. In Handbook of Space Pharmaceuticals. Pathak, Y, dos Santos, M, & Zea, L, Eds. London: Springer Nature, 2018.

Learning Objectives:

1. The participant will be able to understand the basic premise of pharmacogenomics.
2. The participant will be able to understand the application of pharmacogenomics.

[215] THE EFFECTS OF HYPERGRAVITY AND RADIATION EXPOSURE ON PLANTS – PRELIMINARY RESULTS

Marlise dos Santos¹, Beatriz Souza¹, Débora Cunha¹, Thais Russomano², Phillipe Souvestre³, Ana Maria Marques¹, Felipe Escopel¹, Isabel Severo¹, Cintia Ribeiro¹, Everton da Silva Paz¹ ¹PUCRS, Porto Alegre, Brazil; ²Kings College London, London, United Kingdom; ³Aerospace Human Factors Association, Vancouver, Canada

(Original Research)

INTRODUCTION: Plant germination and growth are influenced by innumerable environmental factors, such as the level of gravity and type of radiation. Several plants have nutritive and medicinal value, making the importance of their cultivation and consumption during space missions unquestionable. Studies demonstrate that simulated hypergravity, through centrifuge exposure, increases seed germination, accelerates plant growth and modifies the metabolites produced by some plants. The radiation of space, either in Low Earth Orbit or deep space, could also positively impact on plant growth and metabolite production. The aim of this research was to evaluate the effect of Cobalt 60 radiation (ionizing radiation) alone or in combination with simulated hypergravity on arugula. **METHODS:** Twenty-four different protocols were used to evaluate the effect of Cobalt 60 (ionizing radiation, ranging from 3Gy to 40Gy) alone or combined with simulated hypergravity (+7G) on arugula. Plant growth was analyzed after 25 days (D-25) and 45 days (D-45) of cultivation, and also compared to a control group (1G, no radiation). **RESULTS:** Of the 24 protocols evaluated on D-25, 2 died, while 15 of the experimental group (6 radiation only and 9 radiation and hyperG exposure) presented better results than the control. Considering D-45, 4 died, while 16 (9 radiation only and 7 radiation and hyperG exposure) presented greater growth than the control. The greatest response in plant growth was observed with the highest level of radiation exposure (40Gy) combined with simulated hypergravity. **DISCUSSION:** Faster germination and increased growth of arugula seeds has been demonstrated when subjected to intermittent exposure to +7Gz. UV-C radiation (non-ionizing radiation) has also been shown to increase arugula production of antioxidant and polyphenol compounds. In this experiment, increased plant development at an early stage of growth (D-25) was seen in plants from the control group in only 7 protocols in comparison to the experimental group. This number reduced to four at D-45, suggesting that the growth of arugula can be affected by its maturation. This might indicate the need to wait for the adult stage of the arugula before evaluating the secondary compounds and gene profile for a better understanding of the effect of ionizing radiation either alone or combination with hypergravity exposure, which can impact on its nutritional and medicinal potential in the space environment.

Learning Objective:

1. The effects of hypergravity and radiation exposure on plants.

[216] SIMULATION-BASED TRAINING WITH EXPONENTIAL TECHNOLOGIES TO MAINTAIN HEALTH AND WELLNESS FOR ANALOG ASTRONAUTS LIVING IN ICE

Jesus Guerra, Jeremy Saget, Maria Harney, Susan Ip-Jewell, Reena Tolentino, Karan Ghatora, Jon Rochester, Nicholas Jewell, Nancy Mercado
Mars Academy USA, Van Nuys, CA, USA

(Original Research)

INTRODUCTION: Space medicine, human factors and “astropseudo-sociological” risks and challenges must be address and solutions found integrating innovative concepts, new paradigms, and exponential technologies. The recent successful onboarding of commercial space

industries has increased the interest for human space exploration in various sectors resulting in increased engagement in analog research, in particular, analog astronautics, *Mars Academy USA (MAU) Mars Medics Missions (MMM)*, conducts innovative scientific training programs offered on a monthly basis in low fidelity Mars analogue settings. **METHODS:** Aim is to offer experiential simulation-based learning in a full immersive setting to support the selection of highly trained analog astronaut cohorts for high-fidelity Mars analog sims. Analog studies aims to test group cohesion, collaboration, communication and conflict-resolution strategies that might help predicts team performance; establish baselines for a wide range of human cognitive, social and emotional factors; test viability of exponential technologies, such as VRAR and mixed reality using the “*Hololens*” technologies, as novel therapeutic tools in a multi-countermeasure program to mitigate or significantly reduce stress and anxiety in astronauts living in isolated, confined (ICE) environments. **RESULTS:** The data collected to-date will assist scientists to recommend strategies for crew composition and determine how best to support such crews while they are living in Space. We will discuss the results obtained during multiple MAU sim missions and the feasibility of implementing integrative medicine modalities and innovative technologies, such as, Body Mapping Art in VR using the google tilt brush, meditation VR, to address issues of stress, cohesion. **DISCUSSION:** To-date, the data shown from our on-going studies looks promising. Innovative, approaches incorporating exponential technologies will enable Humanity to “thrive” in extreme environments on Earth, in Space and Mars. New discoveries improving “state-of-the art” medical procedures and development of psycho-social countermeasures for training astronauts can be extrapolated for terrestrial benefits where challenges of Space can become accepted new paradigms on Earth.

Learning Objectives:

1. The participant will be able to understand the importance of exponential technologies for space exploration.
2. The audience will learn about using simulation-based learning tools, such as, VR/ARas a toll for educational training.
3. Discover new alternative methodologies for addressing mental health issues for space travelers and astronauts.

[217] APPLYING SURGICAL TRAINING PRINCIPLES FOR DEEP SPACE MISSION READINESS: BUILDING A CURRICULUM FOR SKILL ACQUISITION, PRACTICE, AND REAL-TIME GUIDANCE

Danielle Carroll¹, Eric Kerstman², Aenor Sawyer³, George Pantalos⁴
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(Education - Tutorial Proposal)

INTRODUCTION: Crew Medical Officer (CMO) proficiency in basic surgical procedures may contribute to crew health and safety in long-duration spaceflight beyond low-Earth orbit. The need for a concise but thorough training protocol warrants diligent planning in order to ensure crew preparedness for deep space missions. **TOPIC:** A review of the literature was performed, encompassing over forty papers geared toward surgical education and training, with the goal of delineating a streamlined pathway for the procedural training of a CMO without a formal surgical background. Lessons from these studies were integrated in order to generate a cohesive framework for building an abbreviated surgical training curriculum. Principles gleaned from the laparoscopic and endoscopic training guidelines published by the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) were also incorporated into the protocol. **APPLICATION:** As is true for any fine motor task, effective surgical training involves progression through the three phases of procedural learning (cognitive, associative, and autonomous) in order to achieve competence. The cognitive phase develops a fundamental understanding of the skills in question, including indications and contraindications for the procedures discussed. In the associative phase, learners develop an understanding of how discrete parts of a given task relate to one another through repetitive, deliberate practice and timely feedback. In the autonomous phase, individuals learn through sustained practice with the goal of performing a task with speed, efficiency, and precision. Our team has generated a model and timeline for procedural

training that incorporates lecture, demonstration, and hands-on practice using synthetic and fresh tissue models, first at 1-g and later in reduced gravity. As with any learned skill, spaced repetition is key for retention; we have incorporated virtual and augmented reality-based training segments to refresh these skills during a mission, as well as modules that provide real-time guidance for use in performance of these tasks on crewmates. **CONCLUSIONS:** An appropriate CMO training module should incorporate lessons learned in prior studies involving procedural education, in order to generate an efficient, effective, and versatile platform for surgical training of the non-surgeon. Such a program may be of use in a multitude of austere environments that have limited personnel with formal surgical training.

Learning Objectives:

1. The most relevant surgical procedures to preserve crew health in long-duration spaceflight beyond low-Earth orbit.
2. An approach for streamlining surgical training for non-surgeon Crew Medical Officers.
3. A means of preserving surgical skills for use when needed on deep space missions.

[218] EVOLVING TECHNOLOGIES FOR BEYOND EARTH ORBIT MISSIONS TO THE MOON, MARS, BASED UPON PAST AND CURRENT LESSONS LEARNED AND TECHNOLOGY DEVELOPMENTS

Dwight Holland

Human Systems Engineering Associates, Roanoke, VA, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Enhancing human performance in long-duration space operations, particularly away from Earth orbit will require a true comprehensive Systems Engineering and Management approach to safe and usable systems design. And, stable, communicative and adaptable organizational structures/culture across various levels to assure the best chance for mission success. Past experience, close calls, and tragedy can be traced through multiple systems levels problems systemically-- or through poor controls/displays and occasional management missteps and can be used as Lessons Learned for avoiding future problems. The integration of advanced technologies from a Human Systems Integration (HSI) perspective given the fast pace of technology improvements in multiple area will be a challenge to properly test and evaluate systems before launch, and after departure as updates are provided. **OVERVIEW:** Given that there is adequate macro-systems engineering and management at launch, key decisions before launch will be on what technologies-- and to what degree-- should be relied upon for mission enhancement and/or success. Areas of technology breakthroughs and concern that will be discussed (and tied back to past lessons learned when obvious) include: adaptive displays, predictive displays, levels of automation and status thereof (mode awareness), sophisticated decision-making systems, and when to just inform-- or to engage-- and the rapidly evolving Artificial Intelligence (AI)/Deep Learning capabilities that might be embedded in systems and robotics. The question of how "human" humanoid robots need (or should be), is particularly salient on long Moon and critical for Mars expedition stays. Other game-changing technologies such as Virtual/Augmented Reality Systems (VR/AR) will be incorporated into various systems to some degree from operational, to training and entertainment use. **DISCUSSION:** Thinking systemically, carefully incorporating these technologies seems reasonable, and worth trying to a degree. Historically however, over-reliance upon new technology has been problematic in every field of endeavor from polar exploration to aerospace systems in history. A thought question arises-- If we think in terms of Reason's well know "Swiss Cheese" model of mishap causation being a card deck shuffle of layers with holes in it; then how do we account for emergent factors where we NO LONGER HAVE the "same deck" of cards being shuffled we THOUGHT we had?

Learning Objective:

1. Complex systems design for Exploration Class space missions requires multi-level systems engineering and management competence and adaptability. A key component of this is good HSI in systems design at all levels. With this, the chance of mishaps large or small are increased.

Wednesday, 05/08/2019

8:30 AM

Brasilia 3

[S-44] PANEL: AEROSPACE MEDICINE BOARD REVIEW SERIES #1

Sponsored by The American Society of Aerospace Medicine Specialists

Chair: Timothy Burkhart

PANEL OVERVIEW: This panel will provide an opportunity for various aerospace medicine topics to be presented in a board review fashion. Topics may include subjects within the areas of the flight environment, clinical aerospace medicine, and operational aerospace medicine.

[219] DECOMPRESSION SICKNESS (HYPOBARICS/HYPERBARICS)

Rambo Yambo-Arias

U.S. Air Force, Colorado Springs, CO, USA

(Education - Tutorial Proposal)

INTRODUCTION: Decompression Sickness (DCS) can be a deadly or disabling condition. You must quickly recognize and treat DCS. **TOPIC:** Decompression Sickness occurs when there is a sizeable reduction in ambient pressure that causes the formation of bubbles in the human body. This rapid decompression can occur in a pressured aircraft cabin or in an altitude chamber. It can also occur when a scuba diver ascends too quickly to the surface. These patients can get sick very quickly, so it is important that you diagnose this condition correctly so that you can get them the appropriate treatment. A high index of suspicion and a thorough physical exam will be your most important aids in making this diagnosis. Once diagnosed, treat with the highest flow oxygen you have available. The bubbles that form in the body are made up of nitrogen because this gas is the most plentiful in the Earth's atmosphere. Therefore, treatment with oxygen will alter that gas gradient and help nitrogen diffuse out of the bubbles; this will reduce the size of the bubbles thereby reducing symptoms of DCS. To make a determination on whether the patient needs to be transported to a nearby hyperbaric chamber, use a decision tree based on the Type of DCS (I or II). Knowing the predisposing factors for developing DCS will help you in developing preventive measures for your aviators and divers. **APPLICATIONS:** This lecture will teach you how to quickly identify DCS so that the patient gets prompt treatment with high-flow oxygen. This treatment may save the patient's life or avert long-term complications. You will also learn how to mitigate the risk of DCS by understanding predisposing factors for DCS. **RESOURCES:** Stepanek J, Webb JT. "Chapter 3: Physiology of Decompressive Stress" in *Fundamentals of Aerospace Medicine*, 4th edition, ed. Jeffrey R. Davis, Robert Johnson, Jan Stepanek, and Jennifer A. Fogarty (Philadelphia: Lippincott Williams & Wilkins, 2008), 46-82.

Learning Objectives:

1. Define decompression illness (DCI), decompression sickness (DCS), and arterial gas embolism, and understand the predisposing factors for DCS, in addition to understanding what causes the symptoms and signs of DCS, and how bubbles may not be the direct cause of all of them.
2. Understand the incidence of DCS and how it varies based on the general setting. This will help to understand why pressurized aircraft cabins, altitude chambers, or diving can lead to DCS. Then describe what the pilot should do if they experience a rapid decompression.
3. Understand the importance of maintaining a high index of suspicion and conducting a thorough physical exam in diagnosing DCS and then be able to describe the three types of DCS and the treatment protocol for each. And, describe the different types of hyperbaric chambers.

[220] TRAVEL MEDICINE

William Nguyen

Naval Aerospace Medical Institute, Pensacola, FL, USA

(Education - Tutorial Proposal)

PROBLEM STATEMENT: Travel Medicine promotes healthy, safe and responsible travel of all people crossing international borders. The

goal is to prevent and mitigate illness and injury with focus on the specific destination of travel. **TOPIC:** In 2017, approximately 88 million U.S. citizens travel to international regions. Healthcare professionals must educate the travelers on the specific health risks associated with the location, risky healthy behaviors and recommend tailored preventative measures such as vaccines, chemoprophylaxis, self-treatment and personal preventive measures to assure an enjoyable experience while traveling and be able to return home in good health.

RESOURCES: 1. CDC Travel Health, <https://www.cdc.gov/travel>. 2. Shoreland Travax, <https://www.mhs.health.mil/TRAVAX/travax.cshtml>. 3. National Center for Medical Intelligence, <https://www.ncmi.detrack.army.mil>. 4. DHA Immunization healthcare Branch (MILVAX), <https://www.health.mil/Military-Health-Topics/Health-Readiness/ImmunizationHealthcare/Vaccine-Recommendations/Vaccine-Recommendations-by-AOR>

Learning Objectives:

1. The participant will have an overall perspective on travel medicine and the potential health problems associated with traveling internationally.
2. The participant will learn the risks and mitigations strategies for illness and injuries during travels.
3. The participant will be given resources to help with pre-travel counseling to specific regions.

Wednesday, 05/08/2019

8:30 AM

Brasilia 4

[S-45] PANEL: THE RISK ASSESSMENT IN AVIATION MEDICINE: PLACE YOUR BETS!

Sponsored by French Society of Aerospace Medicine

Chair: Olivier Manen

Co-Chair: Sébastien Bisconte

PANEL OVERVIEW: To have a clinical practice of aeromedical expertise is traditionally regarded as assessing a risk. But what risk exactly are we talking about? A risk of in-flight incapacitation, or a risk of medical events, on board or on the ground, possibly favored by aviation, and so a risk of unfitness? Airplanes are essential in the transmission of infectious diseases in relation to the movement of populations but also the promiscuity inside this vector. How much professional aircrews are concerned by this infectious risk? A literature study will be discussed. Periodical examinations are a good opportunity to give prevention measures in order to reduce heart diseases particularly. In the context of a minimal content of these visits according to the European regulations, what is the cardiovascular risk in aircrews nowadays? A recent survey will be presented. During a compressed time to examine aircrews, there are different methods to assess the global cardiovascular risk. But are the multifactorial equations better than the subjective evaluation? A comparative study will highlight advantages and drawbacks of both methods. Sleep apnea syndrome is probably under-estimated in aircrew population. Moreover, after a treatment, the risk of excessive daytime sleepiness remains statistically high. How to cope with this risk during the rehabilitation process? The notion of risk is theoretically the basis of the aeromedical decision-making process. However, the philosophy of expertise has changed, particularly in the civilian environment. As far as the AME is much more regarded as a "crewcoach" than a "winghunter", how can he integrate this risk into his practice?

[221] RISK ASSESSMENT FOR AIR CREW IN CASE OF COMMUNICABLE DISEASES ON BOARD

Vincent Feuillie

Air France, Roissy Charles de Gaulle, France

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: We present a bibliographical study on the risk assessment for aircrew in case of communicable diseases on-board. We will see how they have to manage this situation and to avoid to be contaminated. **BACKGROUND:** Air travel is now widely accessible, in

2017 airlines carried over 4 billion passengers. With this resulting increase in the numbers of international air travelers, there is a consequently greater risk of communicable diseases being spread by infectious travelers. During flight, the aircraft cabin is a ventilated, enclosed environment that exposes passengers and flight crew to close proximity to fellow passengers. The transmission of airborne infections between people in confined spaces such as aircraft cabins is of particular concern to health. **CASE PRESENTATION:** We found some reported outbreaks published of serious airborne diseases aboard commercial flights including tuberculosis, severe acute respiratory syndrome (SARS and MERS), influenza, Neisseria meningitidis, measles and rubella. No transmission on board have been established with viral hemorrhagic fever as Ebola virus disease. Some vector-borne tropical diseases have also the opportunity to be transported on board. One case report of plasmodium falciparum infected passengers has been documented after a long-haul flight. **DISCUSSION:** The aircraft cabin environment is presumed to be relevant to disease transmission due to close proximity of passengers, long duration of close contact during flight, confined space, mixing of passengers from disparate geographical regions, and large numbers of travelers that use the space with only limited cleaning/disinfection between uses throughout a given day. Control of biological agents in the cabin environment is primarily accomplished by two means: the environmental control system and surface cleaning. IATA has introduced some guidelines for cabin crew how to manage communicable diseases case on board and how to be protected with a universal precaution kit.

Learning Objective:

1. The audience will learn about the risk assessment for aircrew in case of communicable diseases on-board, and to see how the cabin crew have to manage this situation and to avoid to be contaminated.

[222] SHALL WE BET ON CARDIOVASCULAR RISK FACTORS?

Nicolas Huiban¹, François-Xavier Brocq¹, Laetitia Corgie¹, Jonathan Monin², Gaetan Guiu², Sébastien Bisconte³, Olivier Manen², Eric Perrier², Marc Monteil¹

¹French Military Health Service, Toulon, France; ²French Military Health Service, Clamart, France; ³French Military Health Service, Bordeaux, France

(Original Research)

INTRODUCTION: Cardiovascular prevention remains a key issue in aviation medicine. Validated risk models are adapted to different populations. Their current use allows to take various factors into account for primary prevention in clinical practice. The latest epidemiological studies have shown prevalence of cardiovascular risk factors (CVRF) such as hypertension or dyslipidemia that remains high despite some significant declines in the last ten years. We propose to extend this field of study to flight members as an original sample of the presumed healthy French general population. **METHODS:** The data come from a monocentric (AeMC Toulon) prospective cross-sectional study carried out between October 2017 and April 2018. The main objective was to describe the distribution of major CVRF: age by gender, serum lipids, blood pressure and related treatments, smoking, body mass index and diabetes. In addition, fasting glucose and waist circumference were used to assess the distribution of the metabolic syndrome (IDF criteria, 2005). **RESULTS:** A total of 2,792 persons aged from 18 to 74 were received during this 6-month period for initial or renewal examination for aeronautical license. If 39.5% of aircrew members were free from any risk factor, nearly a quarter was concerned with the association of at least two CVRF. These factors were clearly dominated by hypercholesterolemia (31.9% [CI95:30.2-33.6]) before gender-related age (19.6% [CI95:18.1-21.1]), smoking (17.4% [CI95:16.0-18.8]) and high blood pressure (12.6% [CI95:11.4-13.8]). According to the SCORE model, the proportion of people at high or very high risk seemed to be marginal (<2%) while nearly a quarter of flight members was at moderate risk. The prevalence of major CVRF will be discussed in comparison to data from the general population. **DISCUSSION:** At the French level, this survey represents the largest recent cohort of presumed healthy subjects for the description of the main CVRF, on the way of the 2006-2007 NNHS and the 2015-2016 ESTEBAN study. In our survey, the prevalence of CVRF appears to be lower. This trend is to be seen in the light of the selection process and the

close medical follow-up that aircrews benefit from, associated with the issued messages of prevention. The results underline that prevention strategies should target first and foremost people with moderate cardiovascular risk and encourage a greater respect for therapeutic goals in aircrews with a medical treatment.

Learning Objective:

1. To know the prevalence and the distribution of CVRF in the French aircrews.

[223] FEELING OR SCORING: WHAT IS THE GOOD WAY TO ASSESS THE CARDIAC RISK IN AIRCREW?

Sebastien Bisconte¹, Morgan Chasseriaud¹, Jonathan Monin², Nicolas Huiban³, Violaine Maricourt⁴, Sylvain Nguyen-Huynh¹, Olivier Manen²

¹French Military Health Service, Bordeaux, France; ²French Military Health Service, Clamart, France; ³French Military Health Service, Toulon, France; ⁴Angiologist, Bordeaux, France

(Original Research)

BACKGROUND: Airmen are subjected to periodic medical examinations during which aeromedical examiner searches for causes of sudden incapacitation in flight such as cardiovascular events. That's why cardiovascular risk prediction models should be used in clinical practice to identify high-risk populations. Gold standard scores are often time-consuming. For this reason, this assessment is frequently replaced by an empirical evaluation. The aim of this study is to compare global cardiovascular risk factor assessment by gold standard scores (Framingham score, ASCVD, Systematic Coronary Risk Evaluation) and by empirical evaluation. The secondary goal is to analyse the over- or under-estimated population by the empirical evaluation. **METHODS:** The global cardiovascular risk of over 40 yr old aircrew members (AM) examined for fitness assessment, including a regulatory blood test, at the aeromedical centre of the Bordeaux military hospital were assessed by an aeromedical examiner after clinical examination and, in a second time, compared with the results of three main cardiovascular factors risk scores. **RESULTS:** From 04/01/2017 to 03/31/2018, 564 AM [92.4% male, mean age: 48.6 yr +/- 6 y, range 40-75 yr, 70% military aircrew] was included. Cardiovascular risk factors were low prevalent: smoking 14.7%, obesity 11.2%, hypertension 24.1%, diabetes mellitus 3.2 % and treated or declared hypercholesterolemia 7.3 %. In our study, we observe a good correlation between the empirical assessment and the three main cardiovascular risk score results. In the underestimated population by empirical assessment, a majority of them didn't present cardiovascular risk factor as WHO defined it. In the over estimated population, empirical assessment takes into account all cardiac risk factors (Family history, diabetes, OSAS) and progressive risk factors for overweight and other factors normalize with treatment as hypertension and hypercholesterolemia. **CONCLUSION:** Empirical evaluation has a good correlation with cardiovascular risk scores but it's important to be aware of the reasons for misjudgment in some subpopulations. Each has their own limits and they are complementary.

Learning Objectives:

1. Discuss advantages and disadvantages of SCORE, Framingham and ASCVD.
2. Analyze empirical assessment technics.
3. Compare empirical and gold standard score assessment.

[224] OBSTRUCTIVE SLEEP APNEA SYNDROME IN AIRCREW MEMBERS: HOW TO EVALUATE THE RISK OF SLEEPINESS?

Jonathan Monin¹, Magali Sallansonnet-Froment², Gaëtan Guiu¹, Nicolas Huiban³, Sébastien Bisconte⁴, Sébastien Coste⁵, Eric Perrier¹, Olivier Manen¹

¹Aeromedical Center, Percy Military Hospital, Clamart, France; ²Department of Neurology, Percy Military Hospital, Clamart, France; ³Aeromedical Center, Sainte Anne Military Hospital, Toulon, France; ⁴Aeromedical Center, Robert Picqué Military Hospital, Bordeaux, France; ⁵French Military Health Service Academy, Paris, France

(Original Research)

INTRODUCTION: Obstructive sleep apnea syndrome (OSAS) is a major problem in aviation medicine because it is responsible for

sleepiness and higher cardiovascular risk, which could jeopardize flight safety. **METHODS:** Based on recommendations of the literature, some studies performed in the Aeromedical Center of Percy (Paris), and medical files of aircrew members with OSAS, the authors will discuss the investigations necessary for the return to flying duties, particularly the evaluation of the risk of sleepiness. **RESULTS AND DISCUSSION:** The diagnosis of OSAS is generally posed thanks to ambulatory sleep monitoring, and to polysomnography for atypical or complicated situations. In case of severe OSAS, a treatment by continuous positive airway pressure (CPAP) is generally proposed. For the fitness assessment, an evaluation of the CPAP efficiency is required, looking for a reduction or disappearance of apneas and hypopneas. Furthermore, it is important to have an objective proof of the absence of sleepiness. In this case, Epworth Sleepiness Scale is not sufficient and further evaluation is necessary. Many tests exist but maintenance of wakefulness tests are generally performed. The definition of a normal test in the aeromedical environment will be discussed. In addition, this evaluation should not be reserved to solo pilots only. **CONCLUSION:** In aircrew members treated with CPAP for a severe OSAS, the fitness decision depends on the treatment efficiency and tolerance, and on the cardiovascular risk. An objective proof of a good alertness is necessary to discuss a return to flight duties.

Learning Objectives:

1. To understand the arguments leading to a fit decision in aircrew members with OSAS.
2. To understand how to evaluate the risk of sleepiness in aircrew members with OSAS.

[225] IS A DECISION IN AVIATION MEDICINE STILL BASED ON A STATISTICAL RISK IN 2019?

Olivier Manen¹, Jonathan Monin¹, Gaëtan Guiu¹, Nicolas Huiban², Anne-Pia Hornez¹, Sébastien Bisconte³, Eric Perrier¹

¹French Military Health Service, Percy Military Hospital, Paris, France; ²French Military Health Service, Sainte-Anne Military Hospital, Toulon, France; ³French Military Health Service, Robert-Picqué Military Hospital, Bordeaux, France

(Education - Tutorial Proposal)

INTRODUCTION: The estimated risk of a medical in-flight incapacitation is theoretically the first argument for the aeromedical decision in aircrews. The historical 1% rule is regularly discussed and counterbalanced by different methods such as the 3D risk matrix previously presented in the NATO Aviation Cardiology Working Group panel. We could actually wonder if a precise statistical risk of events is still the key problem for the fitness decision, particularly in the civil environment considering the EASA regulations. **TOPIC:** The author will present several clinical situations in aircrews examined in Percy Aeromedical Center (Paris) for whom the whole risk was high or difficult to assess. With a help of some studies performed in the general population and in aircrews, he will comment the final decisions in the light of the estimated risk and the European regulations which have to be applied as a requirement and a guide. **APPLICATIONS:** One of the most common situations as coronary artery disease appears easy to allow a return to flying duties in airline pilots provided that there is no ischaemia. The residual risk after atrial fibrillation is variable, particularly when complicated of stroke, in relation to the sequelae, the possible recurrence and the adverse effects of anticoagulation, and yet the regulations are somewhat poor about this topic. The well-known risk of recurrence on the ground after a primary spontaneous pneumothorax does not take into consideration the potential effect of hypoxia and aerobatics. Surprisingly, the high risk of hypoglycaemia in relation to insulin-treatment has been refused in Class 1 and 2 pilots but accepted in LAPL pilots. Finally, the French attitude about the use of EEG during initial examinations for military applicants highlights the notion of a long-term risk. **CONCLUSION:** It seems that nowadays the knowledge of a statistical risk of a medical event is interesting to make the aircrew better understand his/her pathology and so the process of a temporary unfitness and a final decision by the aeromedical authority. However, the return to flying duties does not seem correlated to this risk most of the time, particularly in a multicrew civilian environment where a high medical risk is more and more accepted. Many other elements are actually part of the decision.

Learning Objectives:

1. The participant will be able to analyze the place of the statistical risk of a medical event in the aeromedical decision-making process in 2019.
2. The participant will be able to understand the other arguments to consider for the fitness assessment in confirmed pilots and initial applicants.

Wednesday, 05/08/2019
Brasilia 5

8:30 AM

[S-46] PANEL: FROM AVIATION TO SPACE

Sponsored by German Society of Aerospace Medicine (DGLRM)

Chair: Jochen Hinkelbein

Co-Chair: Oliver Ullrich

PANEL OVERVIEW: The topic of this panel of the German Society of Aerospace Medicine (DGLRM) is "From aviation to space". It provides an overview on aviation medicine related topics as well as space medicine related topics. The panel is sponsored by the German Society of Aerospace Medicine (DGLRM).

[226] AVIATION MEDICINE (AM) DURING WORLD WAR I (WW I)

Carla Ledderhose¹, Harald Potempa², Ralf Vollmuth²

¹German Air Force Centre of Aerospace Medicine, Fürstfeldbruck, Germany; ²Bundeswehr Centre of Military History and Social Sciences, Potsdam, Germany

(Original Research)

INTRODUCTION: Except for some previous preliminary work, AM emerged at the beginning of WW I in most European countries. The war both promoted and hindered its development. The rapid technical progress in aircraft construction caused by the war – leading to the first industrial series and remarkable production figures for this time – and a sudden increase in performance made AM, especially in its clinical orientation, a *conditio sine qua non*. Thus, it mainly focused on military needs in its early stages. AM could initially draw on the foundations and experiences from high-altitude medicine and aeronautics; its clinical orientation was only triggered by issues raised during the war. **METHODS:** comprehensive literature research **RESULTS:** One important factor for the developments of this time was the decision to subject candidates, and also pilots, to a selection process and physical fitness examination to minimize withdrawal rates and accident figures. This also led to a growing awareness of the necessity to have these examinations conducted by physicians specially trained in AM. Aeromedical research essentially dealt with the issues created by the increased aircraft performance, i.e. the development of O₂ equipment and masks, aviator goggles, safety belts and flying clothing, but started to look into acceleration-relevant issues as well. This spectrum was supplemented by sensory physiological topics and subjects of multiple load and mental overload. An innovation boost towards concrete training and vocation-related applications also occurred in the field of psychology. Groundbreaking papers were published on the development of survey tools for aptitude diagnostic selection procedures, psychological requirements analyses, and the determination of capabilities that pilots need to execute their tasks. **DISCUSSION:** As a result of WW I, most nations of the belligerent parties established examination centers to test pilot candidates and pilots for their fitness for flying based on clearly formulated – although often empirically generated – examination guidelines. In some countries, aeromedical laboratories were established to address the growing number of psychophysiological issues. In the USA, flight surgeon training was established as early as 1918. In post-war Germany, the Treaty of Versailles and the general conditions deprived AM of its research and work object. Thus, it lost its main content, stagnated and only recovered in the late 1920s and 1930s.

Learning Objectives:

1. Learn about the early beginning of aviation medicine.
2. Learn about the beginning of selection procedures in aviation medicine.

[227] "LARGE" OSTEOSYNTHESIS AND AEROMEDICAL ASSESSMENT

Torsten Pippig

German Centre of Aerospace Medicine, Fuerstenfeldbruck, Germany

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: 2016 214,000 Osteosynthesis of long tubular bones, 140,000 Spondylodesis, 238,000 artificial hip joints and 187,000 artificial knee joints were carried out in Germany. Military and civilian pilots had to undergo these procedures, there is however no information on the number. Important questions arise in the medical assessment of pilots: Which "large" Osteosynthesis can a pilot fly with again and when? **METHODS:** This presentation will focus on 5 different cases: Case 1: Military JET test pilot and class 1, 59 years, right hip TEP caused by Coxarthrosis. Case 2: Civilian helicopter pilot, ADAC, class 1, 42 years, open leg fracture, Osteosynthesis and approximately 30 revision operations due to complications. Case 3: Military pilot, EF-2000 Euro-fighter, 39 years, closed entire fracture of left forearm, Osteosynthesis and paresis of the left Nervus radialis. Case 4: Military flight student (JET) and class 1, 28 years, closed spiral fracture of the left humerus arm press, plate fixation without complications. Case 5: Board technician, E-3A "AWACS", 44 years, TLIF (cage and spinal fusion) of the lumbar spinal segment L5/S1 caused by a spondylolisthesis L5/S1, with secondary degeneration and instability. **RESULTS:** All 5 subjects appeared at the Orthopedic Department of ZentrLuRMedLw and the AeMC Fuerstenfeldbruck and underwent orthopedic and aeromedical examination and evaluation. 3 pilots (case 1, 2 and 3) were examined and found "unfit" for both military and civilian flying service. The further assessment was carried out within the framework of a military medical waiver and in the context of the proceedings of a civilian referral. In case of 4 flight medical was granted again after 3 months following bone healing and Osteosynthesis. Case 5 received an aeromedical waiver for further service as an E-3A onboard engineer. **CONCLUSIONS:** "Large" Osteosynthesis of the long tubular bones without complications can be appraised as "fit for flying service" following closed fracture healing and rehab. All implants, Spondylodesis and "large" Osteosynthesis with complications are to be initially regarded as "unfit for flying" (military and civilian). The expanded medical assessment is carried out in the context of an aeromedical (military) waiver and/or within the framework of a civilian medical class 1 referral. This procedure is usually subject to individual consideration and decision.

Learning Objectives:

1. The participant will be able to understand indication and outcome of "large osteosynthesis" and important questions for the aeromedical assessment.

[228] UPDATE TRAVEL PROPHYLAXIS FOR FLIGHT CREW - 2019

Joerg Siedenburg

Medical Service, Uetersen, Germany

(Education - Tutorial Proposal)

INTRODUCTION: Contagious diseases may affect operation of airlines. Many destinations are located in tropical and subtropical areas. Flight crews are exposed to a range of infectious agents. Therefore, up-to-date pre-travel advice, vaccination and malaria prophylaxis are critical for sustainable operations and well-being of flight crew. Anticipating outbreaks of contagious diseases is another important task. **DISCUSSION:** Malaria is a potential lethal risk in the tropics. Major risk area, especially for European carriers, is Western, to a lesser degree Eastern Africa. The infective agent (*Plasmodium falciparum* is most important) is transmitted by night-active, female *Anopheles* mosquitoes. Layovers rarely exceed 2 nights. Moreover, the risk is reduced by staying in 5-star hotels in urban areas. Nevertheless, meticulous exposure prophylaxis is highly recommended, chemoprophylaxis only in high risk areas. In case of suspicious symptoms after potential exposure malaria should be ruled out immediately to prevent complications or fatal outcome. A range of vaccinations is recommended for flight crew. Vaccinations against tetanus, diphtheria, whooping cough and measles are generally recommended, as well as hepatitis A and influenza vaccination. Others are recommended primarily for international operations, e.g. against poliomyelitis. Some countries require a yellow fever vaccination on arrival even from non-endemic ones, others only if travellers have visited endemic areas recently. A re-vaccination

every ten years is not required any more. Other travel vaccinations may be recommended on a case-by-case basis: hepatitis B, typhoid fever, meningococcal meningitis and tick-borne encephalitis. Vaccinations against rabies, Japanese encephalitis and cholera are only rarely indicated in flight crew, given their urban destinations. Even though traveller's diarrhoea is a common finding in up to two thirds of travellers, urban destinations and acquired knowledge about means of exposure prophylaxis (observing simple rules of hygiene) reduce the risk significantly. Rehydration and substitution of electrolytes is sufficient treatment. Laboratory diagnostics or antibiotic therapy are normally not indicated. Outbreaks of contagious diseases and epidemics may jeopardise air-traffic and the operation of airlines due to restrictions imposed by health authorities. Therefore, collection of the latest epidemiological data is a must to allow for timely reaction.

Learning Objectives:

1. Pre-travel advice and prophylaxis are imperative for flight crews. Malignant malaria (caused by *Plasmodium falciparum*) is a potential occupational hazard of flight crews operating in risk areas. Malaria awareness has to be encouraged.
2. Prevention consists of exposure prophylaxis, vaccinations, chemoprophylaxis and early diagnosis and treatment in case of malaria.
3. Besides traffic accidents malaria is the major lethal risk for crew operating in risk areas, which can be prevented by meticulous preventive measures.

[229] TRANSCRIPTIONAL REGULATION OF OXIDATIVE STRESS-RELATED PATHWAYS IN MICROGRAVITY

Oliver Ullrich, Cora Thiel

University of Zurich, Zurich, Switzerland

(Original Research)

Gravitational force and "oxidative stress" are constant determinants of Earth's evolutionary history. Oxidative stress is not a simple by-product of respiration, but rather a signal system and central part of cellular homeostasis. Oxidative stress is a contributing factor to spaceflight-related dysregulation of the bone and immune system, whereby normalizing the redox homeostasis could mitigate a portion of the adverse phenomena seen in spaceflight. We recently investigated the oxidative burst reaction in mammalian macrophages through real-time on orbit measurements and revealed a rapid sensitivity of the oxidative burst reaction to microgravity, followed by a subsequent rapid full adaptation, raising the question of the adaptivity of oxidative-stress-associated pathways in the cells of the immune. We investigated the immediate effect of altered gravity on the transcription of 86 genes involved in reactive oxygen species metabolism, antioxidative systems, and cellular response to oxidative stress, using a multi-platform approach (parabolic flight and suborbital ballistic rocket experiments) and microarray analysis. The initial transcriptional response of oxidative stress-related pathways was immediate and strong in human myelomonocytic U937 cells, but accompanied by a rapid and severe counter-regulation afterwards. In contrast, the expression of oxidative stress-related genes in human Jurkat T cells was largely insensitive to gravitational changes. We detected a significant up-regulation of p22 phox after 20 s and of p47 phox after 5 min of microgravity. After 20 s of hypergravity, p47 phox was up-regulated and p22 phox, p91 phox, and p40 phox were down-regulated. After 75 s of hypergravity, p91 phox was up-regulated. All of the initially altered transcripts after 20 s of microgravity or hypergravity were counter-regulated afterwards, suggesting a rapid regulatory homeostatic response of the NADPH oxidase transcriptional process. In conclusion, we assume a very well-regulated homeostasis and transcriptional stability of oxidative stress-related pathways in altered gravity in cells of the human immune system. Since ROS are not merely a harmful by-product of respiration, but rather a highly complex and crucial signal system affecting a huge variety of cellular processes, this extensive homeostatic reaction to altered environmental gravity conditions seems very appropriate from an evolutionary perspective.

Learning Objective:

1. Understand the transcriptional homeostatic response of oxidative-stress-related pathways in microgravity.

[230] LIVE CELL IMAGING OF PRIMARY HUMAN IMMUNE CELLS IN MICROGRAVITY

Cora Thiel, Oliver Ullrich

University of Zurich, Zurich, Switzerland

(Original Research)

Microgravity represents a hostile environment for the human body and the weakening of the human immune system is one major factor that might preclude humans to go beyond Earth's orbit. Despite intense research the molecular mechanisms of graviperception and cellular responses to a changed gravitational environment still need to be elucidated. The cytoskeleton is widely discussed to play an important role in gravisensitivity of cells and in the associated transduction of extra-cellular signals into the nucleus where the cellular transcriptome reacts to the environmental changes. We therefore investigated primary human macrophages after 11 days in microgravity during the CELLBOX ISS experiment. Surprisingly, no major quantitative nor structural changes of the cytoskeleton could be identified. To monitor potential early microgravity induced changes of the cytoskeleton and the nucleus we further investigated primary human macrophages on the 3rd Swiss Parabolic Flight and compared short term and long-term effects. Additionally, in order to analyze the dynamics of early adaptation processes we used a high-resolution fluorescence microscope (FLUMIAS) on two suborbital rocket missions for live cell imaging in immune cells. Cytoskeletal, nuclear and cellular organelle dynamics were investigated during the 300s microgravity phase. For the first time high resolution multi-color microscopy with four different dyes was successfully performed on a sounding rocket mission. In the data analysis we focused on actin, mitochondria and lysosome dynamics as well as on structural-geometric analyses of the whole cell and the nucleus. Although the mitochondria dynamics did not show significant differences in transport velocities we could show an increased cytoskeletal dynamics in microgravity in immune cells. The FLUMIAS-DEA demonstrator microscope allows long term investigation of cellular dynamics in high resolution on board the ISS. During the technology demonstration on the SpaceX CRS-15 mission we used stained fixed and living primary human macrophages representing a well characterized and microgravity approved study object to test the microscope. The space suitability of the new high-resolution microscope technology was successfully shown. In our study we combined different microscopy analyses on different microgravity platforms to characterize gravitational induced short term and long-term cellular effects and potential adaptation processes in cells of the immune system.

Learning Objective:

1. The audience will learn about the effects of short term and long-term microgravity on cellular dynamics and adaptation processes in immune cells monitored by live cell imaging.

Wednesday, 05/08/2019

8:30 AM

Brasilia 6

[S-47] PANEL: GRAND ROUND I

Sponsored by The American Society of Aerospace Medicine Specialists

Chair: Mark Coakwell

Co-Chairs: Edgar Rodriguez, Richard Allnutt

PANEL OVERVIEW: This panel will consist of pairs of Aerospace Medicine residents presenting clinical cases of aeromedical interest or significance. During their residency practicum years, residents conduct evaluations of patients with diverse medical problems. Residents prepare and present a case report based on a patient encounter undertaken during their practicum experience. One resident from each pair presents the history of the presented problem. The other resident presents the physical findings and a discussion of the aeromedical policies associated with the condition. Learning Aerospace Medicine at the specialist level involves understanding the impact of medical conditions on aircrew health and mission accomplishment. The cases presented will not only be of academic interest but will also illustrate aeromedical decision making in the operational environment.

[S-47a] BEHÇET'S DISEASE IN AN AIR FORCE CONTROLLER

Mitch Radigan, Joshua Shields

USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Education - Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report describes an Air Force ground-based controller who was diagnosed with Behçet's disease. **BACKGROUND/LITERATURE REVIEW:** Behçet's disease, or Behçet's syndrome, is a rare inflammatory disease that has the potential to adversely affect multiple organ systems. Behçet's is a suspected autoimmune vasculitis that has the potential to attack veins and arteries throughout the body. Behçet's commonly presents with mouth sores, ocular inflammation, and/or arthritis. The typical age of onset is in the 20s-40s. It is a relatively rare disease with less than 20,000 diagnoses per year in the USA. It is a chronic disease, with no known cure. Treatment usually consists of immunosuppressive medication aimed at symptom management. **CASE PRESENTATION:** A 27-yr-old Caucasian male ground-based controller presented multiple times to flight medicine over 8 mo with relapsing and remitting aphthous stomatitis and various symptoms in his integumentary, ocular, neurologic, musculoskeletal, psychiatric, and gastrointestinal systems. During this time, there has been a marked decline in his physical fitness, memory, and intelligence. He has been seen by Ophthalmology, Neurology, and Psychology with non-specific exam abnormalities and trialed on various medications with minimal improvement in his symptoms. He was evaluated by Rheumatology and diagnosed with Behçet's syndrome and started on symptomatic medical treatments. He wishes to remain flying on active duty and is seeking a flying waiver. **OPERATIONAL/CLINICAL RELEVANCE:** Aeromedical concerns include an incurable vasculitis that affects variable organ systems. Particularly concerning are the ocular symptoms that can lead to blindness and neurological symptoms that can impair decision making and reaction times. Additionally, symptomatic treatment often includes the use of medications that are not considered safe in the flight environment. The progressive and unstable nature of this syndrome gives an affected individual a poor prognosis. Furthermore, the declining and unpredictable nature of this disease makes an individual not compatible with military service.

Learning Objective:

1. Understand the implications and safety concerns for Behçet's disease in a flying population.

[S-47b] AVIATION IS NOT FOR THE FAINT OF HEART

Gurdeep S. Buttar

U.S. Army School of Aviation Medicine, Ft. Rucker, AL

(Education - Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report describes an Army aviator who developed syncope with exercise in August 2017. **BACKGROUND/LITERATURE REVIEW:** This case required the need for specialized cardiac evaluation and procedures in addition to genetic testing. **CASE PRESENTATION:** A 27-year-old male Army pilot developed two episodes of syncope with exercise in August 2017. He began taking Bystolic after an initial cardiology diagnosis of syncope and tachycardia. Given the occurrence of symptoms during exercise, the need for further cardiac work-up was recommended. Case presentation will include the workout description, aeromedical disposition and a discussion of related Tri-Service/FAA aeromedical regulations related to the case. **OPERATIONAL/CLINICAL RELEVANCE:** The importance of this cardiac issue is its ability to impair or incapacitate the pilot particularly during critical phases of take-off, final approach, landing, as well as with emergencies and other unexpected contingencies.

Learning Objectives:

1. Understand how to diagnose and treat this cardiac disorder.
2. Determine how to properly aeromedically disposition this cardiac condition.

[S-47c] (formerly [231]) HYPERLUCENCY ON CHEST RADIOGRAPH IN A HEALTHY MILITARY AVIATOR

Michael Harrison, Maryjane Harris, Clayton Cowl

Mayo Clinic, Rochester, MN

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This case describes a healthy active-duty military pilot with a rare finding on chest radiography and the associated dilemma experienced by an aeromedical examiner (AME). **BACKGROUND:** Vague symptoms such as chest discomfort can generate a broad list of differential diagnoses that range from benign to life threatening. The evaluation can be an equally lengthy list of associated investigative tests and procedures. The world of aviation medicine differs from general medicine in that the case specifics are assessed in the context of potential aeromedical implications. **CASE PRESENTATION:** A healthy, physically active, non-smoking 34-year-old active duty U.S. Air Force pilot presented for second-opinion of an isolated hyperlucency on chest radiograph. This was found during evaluation of mild chest heaviness that started after a family member suffered an acute medical emergency. Cardiac evaluation and laboratory results were within normal limits. Pulmonary function testing revealed mild expiratory obstruction without response to bronchodilator therapy, moderately decreased FEV1 (68% predicted), mildly decreased FVC (91% predicted), and an FEV1/FVC ratio of 75%. Computed tomography revealed decreased pulmonary vascularity and mild-to-moderate airway thickening in the right middle and upper lobes. The pilot was diagnosed with Swyer-James-McLeod syndrome (SJMS), a sequela of a remote pediatric infection and unrelated to his now resolved symptom. **DISCUSSION:** This case highlights the challenges faced by an AME in evaluating diagnostic findings in an otherwise healthy aviator. SJMS, a rare specific variant of bronchiolitis obliterans, is an isolated chronic radiographic finding that is often clinically insignificant. In the case of our pilot, his infectious insult occurred many years earlier and, unbeknownst to anyone, he had SJMS at the time of his initial flight physical and throughout his career. His presenting symptom was a physical manifestation of an emotional response and the diagnosis of SJMS was incidental. The subsequent medical evaluation confirmed the diagnosis of SJMS without identifying pathology that would limit his ability to continue to safely perform flight duties. He was returned to active duty. This case highlights the challenge faced by AMEs to determine what is aeromedically relevant; this is further complicated when symptoms are mild and a diagnosis is either elusive or, in this case, incidental and rare.

Learning Objectives:

1. The audience will learn about challenges faced by aeromedical examiners with incidental findings.
2. The audience will learn about a rare radiographic diagnosis and its aeromedical implications.

[S-47d] CLUSTER HEADACHE IN A C-130 PILOT

Latrise Searson-Norris, Alan Flower

USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Education - Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report describes a fixed winged pilot who presented with a history of episodic atypical cluster headaches. **BACKGROUND/LITERATURE REVIEW:** Cluster headache is the most prominent type of idiopathic headache entities that make up the trigeminal autonomic cephalgias, all of which involve unilateral, often severe headache attacks typically accompanied by autonomic symptoms. The prevalence of cluster headache is <1% and mostly affects men. The lifetime prevalence of cluster headache for adults is approximately 125 per 100,000. The overall male to female ratio is approximately 4 to 1. Cluster headache is characterized by periods of brief attacks of severe orbital, supraorbital, or temporal pain. Autonomic symptoms associated with cluster headache (i.e., ptosis, miosis, lacrimation, conjunctival injection, rhinorrhea, and nasal congestion) occur only during the pain attack and are ipsilateral to the pain. Circadian rhythmicity is another clinical landmark of cluster headache. The diagnosis is based on history and diagnostic criteria. In general, cluster headache treatment can be divided into acute therapy aimed at aborting individual attacks and prophylactic therapy aimed at preventing recurrent attacks during the cluster period. Acute treatment in the form of 100% oxygen breathing is usually successful. Triptan medications can be used in individuals who are not relieved by oxygen. Preventive treatments include calcium channel antagonists, glucocorticoids, and anti-seizure medications. Individuals with chronic cluster headache who are not relieved by preventive interventions are candidates for implanted nerve stimulators. **CASE PRESENTATION:** A 29-yr-old male C-130 pilot with over 1530 flying hours

presented with acute headache. Surprisingly, he additionally reported a long history of headaches that typically occurred for 2 wk out of the year. The headaches were characterized as sharp and stabbing, constant pain lasting for hours, located in the left V1 trigeminal distribution, with intensity of 7/10. Headaches were associated with left eye injection and lacrimation, without visual or sensory aura. Tylenol and ibuprofen were not effective. Oxygen therapy did provide complete relief. Interestingly, throughout his headache course, he reported that the headaches never had any operational impact. He was referred to Neurology, and a brain magnetic resonance imaging showed no significant intracranial abnormality. He was diagnosed with episodic atypical cluster headache. **OPERATIONAL/CLINICAL RELEVANCE:** Aeromedical concerns for cluster headache diagnosis include rapid onset and severity of headache with potential for operational distraction or incapacitation: possible association of transient neurological symptoms, rhinorrhea, lacrimation, and Horner's syndrome; future risk of headache recurrence; effects of any residual neurologic symptoms or treatments used for headache management on operational safety and mission effectiveness. According to the U.S. Army and U.S. Navy waiver guides, the aeromedical disposition of members with headaches depends on the frequency and severity of the symptoms, the etiology, and the medication required to control the headaches. According to the Air Force Medical Standards Directory, all headaches, except for the occasional tension headaches, are disqualifying for flying duties in the U.S. Air Force. A single severe/incapacitating headache is also disqualifying; this is to emphasize the need to exclude serious underlying causes before returning to operational duties. The Federal Aviation Administration does not consider the diagnosis of headache/chronic headache as an automatic permanent disqualification. If the applicant meets all the acceptable criteria, the Aviation Medical Examiner can issue a medical certificate. If the applicant does not meet all the acceptable criteria, the examiner must defer to the Federal Aviation Administration to determine whether an airman is medically fit to fly.

Learning Objective:

1. Understand the implications and safety concerns for cluster headaches in aircrew, particularly pilots.

[S-47e] PALINDROMIC RHEUMATISM

Mohammad Al-Nsour

Royal Jordanian Air Force Medical Facility, Amman, Jordan

(Education: Case Study: Clinical / Human Performance)

INTRODUCTION: This case report describes a 41-year military pilot with a long-standing history of eosinophilic esophagitis, and idiopathic urticaria and angioedema who presents with a multi-year history of migratory, intermittent joint pain/stiffness/swelling in knees, elbows, wrists and fingers. **BACKGROUND:** Rheumatoid arthritis (RA) is a systemic disease that characteristically manifests in the joints as articular inflammation and destruction. The typical untreated presentation is one of progressive, symmetric arthritis beginning in peripheral joints with subsequent proximal spread. RA leads to erosion of cartilage and bone; if uncontrolled, such destruction is usually apparent radiographically within a matter of months and may result in physical disability within a decade. RA is a common disease. Prevalence is about 1% in Caucasians, with a lower risk in Africans, but much higher (~5%) in certain Native American populations. Females are affected 2-3 times as frequently as males. Peak age of onset is 30-55 years. **CASE PRESENTATION:** The subject is a 41-year-old A-10 pilot with a distinguished flying career currently serving as a unit commander. Two years prior to grounding, the subject developed intermittent joint pain/stiffness/swelling in his knees, elbows, wrists and fingers (at the distal interphalangeal joints). The symptoms occurred with no identified trigger, would last about two days and then spontaneously remit with weeks to months in between episodes. Rheumatology diagnosed him with palindromic rheumatism and idiopathic urticaria and angioedema. Over the next two years, he partially failed treatment with multiple immunomodulation therapies before identifying specific food triggers. After one year of diet restrictions, he no longer needed immunomodulation therapies. Seven years after initial symptom onset he presents for waiver consideration. **DISCUSSION:** RA must be controlled to reduce chronic morbidity and perhaps mortality. (While there is little argument about the increased mortality associated with RA, evidence that

treatment reduces mortality is slim.) With the exception of Etanercept, the agents required to control moderate disease are incompatible with Air Force aviation. While patients may certainly refuse medical treatment, uncontrolled or poorly controlled RA is also disqualifying, so flying considerations should not enter into such treatment decisions.

Learning Objectives:

1. Review the aeromedical policies of the US Department of Defense, Federal Aviation Authority, and international aviation standards for rheumatoid arthritis.
2. Understand the multiple factors associated with aeromedical decision making posed by the presenting condition as well as comorbidities that may or may not be related.

[S-47f] A RARE CAUSE OF COMMON SYMPTOMS IN A COMMERCIAL PILOT

Christopher T Haas, Jennie MP Wang

University of Texas Medical Branch, Galveston, TX, USA

(Education - Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report discusses a commercial pilot presenting with new, and progressively worsening, shortness of breath. **BACKGROUND/LITERATURE REVIEW:** Pulmonary hypertension is a rare, complex, and debilitating medical disease characterized by pathological remodeling of the pulmonary arteries, ultimately leading to right ventricular heart failure and death. Pulmonary hypertension is defined as a mean pulmonary arterial pressure ≥ 25 mmHg at rest. The gold standard for the diagnosis of pulmonary hypertension is right-heart catheterization. Pulmonary hypertension is classified by the World Health Organization according to its causes or associated underlying conditions. There are five 'groups' of classification for pulmonary hypertension covering the wide array of etiology of the disease including: obstruction of the pulmonary arteries (sequelae of connective tissue disease, HIV, autoimmune, drug-related side effects, or idiopathic), left-sided heart disease, intrinsic lung disease (i.e., COPD, pulmonary fibrosis, chronic high altitude exposure, obstructive sleep apnea), multifactorial/metabolic/systemic/hematologic disease, and thromboembolic. Symptoms of pulmonary hypertension include shortness of breath, fatigue, chest pain, and palpitations. Treatment is largely aimed at control of any underlying disease and symptom management.

CASE PRESENTATION: A 60-year-old commercial pilot presented to his physician for evaluation of gradual onset shortness of breath with routine daily activities. He further noted increased dyspnea on exertion and chest tightness, restricting his daily activities. A few days a week, he experienced palpitations and dizziness. He reported that his sleep was unrefreshing. His past medical history included type II diabetes mellitus, hyperlipidemia and hypertension. He had an unremarkable physical exam. The patient underwent numerous medical tests. His echocardiogram revealed a normal ejection fraction but demonstrated an elevated right ventricular systolic pressure of 46mmHg. He underwent right-heart catheterization which confirmed the elevated pulmonary artery pressure. There was no evidence of coronary artery disease. The remainder of his medical work-up including chest CT, pulmonary function tests, V/Q scan, laboratory studies, and polysomnography were otherwise unremarkable. Given no other possible etiology for his disease, he was diagnosed with idiopathic pulmonary hypertension. His thorough work-up excluded other causes of pulmonary hypertension such as connective tissue disease, autoimmune disease, HIV, drugs and toxins, primary cardiac and lung disease, and thromboembolic events.

OPERATIONAL/CLINICAL RELEVANCE: This case demonstrates key aspects of evaluating a pilot with progressive shortness of breath. The case also highlights important considerations for determining a pilot's aeromedical disposition given a diagnosis of pulmonary hypertension and an anticipated further decline in respiratory function to include the potential need of supplemental oxygen and unique risks of flight (i.e. long duration, potential for hypoxemia precipitated by change in altitude, etc.).

Learning Objective:

1. Understand the basic characteristics and safety implications of pulmonary hypertension in the pilot population.

Wednesday, 05/08/2019
Brasilia 7

8:30 AM

[S-48] PANEL: DETECTING, DEFINING, AND DIAGNOSING SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME (SANS)

Chair: Tyson Brunstetter

Co-Chair: Mary Van Baalen

PANEL OVERVIEW: First discovered in 2005, Spaceflight Associated Neuro-ocular Syndrome (SANS; formerly known as "VIP") is a condition unique to long-duration spaceflight. SANS is associated with a multitude of signs such as optic disc edema and retinal nerve fiber layer thickening; globe flattening and shifts in refractive error; retinal hemorrhages and cotton wool spots; and chorioretinal folds. Other potential signs include optic nerve tortuosity/kinking and optic nerve sheath distention, etc.; however, it is unclear whether or not these signs are induced by spaceflight and are truly associated with SANS. While the pathogenesis and pathophysiology of SANS remain elusive, several theories exist. This panel will explore the latest technologies in detecting, defining, and diagnosing SANS; present recent analyses of short- and long-duration crewmember ocular data; and explore potential physiological factors that may contribute to the generation of SANS.

[232] TRANSITIONING TOWARDS OBJECTIVE MEASURES TO DIAGNOSE AND MONITOR SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME (SANS)

Tyson Brunstetter¹, Sara Mason², C. Robert Gibson³, Mary Van Baalen⁴, William Tarver⁴

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(Original Research)

INTRODUCTION: Spaceflight Associated Neuro-ocular Syndrome (SANS) is associated with numerous signs; however, an official SANS diagnosis is determined by the presence/absence of optic disc edema (ODE) as visualized by funduscopy. While adequate for terrestrial ODE cases, this technique lacks sensitivity in diagnosing SANS, especially mild cases. Optical coherence tomography (OCT) is a potentially improved technology in documenting SANS, and therefore, a new, advanced device (Heidelberg SPECTRALIS® OCT2) was deployed to the International Space Station in 2018 to replace the unit that has served there since 2013.

METHODS: A comparison of funduscopy and OCT images collected pre-, in-, and post-spaceflight, as well as from healthy terrestrial patients and those with ocular pathology, was performed to assess the OCT's ability to detect ocular signs of SANS (i.e., ODE, chorioretinal folds, cotton wool spots [CWS], and retinal hemorrhages). OCT imagery included standard OCT scans, MultiColor Imaging (MCI), and Autofluorescence (AutoFL). In addition, international SANS and OCT experts were consulted for their recommended strategy on transitioning towards objective measures to describe SANS. **RESULTS:** Initial analyses indicate that OCT imaging modalities, especially when combined, meet or exceed standard funduscopy for detecting SANS signs. MCI permits efficient detection of CWS and retinal hemorrhages, but also provides lesion depth information; AutoFL and MCI provide insight into retinal disruption; and when merged, OCT scans and MCI greatly exceed funduscopy in detecting ODE and chorioretinal folds. Experts are recommending specific OCT-generated parameters to describe SANS ODE (i.e., minimum rim width, Bruch's membrane opening, total retinal thickness, neural rim volume, lamina cribrosa depth), and a new custom OCT protocol has been proposed to better measure ocular SANS signs during spaceflight. **DISCUSSION:** Based on these results, NASA is adopting a new OCT protocol that includes higher-density scans and MCI imaging of the macula and optic disc. It is anticipated that MCI will replace funduscopy for nominal on-orbit retinal photo-documentation, but with funduscopy remaining available when standard color photos are required. And as a step towards

adopting objective measurements to describe SANS, a hybrid diagnostic algorithm has been executed that incorporates funduscopy and OCT to document SANS ODE in long-duration crewmembers.

Learning Objectives:

1. Understand the advantages and disadvantages of funduscopy and optical coherence tomography (OCT) in detecting, documenting, and diagnosing optic disc edema and other signs associated with Spaceflight Associated Neuro-ocular Syndrome (SANS).
2. Learn about the specific OCT-generated parameters that are being recommended to potentially better describe optic disc edema.

[233] ORIGINS OF CEREBRAL EDEMA AND ITS IMPLICATIONS IN THE ETIOLOGY OF SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME (SANS)

Laura Galdamez¹, Tyson Brunstetter², William Tarver³

¹Baylor College of Medicine, Houston, TX, USA; ²U.S. Navy, NASA Johnson Space Center, Houston, TX, USA; ³NASA Johnson Space Center, Houston, TX, USA

(Original Research)

INTRODUCTION: Spaceflight Associated Neuro-ocular Syndrome (SANS) was first described in peer-reviewed scientific literature in 2011 and is associated with several structural ocular changes found to occur in astronauts following long duration missions. The defining characteristic for SANS is optic disc edema (ODE), which is located within the central nervous system behind the blood-brain/retinal barrier and can persist days to years after return. Despite multiple insufficient potential terrestrial models, an understanding of the etiology of SANS ODE has yet to be determined. **METHODS:** A systematic review was conducted on literature published about the pathophysiology of cerebral edema. This information was then applied to create theories on possible mechanisms behind SANS etiology. **RESULTS:** Cerebral edema occurs via two general mechanisms: redistribution of ions and water intracellularly (i.e., cytotoxic edema), and displacement of ions and water from the vascular compartment to the brain parenchyma (i.e., vasogenic edema). These processes occur via interconnected endocrine and inflammatory pathways and involve mediators such as cytokines, matrix metalloproteinases, nitric oxide and free radicals. The pathways ultimately lead to a violation of the cellular membrane ionic gradient and degradation of the blood-brain barrier. **DISCUSSION:** ODE is seen in various disorders with multiple theorized etiologies. By applying the principals of cerebral edema pathophysiology to the ODE seen in SANS, several theories regarding its etiology can be formed. Venous stasis may lead to ODE via venous and capillary distension and leak, as well as relative hypoxia and insufficient ATP substrate delivery causing axoplasmic flow stasis and local oxidative stress. A regional immunologic response also likely contributes to the blood-retinal barrier breakdown and vasogenic edema. Increased intracranial pressure may also play a role in axoplasmic flow stasis and ODE formation, but its level of contribution to SANS has been questioned recently. Directed investigation of these theories may help to elucidate the etiology of SANS and develop mitigation strategies to prevent the structural changes from progressing on a long duration mission, such as the anticipated Mars endeavor.

Learning Objective:

1. Understand the general pathophysiology of cerebral edema and its potential role(s) in the generation of Spaceflight Associated Neuro-ocular Syndrome (SANS) in long-duration astronauts.

[234] DEFINING THE NORMAL RANGE OF CEREBROSPINAL FLUID OPENING PRESSURE IN ADULTS: A SYSTEMATIC REVIEW

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(Original Research)

INTRODUCTION: Elevated intracranial pressure (ICP) is a proposed mechanism of Spaceflight Associated Neuro-ocular Syndrome (SANS) observed in the astronaut population. To better understand the mechanism of SANS and provide adequate prevention, treatment, and

countermeasures for this population, direct measurement of ICP via lumbar puncture has been suggested. However, the normal range of cerebrospinal fluid opening pressure (CSFOP) is first needed to interpret values obtained via lumbar puncture in the astronaut population. Many clinical guidelines utilize an upper limit of normal CSFOP of 20 cmH₂O, but clinical and research experience suggests many normal individuals have a CSFOP above this cutoff. The aim of this study is to provide a description of the normal CSFOP range in adults via a qualitative systematic review of the literature. **METHODS:** The PubMed (MEDLINE) database was searched including records published through June of 2018. Reference lists from eligible articles were manually reviewed and physicians in relevant fields contacted to ensure a comprehensive search. The primary outcome was the mean CSFOP with standard deviation where reported. An additional 9 items were abstracted by a single reviewer including range of CSFOP. **RESULTS:** Overall, 164 records were identified for screening, with 12 studies remaining after inclusion and exclusion criteria were applied. Data were abstracted by the author and presented in table format. Mean CSFOP ranged from 12.98 to 18.8 cmH₂O where reported. The overall range of CSFOP reported was 6 to 28 cmH₂O for all 12 studies. Of the studies included, six (50%) reported subjects with a CSFOP that exceeded 20 cmH₂O. Five (42%) studies recruited healthy volunteer subjects only, and six (50%) included subjects undergoing diagnostic LP who did not have a diagnosis that is thought to affect ICP. **DISCUSSION:** A qualitative systematic review of the literature suggests that the upper limit of normal for CSFOP likely exceeds 20 cmH₂O. The findings of this study are relevant to research or occupational surveillance programs in which a baseline CSFOP is required for comparison. Data is limited on the normal range of CSFOP in the literature as studies involving only healthy, asymptomatic individuals had a smaller sample size. Future work will involve a quantitative meta-analysis of identified records to provide a more precise definition of CSFOP for comparison to the astronaut population.

Learning Objective:

1. Understand the normal range of cerebrospinal fluid opening pressure obtained via lumbar puncture based upon a systematic review of the literature.

[235] A PILOT STUDY TO DESCRIBE OPTIC NERVE SHEATH DIAMETER (ONSD) CHANGES IN ASTRONAUTS DURING LONG-DURATION SPACEFLIGHT

Michael LaBarbera¹, Lucas Beven², Wafa Taiym³, Tyson Brunstetter⁴, Sara Mason⁵, Mary Van Baalen⁶, Ashot Sargsyan³, Caroline Schaefer⁵, William Tarver⁶

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(Original Research)

INTRODUCTION: Spaceflight Associated Neuro-ocular Syndrome (SANS) is characterized by optic disc edema, globe flattening, choroidal folds, and hyperopic refractive changes. With its risk to crew and mission, early detection of SANS and the development of effective countermeasures are critical. Astronauts are subjected to a battery of ocular testing prior to and during spaceflight, though the pathophysiology of SANS remains unclear. One proposed mechanism for SANS includes elevated intracranial pressure (ICP), although testing this theory on-orbit is technically challenging. Terrestrially, ultrasound (U/S) measurement of optic nerve sheath diameter (ONSD) is a validated, non-invasive technique to screen for elevated ICP, and U/S is currently used to aid in detecting SANS. This pilot study tested the methodology of quantifying ONSD in astronauts, and the feasibility of detecting changes in ONSD as a result of long-duration spaceflight. **METHODS:** Reference ranges of ONSD in patients with and without elevated ICP were identified via meta-analysis. Optic nerve U/S were obtained pre- and in-flight onboard the International Space Station, with three binocular ONSD values per session measured 3 mm posterior to the retinal junction by two medical students (ML and LB) and assessed for inter-operator concordance. **RESULTS:** ONSD in terrestrial populations

without elevated ICP averaged 4.64 +/- 0.57 mm (6 studies, 284 U/S scans), and ONSD in elevated ICP patients averaged 5.95 +/- 0.66 mm (6 studies, 173 U/S scans). Pre-flight astronaut ONSD was 6.64 +/- 0.64 mm (8 subjects, 40 U/S scans), which was greater than the normal and elevated-ICP controls ($p < 0.001$). On average, ONSD increased during spaceflight by 6.3% (CI95: 2.5-10.1%, $p = 0.003$). **DISCUSSION:** Astronauts in this study experienced a 6.3% average increase in ONSD in-flight, which remained stable throughout the mission. Their pre-flight ONSD was elevated compared to controls from literature, which may be a result of pre-flight training conditions (e.g., exposure to high G loads, Valsalva during conditioning, etc.). This pilot study successfully assessed the feasibility of screening astronauts for elevated ONSD. An expanded follow-on study will investigate the influence of factors on ONSD (e.g., prior spaceflight, sex, side bias, etc.), post-flight ONSD trends, and ONSD's association with SANS.

Learning Objective:

1. The audience will learn the utility of and considerations for using ultrasound to measure optic nerve sheath diameter in terrestrial patients and those with Spaceflight Associated Neuro-ocular Syndrome (SANS).

[236] A STUDY OF RETINAL NERVE FIBER LAYER (rNFL) THICKNESS IN SHORT- AND LONG-DURATION ASTRONAUTS

Mary Van Baalen¹, Sara Mason², Millennia Young¹, Charles Gibson³, William Tarver¹, Nimesh Patel⁴, Wafa Taiym⁵, Caroline Schaefer², Tyson Brunstetter⁶

¹NASA Johnson Space Center, Houston, TX, USA; ²MEIT, Houston, TX, USA; ³Coastal Eye Associates, Webster, TX, USA; ⁴University of Houston, Houston, TX, USA; ⁵KBRwyle, Houston, TX, USA; ⁶NASA / U.S. Navy, Houston, TX, USA

(Original Research)

INTRODUCTION: Ocular changes ranging from hyperopic refractive error shift to disc edema have been identified in crewmembers following long-duration spaceflight. After several cases of Spaceflight Associated Neuro-ocular Syndrome (SANS) were identified, ocular-related screening/monitoring was expanded pre-, in-, and post-flight to more closely monitor the health of our crewmembers in association with mission. As part of the Lifetime Surveillance of Astronaut Health (LSAH) Program, optical coherence tomography (OCT) was added to NASA's annual testing protocol to assess the long-term impacts of spaceflight on our crewmembers. **METHODS:** Annual OCT imaging is obtained on both active and retired crewmembers using the Heidelberg Spectralis OCT as part of the LSAH occupational monitoring program. We retrospectively analyzed OCT data collected at least once post-spaceflight in active and retired crewmembers. Retinal nerve fiber layer (rNFL) thickness was determined using Heidelberg's proprietary segmentation algorithms. Mixed effects modeling was used to assess the relationship between age and rNFL measurements and examine the effects of gender, duration of mission, and right vs. left eye. **RESULTS:** Thickness measures for rNFL decreased by 0.18 microns/year, on average, within the active and retired crewmember population, with most sectors showing a similar magnitude of change. This loss in rNFL thickness is comparable to the normal thinning expected in the normal terrestrial population (i.e., approximately 2 microns per decade). While sex (N=27/174, Females/Males) and spaceflight duration (N=53/148, ≥30-day mission/<30-day mission) were not found to significantly affect rNFL thickness, there was a significant asymmetry in some sectors, with global rNFL measuring 1.36 microns larger in the right eye (OD) as compared to left eye (OS). **DISCUSSION:** Based on cross-sectional studies, age-related rNFL loss in active and retired astronauts is comparable to normal healthy populations. Gender and time in space (i.e., short- vs. long-duration) did not affect the age/rNFL relationship, though the number of long duration flyers is a smaller cohort with less follow-up time.

Learning Objectives:

1. Understand the use of objective eye measures used to monitor the long-term health of NASA astronauts.
2. Understand the impact of short- and long-duration spaceflight on long-term ocular health.

Wednesday, 05/08/2019
Miranda 5/7

8:30 AM

[S-49] PANEL: NON-INVASIVE BRAIN STIMULATION FOR COGNITIVE PERFORMANCE ENHANCEMENT

Chair: Lindsey McIntire

Co-Chair: Richard McKinley

PANEL OVERVIEW: This panel will discuss the effects non-invasive brain stimulation technologies including transcranial direct current stimulation (tDCS), transdermal trigeminal nerve stimulation, and transdermal vagal nerve stimulation on aspects of cognition relevant to the military. These techniques apply weak electrical currents (either AC or DC) through electrodes attached to the scalp or neck. The current passes through the underlying tissues and into the brain or peripheral nerve structures modifying activity. These changes in activity have been shown to generate performance improvements in a variety of cognitive tasks, especially learning, attention, and memory. In addition, these effects have been shown under stressors such as sleep-deprivation induced fatigue. This panel will showcase new experimental findings that provide evidence tDCS can improve attention/arousal and reduce fatigue. In addition, new evidence the effects of peripheral nerve stimulation on learning, memory retention, and attention will be presented. The underlying mechanisms of action causing the behavioral changes will also be presented and discussed. These mechanisms will include physiological changes (e.g., oculometrics) and biomarkers such as those present in blood (e.g., norepinephrine). These markers provide evidence of how the stimulation causes changes in behavior and may help researchers optimize stimulation paradigms for specific applications.

[237] ENHANCED MEMORY RETENTION FOLLOWING IMAGE ANALYST TRAINING WITH TRANSDERMAL VAGAL NERVE STIMULATION (TVNS)

Richard McKinley¹, Lindsey McIntire², Brandon Minnery³, Chuck Goodyear²

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(Original Research)

INTRODUCTION: To develop a highly effective fighting force, US military operators must undergo extensive training for a variety of career fields. Intelligence Surveillance and Reconnaissance (ISR) products within the Department of Defense (DoD) and Intelligence Community (IC) are in particularly high demand. Further, human analysts are limited in number, have a finite operational lifespan, and are costly to train. In this study, we examined the efficacy of transdermal vagal nerve stimulation (TVNS) to enhance learning retention following training on a simulated synthetic aperture radar (SAR) image task in healthy, active duty Air Force members. Vagal nerve stimulation (VNS) has been shown to significantly augment plasticity, accelerate learning, and improve memory and performance of cognitive tasks in both rats and humans. **METHODS:** 48 participants completed four 1-hour training sessions followed by a test, with each occurring on a separate consecutive day. The TVNS was paired with training on days 1 and 3 only. Retention tests were provided 24 hours, 1 month, and 3 months after training concluded. Twenty-four participants received 4 minutes of tVNS at 25 Hz immediately before and after training, the other twenty-four received sham tVNS. Attention and reaction time tests were also given each day. **RESULTS:** The data analyses revealed a significant main effect of tVNS applied at 25 Hz on both target detection accuracy ($p=0.039$) and visual search times ($p<0.001$) during the retention tests. Paired t-tests showed tVNS at 25 Hz produced significantly greater improvements in test scores compared to sham on each test day. In addition, there was a significant main effect of group on change detection accuracy ($p=0.026$) and number of errors ($p=0.026$). The 25Hz tVNS performed significantly better than sham for both metrics on each retention day. The data also revealed significantly higher performance for the 25 Hz tVNS group on the Mackworth Clock test and psychomotor vigilance test during retention tests, and these differences

appeared to intensify as time progressed. **DISCUSSION:** The data suggest that tVNS (particularly when delivered at 25 Hz) may improve image analysis training retention by ~30% and this performance advantage is coupled with enhancements in sustained attention and arousal. These results provide initial evidence that tVNS may be a tool to enhance the efficacy of training and maintain its benefits for a much longer period of time.

Learning Objectives:

1. The effects of transdermal vagal nerve stimulation on target recognition learning retention.
2. The effects of transdermal vagal nerve stimulation on change detection learning retention.
3. The lasting effects of transdermal vagal nerve stimulation on attention.

[238] STIMULATING AROUSAL SYSTEMS WITH NONINVASIVE BRAIN STIMULATION

Nathaniel Bridges¹, Richard McKinley¹, Lindsey McIntire², Chuck Goodyear²

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(Original Research)

INTRODUCTION: One hypothesis is that transcranial direct stimulation (tDCS)-related performance improvements are mediated by indirectly targeting the locus coreulus (LC) via stimulating cranial nerves such as the vagus nerve along the face. As such, we recently investigated whether transdermal vagus nerve stimulation (tVNS) results in similar performance improvements seen with tDCS. In an effort to investigate tDCS and tVNS effects on arousal systems, we explored epinephrine and norepinephrine (NE) blood plasma and saliva changes following tDCS and eye tracking metrics following tVNS. Given that the LC is a major site for NE release with corresponding influences on arousal, and the sensitivity of eye metrics to arousal changes, we expected that quantified measures would be differentially modulated when comparing active and sham stimulation. **METHODS:** In the tDCS study, subjects were divided into groups that received either sham, motor cortex (M1), or dorsolateral prefrontal cortex stimulation (DLPFC; ~10-12 each group). Bioassays were used to quantify epinephrine and NE blood plasma and NE saliva levels from before and after tDCS. In the tVNS study, we quantified blink duration, blink frequency, percentage of eye closure (PERCLOS), and pupil diameter before and after 4 minute of 25 Hz tVNS. **RESULTS:** We did not find a significant change pre to post tDCS in plasma epinephrine and NE levels within the sham, M1, and DLPFC groups. In contrast, saliva NE levels changed pre to post sham tDCS, whereas M1 and DLPFC tDCS did not show changes. In the tVNS study, sham tVNS resulted in an increased PERCLOS and no changes in the blink duration, blink frequency and pupil diameter eye metrics. In contrast, 25 Hz tVNS decreased PERCLOS as well as blink frequency. Like the sham group, the 25 Hz tVNS group did not change blink duration or pupil diameter. **DISCUSSION:** Salivary sham tDCS NE level changes may be a result of increased subject engagement while performing cognitive tasks. It is possible that tDCS may influence pathways associated with NE release as expected. This effect is consistent with research suggesting that tDCS indirectly activates the LC. In the tVNS study, decreased PERCLOS and blink frequency suggests an increase in arousal, which would also be consistent with activating the LC. The results fall in line with improved performance in the arousal-sensitive psychomotor vigilance task (PVT), which was observed in this study.

Learning Objectives:

1. The effects of non-invasive stimulation techniques on arousal.
2. The effects of non-invasive stimulation techniques on biomarkers such as norepinephrine.
3. The effects of non-invasive stimulation techniques on human physiology.

[239] ACCELERATION OF IMAGE ANALYST TRAINING USING TRANSDERMAL TRIGEMINAL NERVE STIMULATION (tTNS)

Justin Nelson¹, Richard McKinley², Lindsey McIntire³, Charles Goodyear³

¹Consortium Research Fellow, Wright-Patterson AFB, OH, USA; ²Air Force Research Laboratory (AFRL), Wright-Patterson AFB, OH, USA; ³Infoscitex, Inc., Dayton, OH, USA

(Original Research)

INTRODUCTION: One of the more difficult assignments for image analysts within the military is to distinguish between potential enemy ground target and ally vehicles in synthetic aperture radar (SAR) imagery. Initial Air Force SAR technical training for image analysts takes place over a 110-day period, however in many instances continual training is needed. Therefore, the need to reduce training time is of grave importance to the Department of Defense (DoD). This study examined the effects of non-invasive transdermal trigeminal nerve stimulation (tTNS) on SAR imagery learning and retention in healthy active-duty military personnel from Wright-Patterson Air Force Base. **METHODS:** Forty participants completed four 1hr training sessions followed by a test over four consecutive days. During training, the participant was provided with several two image sets of SAR imagery. In the first image, the participant was instructed to locate and identify an enemy ground target vehicle. In the second image, the participant must determine a change from the first image. Feedback was provided during the training session. Following training, a test was provided without feedback. tTNS was administered on-line during the first 10 minutes of training for each of the four consecutive days. Retention tests were provided 24hrs, 1 month, and 3 months after training concluded. Twenty participants received tTNS at 1000 Hz during training while the other twenty participants received sham tTNS. The Mackworth Clock test and the psychomotor vigilance test were also performed on each day. **RESULTS:** The findings indicate that on-line tTNS applied at 1000 Hz improved target detection accuracy and reduced visual search times compared to sham tTNS. In addition, the 1000 Hz group displayed higher target detection accuracy and lower visual search time at the 24 hr, 1 month, and 3 month retention follow-up sessions. Improvements were also observed for the Mackworth Clock test and the psychomotor vigilance test for the 1000 Hz tTNS group. **DISCUSSION:** The results provided evidence that on-line tTNS at 1000 Hz could accelerate target detection accuracy and search time in SAR imagery. An increase of target detection accuracy up to 20% was observed during the retention tests. These findings provide underlying evidence that tTNS may be an effective tool to accelerate training for image analysts evaluating SAR imagery and encodes the information more effectively.

Learning Objectives:

1. The effects of transdermal trigeminal nerve stimulation (tTNS) on target detection accuracy for image analysts training.
2. The effects of transdermal trigeminal nerve stimulation (tTNS) on visual search time for image analysts training.
3. The effects of transdermal trigeminal nerve stimulation (tTNS) on attention and vigilance.

[240] DIFFERENCES IN STIMULATION LOCATION FOR TRANSCRANIAL DIRECT CURRENT STIMULATION TO MITIGATE FATIGUE INDUCED BY SLEEP-DEPRIVATION

Lindsey McIntire¹, R. Andy McKinley², Chuck Goodyear¹

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(Original Research)

INTRODUCTION: There has been a rapid increase in research over the past decade showing a form of non-invasive brain stimulation known as transcranial direct current stimulation (tDCS) is effective in enhancing cognitive performance in healthy humans. Our previous studies have shown that tDCS can mitigate the deleterious effects of fatigue induced by sustained wakefulness for 6-24 hours post-stimulation depending on the behavior you are testing. Still, this research only looked at stimulation over the left dorsolateral prefrontal cortex (IDLPCF). In clinical populations it has been found that this location has an excitatory effect; however, moving the electrode to the primary motor cortex (M1) for stimulation has been shown to have the opposite effect and can also effect the amount of time spent asleep. This study examined these differences during and after the sleep-deprivation vigil in a healthy human population. **METHODS:** Three groups of 12 participants in each group participated in the study. One group received tDCS over the IDLPFC at 1800. Another received tDCS over M1 at 1800. The final received sham brain stimulation at 1800. Participants completed 37 hours of sustained wakefulness. They were tested every two hours on a monotonous 30 minute driving task, a sustained attention task, a working memory task, a risk-taking task, and a reaction time task from

1800 to 2000 the next day for a total of 9 sessions. At the end of the 9th session they were sent home with an actigraph watch that monitored their sleep/wake time for a week post-data collection. **RESULTS:** Participants receiving stimulation over IDLPFC slept approximately 2 hours less on the 3rd night post-testing than sham ($p \leq 0.016$) and experience poorer sleep efficiency compared to sham on the same night ($p \leq 0.037$). There were no statistical difference for the M1 location group or on any of the other 6 nights monitored post-testing. **DISCUSSION:** To use tDCS as a fatigue countermeasure the results indicate that stimulation to the IDLPFC provides greater benefit than M1 location. While increasing performance is temporary from one 30-min dose (6 hours of benefit) it is possible that arousal remains elevated leading to less sleep at 3 nights post-stimulation. More research needs to be conducted in a sleep lab to determine if these effects are repeatable and what effect this is possibly having on sleep quality.

Learning Objectives:

1. The influences of transcranial direct current stimulation on sleep quality.
2. Transcranial direct current stimulation as a fatigue countermeasure.
3. Differences in the location of stimulation on behavior.

[241] TRANSCRANIAL DIRECT CURRENT STIMULATION AFFECTS LEARNING AND MEMORY ASSOCIATED SYNAPTIC PROTEINS IN RAT HIPPOCAMPUS

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(Original Research)

INTRODUCTION: Transcranial direct current stimulation (tDCS) enhances learning and memory in human subjects, but the underlying mechanisms remain unclear. Here, we utilized a rodent model to test the effects of tDCS on behavioral performance in the passive avoidance task (PAT), a learning and memory test. Following the PAT, global proteomics analysis on rat hippocampal synaptic proteins was employed to obtain more information about tDCS-affected neuronal pathways involved in learning and memory. We hypothesized tDCS would significantly upregulate hippocampal proteins associated with learning and memory in rats that have an enhancement of cognition in the PAT. **METHODS:** tDCS at 250 μ A for 30 minutes was applied to Sprague-Dawley rats randomly assigned to three treatment groups receiving sham ($n=14$), stimulation prior to training ($n=14$), or stimulation prior to testing ($n=14$) during the PAT. Rat hippocampal tissue was prepared into synaptoneuroosomes. The hippocampal synaptoneuroosomes were analyzed using mass spectrometry LC-MS/MS for proteomics analysis. Multiple bioinformatics methods were utilized to evaluate the protein expression differences between the treatment groups. **RESULTS:** In the PAT, stimulation prior to training enhanced learning and memory compared to sham and stimulation prior to testing ($p < 0.05$). Proteomics analysis identified 3687 proteins. For the bioinformatics analysis, we focused on comparisons between the sham and stimulation prior to training treatment groups. Ingenuity pathway analysis yielded the top canonical protein pathways including glutamate receptor signaling, calcium signaling, synaptic long-term depression, CREB signaling in neurons, and synaptic long-term potentiation. Further analysis of protein-protein interaction networks identified significant clusters involved in glutamate receptor signaling pathways, learning, memory, cognition, and long-term memory. **DISCUSSION:** tDCS prior to testing enhanced learning and memory in the passive avoidance task indicating that tDCS was more effective in enhancing memory encoding during training versus memory retrieval during testing. Bioinformatics analysis identified multiple neuronal pathways associated with synaptic plasticity that were significantly enhanced after tDCS prior to testing compared to sham. This work has identified multiple protein targets and regulatory pathways underlying the effects of tDCS on learning and memory, that may translate to applied human studies.

Learning Objectives:

1. The effects of transcranial direct current stimulation (tDCS) timing on learning and memory in the passive avoidance task.
2. The effects of transcranial direct current stimulation (tDCS) on protein expression in the rat hippocampus.
3. Regulatory pathways for the effects of transcranial direct current stimulation (tDCS) on learning and memory.

Wednesday, 05/08/2019
Exhibit Hall

8:30 AM

[S-50] POSTER: PHYSIOLOGY

Chair: Nora Johnson

Co-Chair: Tami Averett-Brauer

[242] ENDOTHELIAL FUNCTION EVALUATION BY ULTRASOUND FLOW MEDIATED DILATION IN HIGH PERFORMANCE AIRCRAFT ITALIAN MILITARY PILOTS: PRELIMINARY RESULTS

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(Original Research)

INTRODUCTION: +Gz exposure in high performance aircraft produces important cardiovascular effects that can lead to well-known phenomena as A-LOC and G-LOC. Blood pool redistribution and pressure changes due to +Gz are the main processes involved in visual and neurological alterations. These cardiovascular modifications affect endothelium, a dynamic organ which lines the entire vascular system. Endothelial cells, located on the intima, control vascular function by responding to various hormones, neurotransmitters and vasoactive factors which affect vasomotion, thrombosis, and inflammation. The balanced production of these factors is atheroprotective, whereas a damaged endothelium causes disrupted production of these molecules. The ensuing imbalance leads to endothelial dysfunction (ED), which is an early indicator of atherosclerosis. Aim of our study was to evaluate endothelial function in F-2000 pilots before and after BFM sorties (mean G load: +6 Gz), compared to air transport pilots (KC767, no high +Gz sorties, control population). **METHODS:** Every pilot underwent fasting ultrasound Flow Mediated Dilatation (FMD) test (that reflects endothelium-dependent vasodilation) before take-off and soon after landing.

RESULTS: Data from 19 male military pilots were recorded. Statistical analysis showed that post-flight FMD was 22.8% lower than pre-flight in every pilot (7,3 vs 9,5%, p=0,00914, lower in F-2000 vs KC767). Furthermore, F-2000 pilots showed lower vascular (brachial artery) diameter than controls, even pre- and post-flight (4,0 vs 4,4mm, p=0,039). Prior performing FMD test, F-2000 pilots showed lower vascular diameter than transport pilots but showed a significant increase in vascular diameter soon after landing than controls in the same situation. **DISCUSSION:** Although the small number of pilots limits the significance of the study, our results show that +Gz acceleration provokes a significant post-flight FMD reduction, especially in fast-jet pilots. These pilots seem to have narrower arterial diameters than controls in every examined condition. We can't determine if this is a subclinical ED due to repeated +Gz-induced blood redistribution or a positive compensative adaptation (vasoconstriction) that helps to sustain +Gz acceleration. Further research is needed to follow up fast-jet pilots in order to detect early cardiovascular organ damage (e.g. IMT) and/or to hypothesize a FMD cutoff value to select young pilots "naturally" prone to better sustain +Gz.

Learning Objectives:

1. Flow Mediated Dilatation is less effective after flights in high performance and conventional military pilots.
2. High performance military pilots seems to have narrower brachial artery diameter than controls.

[243] REVIEW OF TEN YEARS OF HIGH-G CENTRIFUGE TRAINING AT THE GERMAN AIRFORCE CENTRE OF AEROSPACE MEDICINE

Michael Nehring¹, Michael Kopischke¹, Matthias Richter¹

¹German Airforce Centre of Aerospace Medicine, Koenigsbrueck, Germany

(Original Research)

INTRODUCTION: The Air Force Centre of Aerospace Medicine has provided high G- training for German and foreign fighter pilots covering NATO requirements for more than ten years. (HSG) environment is one in

which the gravitational force (G), over a period of at least 15 seconds, is equal or greater than +7 Gz for aircrew wearing anti-G protection. The recommendation is that a 9 Gz profile is part of the training. The goal is to gain G awareness and to perform an effective anti-G straining maneuver (AGSM) by avoiding G-LOC and G-related health problems during air combat maneuvers. **METHODS:** 971 pilots (966 males, 5 females, age 36 ± 7 yr) were trained between 2008 and 2017. HSG training is granted by completing a 9 g run for 15 secs with a G-onset of 6g/sec. 663 pilots were using full coverage anti-G trousers (FCAGT) and pressure breathing for G (PBG), which is called Aircrew Equipment Assembly (AEA). This group were instructed to use a modified AGSM technique ("strain hard for fast onset, then normal breathing"). 308 pilots were using the five bladder anti-G trousers performing the traditional AGSM. All centrifuge runs were supervised by a flight surgeon with video and electrocardiographic monitoring. A dynamic flight simulation (DFS) with simulated air combat maneuver (SCAM) in the Human Centrifuge (HC) completed the program. **RESULTS:** There was a large difference among the AEA group and the anti-G trousers group regarding G-induced loss of consciousness (G-LOC). In the AEA group (n=663) 8 pilots fell into G-LOC. This is a share of 1%. In the group using anti-G trousers (n= 308) 36 pilots experienced GLOC which is a share of 12%. Common side effects of centrifuge training were cardiac arrhythmias and arm pain. Ventricular extrasystoles, bigeminy and couplets were found in nearly 20% of the pilots. Arm pain occurred in 11%. One pilot suffered from scrotal hematoma due to an asymptomatic varicocele. **DISCUSSION:** The HC is a good (aeromedical) training device and has shown to be medically safe. Stopping the centrifuge for a medical reason is very seldom. The FCAGT in combination with PBG and modified AGSM has proven to be a more effective G-protection with less physical demand in comparison to legacy anti-G systems. The DFS Mode is a useful tool but pilots often complain about tumbling sensation. Future research should figure out countermeasures to reduce vestibular stimulation and tumbling sensation in the HC for a better pilot's acceptance.

Learning Objective:

1. Understand the benefit of centrifuge training.

[244] THE MEANING OF ARRHYTHMIA OCCURRED IN THE CENTRIFUGE TRAINING FOR PILOTS OF JAPAN AIR SELF DEFENSE FORCE

Masataka Mine

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(Original Research)

INTRODUCTION: Electrocardiogram (ECG) is monitored during centrifuge training in Japan Air Self Defense Force Aeromedical Laboratory (JASDF AML). However, ECG is not routinely checked in many other countries since arrhythmia is thought not to be accompanied with the symptoms. Thus, interpretation of arrhythmia occurred during the training for aviation safety is still controversial. We therefore investigated the relationships between types of arrhythmia and symptoms. **METHODS:** Of the cases during centrifuge training at JASDF AML until September 2018, those who had received the precision inspection for arrhythmia were extracted. Based on the recorded ECG waveform, we grouped them into the following three groups; narrow QRS tachycardia (NQT), wide QRS tachycardia (WQT) and bradycardia arrhythmia (BA). **RESULTS:** Fifty cases had arrhythmia in the training. We detected 27 cases (54.0% of total arrhythmia) of NQT, 16 cases (32.0%) of WQT, and 7 (14.0%) of BA, respectively. In them, 43 cases (86.0%) complained no symptoms and 7 cases (16.0%) were symptomatic during arrhythmia [NQT 3 cases (11.1% of NQT, P=0.90), WQT 1 case (6.3% of WQT, P=0.37), BA 3 cases (42.9% of BA, p=0.27), P=0.36]. According to the detail of the symptoms, loss of consciousness (LOC) was observed in 4 cases (8.0%) [NQT: 2 cases (7.4%, p=0.91), WQT: 1 case (3.7% p=0.80), BA: 1 case (14.3%, p=0.54), P=0.79]. Those who had visual symptoms (VS) including gray-out were 3 cases (6.0%) [NQT: 1 case (3.7%, p=0.62), BA: 2 case (28.6%, p=0.01), P=0.02]. 4 of these 7 cases are piloting aircraft as pilots after treatment [NQT 3 cases (11.1%, P=0.55), WQT 1 case (6.3%, P=0.76), p=0.51] and the remaining 3 cases are still working as pilots under limitations [BA 3 cases (42.9%, p<0.01), P=0.19]. **DISCUSSION:** VS due to BA showed a significant difference. But in the majority of cases, the High G-related symptoms were due to decreased cerebral blood flow, and not associated with arrhythmia. However, we think that monitoring of ECG during centrifuge

training is still necessary for pilots' aeromedical certification to exclude arrhythmogenic syncope. On the other hand, further accumulation of data is important to decrease overdiagnosis of arrhythmia prohibiting aviation.

Learning Objectives:

1. The participant will learn what the arrhythmia during centrifuge training is.
2. The participant will be able to understand the relations of symptoms and arrhythmia due to high G environment during centrifuge training.
3. The participant will understand the necessity of electrocardiogram during centrifuge training.

[245] A NEAR MISS AND LUCKY CATCH - RISK OF BAROTRAUMA TO A NON-FLYER IN A TEMPORARY FLYING ROLE: A CASE REPORT

Tatiana Villalobos, Maryjane Harris

108th MDG, NJ ANG, Burlington County, NJ, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This case report describes a non-aircrew military member who was put at risk for flight-induced barotrauma during a training exercise. **BACKGROUND:** When the eustachian tube does not function well due to infection or edema, pressure differences develop between the middle ear and ambient air that can distort the tympanic membrane and lead to discomfort, hearing loss, and injury, otherwise known as Otic Barotrauma. Sinus Barotrauma can develop due to the same mechanisms as in the middle ear. The most frequent etiology of barotrauma is flying. The best strategy is avoidance. This case demonstrates the importance of recognizing risk for barotrauma in unusual settings. **CASE PRESENTATION:** The subject is a 21-yr-old male USAF member, who presented to the medical clinic during a training exercise complaining of nasal congestion. He was diagnosed with a severe upper respiratory infection and treated symptomatically. The flight surgeon neglected to discuss potential dangers related to this condition and flying as the patient was a Communications Specialist, and there was no indication that he might engage in a different role during the exercise. The following day, the flight surgeon was participating in a flying mission and noticed that one of the simulated patients on the aircraft was the member that had been diagnosed with a severe upper respiratory infection the day prior. Concern was raised that he should not fly and had not received proper counseling. The subject was removed from the flight and advised not to accept any role in the exercise that would include flying. **DISCUSSION:** This case exposes gaps in procedures during non-standard situations, such as the training exercise in which it took place, highlighting the need for situational awareness to include all those taking part in an event which may create an atypical environment. In this case, the flight surgeon recognized a communications failure and used good crew resource management skills to prevent an incident. Subsequent training was conducted for all Aerospace Medicine Personnel and the following protocol was implemented to prevent similar occurrences moving forward: "Flight Surgeons will brief all patients that in the event of illness or injury, flying should not take place or be required unless explicitly cleared". Flight surgeons should keep in mind that under unconventional circumstances, people may be subject to harm that would otherwise not be expected.

Learning Objectives:

1. When treating patients during an exercise or other non-standard circumstances, flight surgeons should keep in mind that members may be participating in unusual roles and should be counseled regarding the applicable dangers related to their condition.
2. The potential risks associated with flying while experiencing an upper respiratory infection could consequently compromise mission accomplishment.

[246] HYPERBARIC MEDICINE: CURRENT PRACTICES (POSTER)

William Dodson¹

¹Air National Guard Ret, Trenton, NJ, USA

(Education - Tutorial Proposal)

INTRODUCTION: Undersea Hyperbaric Medicine (UHM) is an American Board of Medical Specialties subspecialty that is supported by the American Board of Emergency Medicine and the American Board of

Preventive Medicine. In the USA over the past 25 years, the number of hyperbaric chamber sites has expanded to over 1200, a growth rate during the time period of over 500%. In carefully selected patients with certain diagnoses, hyperbaric oxygen (HBO2) treatment has the ability to save life, limb, and eyesight. Unlike many other specialties, training in the basics of UHM is not offered at all medical schools nor in all residencies. The clinical practice of UHM continues to evolve, and knowledge of current practices would benefit all medical personnel including aerospace physiologists and flight surgeons. **TOPIC:** The Undersea and Hyperbaric Medical Society (UHMS), based in the USA, maintains a list of diagnoses, which has grown over the decades. To be placed on the list, data from research and experience are carefully assessed by panels of experts with expertise in multiple specialties, not just in UHM. Over the recent years, the list has grown; currently, as of 2019 the list comprises 14 diagnostic categories. Carefully selected patients with diagnoses on this list, who have failed to improve in a timely manner with other indicated interventions, may be considered for HBO2 treatment consultation (bearing in mind that not all patients referred for HBO2 consultation will be selected for HBO2 treatment). **APPLICATION:** Some of the current parameters used in the patient selection process will be described, providing physicians, nurses, and other medical professionals with the knowledge and awareness of HBO2 treatment to enable them to select patients who might benefit from an HBO2 consultation and, if appropriate, subsequent treatment.

Learning Objectives:

1. Know the current diagnoses that are indications per the Undersea Hyperbaric Medical Society in 2019 for hyperbaric medicine consultation in carefully selected patients.
2. Know where to find the current UHMS list of diagnoses for 2019 that are indications for consideration of obtaining a consultation.
3. Know some resources in 2019 that are currently manned 24/7 for hyperbaric medicine consultation concerning both initial care and hyperbaric chamber locations.

[247] HYPOXIA INCREASES BLOOD METABOLITES LACTATE AND SUCCINATE

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(Original Research)

Oxygen delivery to the brain via the bloodstream is vital for cognitive functioning, making recognition of hypoxia critical to optimize pilot performance. Currently, there are no reliable, robust markers of prior hypoxic events to provide forensic information following in-flight emergencies and to help identify the root cause of unexplained physiologic events resulting in cognitive decline. Still-unexplained pilot performance deficits and incapacitation incidents prompted us to design a blood bioenergetics/biomarker system that could identify whether a hypoxic exposure had occurred during flight. Blood samples were collected from 13 volunteers before and after exposure to placebo and hypoxia in a Reduced Oxygen Breathing Environment, a room capable of simulating altitudes from sea level up to 30,000 ft. The Baseline and Hypoxia Exposure Phases each involved a 27-min trial and were conducted at two different time points. Simulated flight profiles consisted of an exposure to sea level (21% O₂) prior to altitude (17,500 ft equivalent air mixture for 5-20 min) or placebo (21% O₂). Serum samples were subjected to ¹H NMR metabolomics. A bioenergetics assessment was utilized to give oxidative phosphorylation and glycolytic profiles of peripheral blood mononuclear cells (PBMCs) pre- and post-exposure to placebo or hypoxia. PBMCs from hypoxic subjects do not show respiration effects, but a trend toward decreased glycolytic activity. Metabolites were isolated from blood for quantitative metabolomics, which identified novel prognostic markers of hypoxia. However, PCA on ¹H NMR dataset showed variability in samples from subjects exposed to hypoxia. A closer look at data from five subjects with a higher

response to hypoxia indicated significantly increased lactate (43%) and succinate (69%). When reviewing bioenergetics, glycolytic reserve significantly decreased in serum of one exposed to hypoxia (11%, $p=0.0061$), while the other four showed the same trend. Under hypoxia, glycolysis is the prime energy source, which leads to vast production of lactate and protons. Bioenergetic analysis showed that parameters of glucose metabolism can be useful predictors and prognostic criteria for severity of hypoxia. A larger sample size would be beneficial in identifying indicators for early detection. Differences in timing of blood draws following exposures, as well as individual differences in diet, rest and other activities contributed to the variability of the data.

Learning Objective:

1. The participant will be able to see effects of hypoxia in bioenergetics and metabolites in a preliminary human blood study.

[248] DON'T HOLD YOUR BREATH: A CASE OF PULMONARY BAROTRAUMA IN A FREE DIVER

Robert Ashley, Alex Schloe, John Gayk
Eglin AFB, Fort Walton Beach, FL, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This case report describes an active duty military member who experienced pulmonary barotrauma during recreational free diving. **BACKGROUND:** Pulmonary barotrauma (PBT) is a rare complication in diving sports, particularly in freediving which lacks a compressed air source. A case of PBT in a recreational free diver demonstrates the danger of this sport, especially for those without formal training, and it is imperative for clinicians to be familiar with the diagnosis and treatment of this condition. **CASE PRESENTATION:** A previously healthy 35-year-old male presented to the emergency department with headache, dizziness, fatigue, and chest pain. CT chest showed extensive pneumomediastinum and pneumopericardium suggesting barotrauma. He was freediving the previous day and inhaled from a pocket of air 25 feet below the surface. The patient developed excruciating chest pain upon ascent. The symptoms resolved with supplemental oxygen from EMS. He presented to the ED the following morning for reoccurrence of his symptoms. The on-call dive physician was contacted and recommended high-flow oxygen at 15L/min via non-rebreather mask which resolved his symptoms within 12 hours. **DISCUSSION:** PBT occurs in diving activities when inhaled gases expand during ascent and ventilation inadequately compensates. Common manifestations include pneumomediastinum, pneumothorax, and air gas emboli (AGE). Treatment involves high flow oxygen or recompression in a dive chamber if AGE is suspected. PBT is not commonly associated with freediving as compressed air is not typically utilized for the sport. This case demonstrates that no modalities are exempt from risk of PBT, and serves as a warning for practitioners serving populations where diving activities are common, including the military community. While the risk of freediving associated PBT is low, it should be on the differential for any patient with recent diving activities.

Learning Objective:

1. The importance for clinicians serving populations where diving activities are common to include pulmonary barotrauma in the differential diagnosis for any patient that has engaged in recent diving activity.

[249] CARDIOPULMONARY EFFECTS OF NORMOBARIC HYPOXIC ALTITUDE EMULATIONS OF 14,000 OR 20,000 FEET ABOVE MEAN SEA LEVEL WITH OR WITHOUT FATIGUE

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²Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, USA

(Original Research)

INTRODUCTION: Hypoxia remains a major hazard for aviation, particularly military aviation in non-pressurized aircraft and it is likely to remain so for the foreseeable future. Fatigue is another perennial major hazard for aviation. The purpose of this experiment is to investigate the unique contribution of each stressor and their combined impact on human physiology. **METHODS:** As part of a larger study, volunteers were made hypoxic in a nonpressurized room that circulated normal air diluted

with nitrogen to reduce the amount of available oxygen to approximate the oxygen density encountered at altitude. One group ($n = 9$) breathed an oxygen density approximation to 14,000 ft. above mean sea level (MSL) whereas another group ($n = 11$) breathed an approximation to 20,000 ft. above MSL. Both groups were tested under four conditions: a) well rested, b) fatigued by 23 hours of supervised continuous wakefulness, c) rested and hypoxic, and d) fatigued and hypoxic. **RESULTS:** Reported are descriptive statistics of pulse rate (PR), peripheral percent blood oxygen saturation (SpO₂), end tidal carbon dioxide (ETCO₂), end tidal oxygen (ETO₂), and near infrared cranial spectroscopy (NIRS). The main effect for altitude emerged significant ($p < .05$; however, the main effect for fatigue and the interaction were not significant. Compared to baseline, 20,000 ft. increased PR 34%, and decreased SpO₂ 31%, ETCO₂ 17%, ETO₂ 72%, and NIRS 33%; whereas the 14,000 ft. condition had less of an effect, with increased PR 18%, and decreased SpO₂ 19%, ETCO₂ 6%, ETO₂ 57%, and NIRS 17%. Compared to the non-fatigued conditions, PR trended lower in all of the fatigue conditions. **CONCLUSION:** As expected, the 20,000 ft. above MSL condition had a greater impact on all measures than did 14,000 ft. above MSL condition, however there is no evidence that fatigue had an additional measurable impact. The PR observation may represent a decreased sympathetic drive when fatigued. These results define the physiological effects of the hypoxia and fatigue in preparation for assessing their effects on oculometric and cognitive performance.

Learning Objective:

1. Hypoxia and fatigue remain common major hazards for aviation, particularly military aviation in non-pressurized aircraft. The audience will learn about the effects of normobaric hypoxia and fatigue on pulse rate, peripheral percent blood oxygen saturation, end tidal carbon dioxide, end tidal oxygen and near infrared cranial spectroscopy.

[250] DECOMPRESSION SICKNESS "SOFT CALLS": A CASE SERIES FROM THE USASAM ALTITUDE CHAMBER

Steven Gaydos, Joseph Pavelites, Roger Williams

U.S. Army School of Aviation Medicine, Fort Rucker, AL, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This poster presents a case series of US Army aircrew who were medically evaluated due to subtle symptoms of decompression sickness (DCS) that developed during altitude (hypobaric) chamber training. **BACKGROUND:** The U.S. Army School of Aviation Medicine (USASAM) is home to the Army's only training Altitude (Hypobaric) Chamber. To date, the chamber has trained approximately 65,000 aircrew members. USASAM conducts initial and refresher Hypobaric Chamber training for Fixed-wing and Rotary-Wing aviators, Flight Medics, Aviation Psychologists, Aviation Safety Officers, Flight Surgeons, Special Operations Forces, School of the Americas, High-altitude Parachutists, (HALO), and a variety of DoD supported agencies. Though altitude chamber trainees and staff have a low rate of confirmed DCS (approximately 1 case per 1000 persons exposed), it is not uncommon for participants in reduced pressure/reduced oxygen training scenarios to report the onset of ambiguous health symptoms that prompt their removal from training to be medically evaluated. **CASE PRESENTATION:** Five cases of possible, but unlikely, Altitude Chamber DCS are presented. These "soft calls" are made out of an abundance of caution but do have the negative effects of interrupting service member training and the overutilization of medical resources. **DISCUSSION:** Though altitude chamber induced DCS is a low probability event in light of many precautions that include 100% oxygen pre-breathe protocols and low provocation flight profiles, symptoms, no matter how equivocal, result in immediate medical action. This presentation will discuss how DCS soft calls are handled by USASAM and implications for possible prevention.

Learning Objectives:

1. The participant will become familiar with common "soft calls" of possible decompression sickness seen by USASAM altitude chamber staff.
2. The participant will be introduced to actions taken to address "soft calls" of possible decompression sickness seen by USASAM altitude chamber staff.

[251] IMPROVING THE ASSESSMENT OF SPATIAL ABILITY IN CANDIDATES FOR NAVAL AVIATION

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(Original Research)

INTRODUCTION: The Naval Aerospace Medical Institute (NAMI) maintains the Aviation Selection Test Battery (ASTB), the primary selection tool for selecting pilots and flight officers for the USN, USMC, and USCG. Scores on the ASTB are used to screen out candidates unqualified for flight training and screen in those who will do well. The current ASTB assesses numerical reasoning, verbal reasoning, aviation knowledge, personality, and psychomotor skills. There is also a Direction Orientation Task (DOT) which measures applicants' spatial orientation skills. A NAVAIR task analysis of pilot training identified spatial orientation and spatial visualization as two of the top four most important cognitive skills required for the job. As a result, the purpose of the current study was to determine whether more comprehensive measurement of the spatial ability domain could improve the prediction of aviator performance. **METHODS:** Participants were recruited from initial flight training at Naval Aviation Schools Command on NASP. The final sample included 130 aviation students from the USN, USMC, and USCG. Sample composition was 87% male, 13% female and 83.1% White, 7.7% Hispanic, 4.6% Asian, 2.3% Black, 2.3% Other. Participants had completed the DOT subtest of the ASTB during their application to flight training. They completed three more spatial ability assessments: Compass Directions (CS), Spatial Viewpoints (SV), and Verbal Test of Spatial Ability (VTSA). Participants' performance in the initial academic phase of flight training was then tracked and linked to their scores on all four spatial ability tests. **RESULTS:** Relationships between initial academic flight performance and the spatial ability tests were: $r = 0.15$ (DOT), $r = 0.25^*$ (CD), $r = 0.32^*$ (VTSA), and $r = 0.34^*$ (SV). Also, each of the three spatial ability tests administered for research purposes showed incremental validity in predicting initial academic flight training performance above and beyond the DOT: $\Delta R^2 = 0.05^*$ for CD, $\Delta R^2 = 0.08^*$ for SV, and $\Delta R^2 = 0.09^*$ for VTSA. **DISCUSSION:** Findings reveal spatial ability is an important cognitive domain for predicting aviation training outcomes. Results suggest more comprehensive measurement of the spatial ability domain may improve the current predictive validity of the ASTB. Future research should move beyond academic training outcomes and investigate relationships between spatial ability and student aviator flight performance in Primary flight training.

Learning Objective:

1. The learner will develop familiarity with psychological constructs that are relevant to aviation training performance.

[252] OPTIMIZING THE KRACKEN: INTEGRATION OF A VESTIBULAR MODEL AND STATE ESTIMATOR FOR DISORIENTATION RESEARCH DEVICE (DRD) MOTION ALGORITHM APPLICATION

Jordan Dixon¹, Cortland Etgen², Torin Clark¹, Rich Folga²

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(Education - Program / Process Review Proposal)

BACKGROUND: The Disorientation Research Device (DRD) AKA the 'Kraken', is the Navy's newest and most powerful aerospace medicine research device. Designed for basic research, NAMRU-Dayton has established an applied research program centered on the Kraken to address pilot spatial disorientation (SD). One of the most important aspects of developing this world-class capability into a functional applied research tool is creating a valid computational model for human perception of motion in the six degrees of freedom the DRD provides. **DESCRIPTION:** The 'observer' model developed for this goal is an offline vestibular model that accurately predicts linear acceleration and angular velocity perceptions while providing a realistic vestibular state estimation. A collaborative effort between researchers from the University of Colorado and NAMRU-Dayton's Naval Aerospace Medical

Research Laboratory was undertaken to develop this observer model. This work was done in parallel with the first ever application of motion washout for commercial pilot subjects performing human-in-the-loop control inside the DRD. **DISCUSSION:** At the conclusion of the collaborative period, the augmented Kraken Motion Control team created an extensive compendium of washout filter methods and vestibular perception model data for the DRD. The output of these models are used to assess the veracity of complex motions perceived inside the DRD as compared to the simulated flight scenario, and subsequently optimize filtering methods. Moving forward, the observer model will be converted to a real-time, 'online' vestibular model and state estimator to be used in optimizing the DRD motion algorithm during simulated flights.

Learning Objective:

1. The audience will learn about the vestibular model and state estimation procedures used to optimize Disorientation Research Device motion algorithms.

[253] PREVALENCE OF MOTION SICKNESS SYMPTOMS REPORTED BY STUDENT-ATHLETES TRAVELING BY BUS TO AWAY GAMES AND COMPETING SHORTLY AFTER ARRIVAL

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State University of New York at Oneonta, Oneonta, NY, USA

(Original Research)

INTRODUCTION: Performance of athletes during a game that required a bus trip may be detrimentally influenced by several factors including susceptibility to motion sickness. Comments from women athletes indicated they requested bus drivers to avoid short-cuts and remain on the highway so as not to worsen their symptoms. This change in the route increased travel time-on-the-bus. The purpose of this research was to document the prevalence of motion sickness of a Division III sports program that travels by bus and shortly after arriving, competition began. **METHODS:** Eighty-five men and 84 women with a Mean age of 19.2 years volunteered their participation. All were college varsity athletes from the soccer, swimming/diving, tennis, volleyball, cross-country, and wrestling teams. They were administered the Motion Sickness Assessment Questionnaire (MSAQ) containing four subscales: Central, Peripheral, GI, and Sopite; the Motion Sickness Susceptibility Questionnaire (MSSQ-short form), and a questionnaire of their personal experiences of motion sickness, if any, as they traveled to away games. **RESULTS:** MSAQ% total was significantly correlated with MSSQ total, $r(167) = 0.74$, $p < 0.001$. For each athlete, using his/her MSAQ% total score, we identified a value of 50% or greater as being susceptible to motion sickness. Using a proportional z-test, significantly more women (32%) were identified as susceptible than men (10%), $p < 0.001$. Examining the MSAQ% GI subscale, significantly more women reported these symptoms (50%) than men (24%), $p < 0.001$. Three men and six women rated MSAQ GI% symptoms greater than 90%. Two women reported the maximum score possible, i.e., 100%. For both men and women who rated their likelihood of developing motion sickness symptoms on a 4-point scale (1 = none and 4 = severe) while traveling, MSAQ% total and the four subscales were significantly correlated, $r = 0.60$ to 0.71 , $p < 0.001$. **DISCUSSION:** Motion sickness is a serious issue for student-athletes expected to perform at their best shortly after arriving by bus. Teams that are identified as 2nd half teams where their performance overshadowed their earlier play may be due to resolving their symptoms by halftime. From our interviews, athletes do not readily share their susceptibility nor discuss their unique attempts to control their symptoms. Introducing the athletes to different countermeasures may be beneficial to identify other techniques to reduce/control their symptoms.

Learning Objectives:

1. Understand and be made aware of the symptoms of motion sickness after a bus trip and the possible effect these symptoms may have on game performance.
2. Begin a mentoring program for student-athletes to discuss the prevalence of motion sickness, identify their techniques to reduce motion sickness, and sharing other countermeasures that may be more effective.

[254] TO SPIN OR NOT TO SPIN: A CASE SERIES FROM THE USASAM MOTION SICKNESS DESENSITIZATION PROGRAM

Joseph Pavelites, Ryan Green, Alex Marulanda
US Army School of Aviation Medicine, Fort Rucker, AL, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This poster presents a case series of US Army aviation students who were referred to the U.S. Army School of Aviation Medicine (USASAM) Motion Sickness Desensitization Program. Motion sickness is not an uncommon problem for US Army pilots and aircrews. Episodes of motion sickness can be disruptive in flight, endangering personnel and negatively impacting mission success. The US Army Motion Sickness Desensitization Program is carried out at the US Army School of Aviation Medicine at Fort Rucker, AL. The program is currently based on teaching participants arousal recognition, relaxation and motion tolerance techniques utilizing the Barany Chair. However, not all participants are appropriately referred to the program. Motion sickness desensitization participants are occasionally enrolled directly by USASAM staff but are most commonly referred by junior aeromedical providers from the local flight medicine clinic. Referrals are predominantly derived from Fort Rucker initial flight training students. USASAM staff, that includes a senior flight medic, aeromedical psychologist and senior aeromedical physician, interview each referral to assess need and appropriateness of desensitization training. **CASE PRESENTATION:** This poster presents a series of five aviation students referred for motion sickness desensitization who may have conditions not amenable to desensitization training or who sought outcomes that did not necessarily include returning to flight. **DISCUSSION:** Inappropriate referral to motion sickness desensitization programs may subject patients to needless treatment and training and can place unwanted demands on the program. However, such referrals do give more senior aeromedical providers the opportunity to better disposition health concerns misdiagnosed as air sickness. In this presentation aeromedical disposition of these cases are discussed. In addition, the interplay between US Army desensitization training, "Close Hold" status and the possible impact of newly acquired spatial disorientation flight simulators in the desensitization protocol will be discussed.

Learning Objectives:

1. Participants will learn about the motion sickness desensitization protocol used by USASAM.
2. Participants will learn how the USASAM Motion Sickness Desensitization Program can be a gateway for further medical care or counseling unrelated to the initial referral.

[255] IMPORTANT FLIGHT PERFORMANCE ASPECTS DURING MILITARY HELICOPTER FLIGHT: A DELPHI STUDY

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Endorsed by: International Association of Military
Flight Surgeon Pilots

(Original Research)

INTRODUCTION: In military flight, pilots must maintain a high performance level to ensure the success of a mission. During flight, pilots can be exposed to different internal and external stressors such as fatigue and hypoxia that can affect their alertness levels and as a result their flight performance. A flight is composed of many flight performance aspects. However, not all of these aspects are equally important for the success of a mission. When investigating the influence of a stressor on flight performance, it is important to understand not only which flight performance aspects are important for the success of a mission, but also which of these aspects will be most affected by reduced pilot alertness. **METHOD:** A total of 136 helicopter pilots of the Royal Netherlands Air Force (RNLAf) of all pilot qualification levels were invited to participate in a three-round ranking Delphi study. The first round included all the pilots, regardless of their qualification level. The second and third rounds

included only the flight instructors. After the first round all the terms describing the same aspect were grouped and provided with one consolidated description. In the second and third rounds the flight instructors received consolidated lists of the items from the previous round in a random order. **RESULTS:** 41 (30%) pilots completed the first questionnaire round and 20 (77%) flight instructors completed the ranking round. After the first questionnaire round a total of 21 consolidated groups were identified. The 21 groups were composed of five technical skill (TS) elements and 16 non-technical skill (NTS) elements. The top ten ranked skills elements were comprised out of seven NTS – namely awareness of the environment, decision making, workload management, stress management, planning and coordinating, general knowledge, and basic fitness – and three TS, that is, advanced aircraft handling, flight maneuvers and procedures, and abnormal and emergency procedures. The top three ranked skill elements (awareness of environment, decision making, and workload management) were considered by the flight instructors to be most highly influenced by reduced pilot alertness. **CONCLUSION:** NTS are considered more important and more affected by reduced pilot alertness during operational helicopter flight compared to TS. During flight, poor NTS can increase the chance of error, which in turn can increase the chance of an adverse event, even if the pilot has high TS.

Learning Objectives:

1. The use of a ranking Delphi method as a tool to investigate which flight performance aspects are important during flight and are most affected by reduced pilot alertness.
2. Become familiar with the pilot skills flight instructors considered more important and most influenced by reduced alertness during operational military helicopter flight.

[256] IN-EAR PULSE OXIMETRY FOR IN-FLIGHT PHYSIOLOGICAL MONITORING

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(Education - Program / Process Review Proposal)

BACKGROUND: Unexplained Physiological Events (UPEs) are events with hypoxia-like symptoms which have recently caused operational pauses of various USAF and USN aircraft. The DoD lacks forensic data to identify event root causes, and operators lack objective means to confirm them real-time, degrading aviator confidence. **OVERVIEW:** A custom-molded in-ear pulse oximeter placed with commonly-used communication earpieces was recently shown to be feasible by the Air Force Research Laboratory (AFRL). In-ear pulse oximeters are small, resistant to motion artifact and centralization, and are compatible with common flight gear. The system would provide in-flight physiological monitoring for early detection and warning of hypoxia onset. Final capabilities will include transmission of vital signs of an isolated person during search and rescue operations after aircraft egress. **DISCUSSION:** Physiological events can have a variety of root causes which all have similar symptoms, such as hypoxia, hypocapnia, and dehydration. These events and their root causes are currently identified solely from subjective symptom recognition by the operator without any method of objective confirmation. Because of the multiple root causes, it may be possible that some of these UPEs are not due to hypoxia at all. In-flight physiological monitoring would allow for early detection and warning while also providing data recording for post-flight analysis. Utilizing the signal to determine relative perfusion to the head would also allow for quantitative post-flight analysis of the effectiveness of a pilot's Anti-G Straining Maneuver. Additionally, not all aircraft egress events leave the individual in a condition which allows them to operate their CSEL radio. A capability to transmit the individual's vital signs after egress would provide valuable information to search and rescue forces on the isolated person. Currently, the project has defined the design requirements and has undergone initial prototyping, with a minimally viable product for ground testing to be produced within the next 6 months.

Learning Objectives:

1. The audience will learn about one current effort to solve the Unexplained Physiological Events.
2. The audience will learn about how wearable physiological sensors can be applied to Search and Recovery operations.

[257] SIMULATING A VIRTUAL HIGH-PERFORMANCE AIRCRAFT PILOT USING PHYSIOLOGICALLY-BASED PHARMACOKINETIC MODELING

Tammie Covington¹, Darrin Ott², Jeffery Gearhart², Heather Pangburn³

¹USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA; ²USAF School of Aerospace Medicine, Aeromedical Research Department, Force Health Protection, Wright-Patterson AFB, OH, USA; ³711 Human Performance Wing, Wright-Patterson AFB, OH, USA

(Original Research)

INTRODUCTION: Recent increases in reported respiratory symptoms among pilots of high-performance aircraft could be a result of exposure to various chemical irritants passing through the onboard oxygen generation system. Previous work used pre- and post-flight pilot exhaled breath samples in conjunction with physiologically-based pharmacokinetic (PBPK) modeling and Monte Carlo analysis to predict in-flight concentration ranges for some possible inhalation exposures. However, these reconstructions did not account for differences in pharmacokinetics due to flight conditions such as altitude and G-forces. **METHODS:** The work presented here utilizes an updated PBPK model in which linear equations were incorporated to describe changes in ventilation, cardiac output, and tissue blood flows due to G-forces. Available data on arterial pressure changes due to G-force changes were used to define these equations. Times, durations, and G-force magnitudes were then randomly selected to simulate G-force maneuvers during a 1-h flight, and potential exposures for isopropanol, acetone, and toluene were reconstructed. Work on implementing a more complex model to adjust physiology based on pressure changes due to altitude and G-forces is ongoing. This model will incorporate sub-models for the oxygen delivery, pulmonary, and cardiovascular systems. **RESULTS:** Exposure reconstructions using the modified PBPK model were compared to the previously determined exposure ranges and were affected by the simulated G-force maneuvers, particularly for exposures during a maneuver. In particular, concentrations for simulated exposures occurring during a simulated maneuver were lower than the corresponding concentrations estimated previously. Simulated maneuvers of longer length or exerting more G-forces could have an even larger impact. It is expected that incorporation of more complex methods of accounting for physiology changes will have more of an effect on predicted exposure concentrations. **DISCUSSION:** This work demonstrates the importance of accounting for in-flight physiology changes in predicting in-flight exposures. By expanding the current PBPK model paradigm to the physiological changes of high-performance aircraft flight, a capability is being developed to assess true pilot physiology in a "virtual" context, which will help produce aircraft cabin exposure guidelines to ensure limited probability of contaminated cabin spaces that might contribute to reported symptomatology.

Learning Objective:

1. The audience will learn about ongoing work to develop a physiologically-based pharmacokinetic model to simulate a "virtual" pilot to be better able to predict potential exposures and develop safety standards.

[258] COMPUTATIONAL FLUID DYNAMICS PREDICTION OF AIRCRAFT EXHAUST THERMAL AND CHEMICAL POLLUTANT DISPERSION IN A FLIGHT LINE SETTING

Steven Fisher, Dan Reilly
UES, Inc., Beavercreek, OH, USA

(Original Research)

INTRODUCTION: There are concerns at Luke Air Force Base that aircraft exhaust is causing extraneous thermal and chemical exposures to Air Force personnel due to an expanding number of high-thrust, fifth-generation fighter aircraft. Computational fluid dynamics simulations compared exhaust plume structure in two proposed infrastructure designs with three wind conditions to provide insight to aid in future parking structure designs in an effort to reduce Air Force pilot and maintainer thermal and chemical exposure. **METHODS:** Six computational fluid dynamics solutions were developed in a parametric study to

predict chemical transport and thermal plume structure. Geometries with and without a blast shield bisecting rows of aircraft were simulated for wind conditions perpendicular, parallel, and at a 45° angle to the blast shield. Each model employed eight aircraft simulated to 15% thrust, a typical flight line taxi condition. The predictions were investigated at typical maintainer and pilot working locations and compared to standard exposure limits. **RESULTS:** The addition of a blast shield changed the aircraft exhaust plume structure. The no blast shield cases showed plume-to-plume interaction, while the blast shield cases showed plume-to-shield interaction, which then became plume-to-plume interaction after exceeding the height of the blast shield. Plume-to-plume interaction without a blast shield created flow eddies coincident with the flight line at a greater magnitude than in the plume-to-shield cases. Carbon monoxide concentration values exceeded the 8-h time-weighted average threshold limit value in the absence of the blast shield, but not in the presence of the blast shield. Carbon dioxide concentration values were well below exposure limits for the majority of pilot and maintainer working locations with and without the blast shield. In all cases, wind greatly influenced nearfield plume structure, causing thermal and chemical plume transport into subsequent sunshades under certain conditions. **DISCUSSION:** The solutions predicted that a blast shield addition will reduce, but will not eliminate chemical and thermal exposures, especially under certain wind conditions. Future simulations have the potential to investigate transient plume physics (change with time), aero-acoustics, particulate matter, aircraft movement, atmospheric wind, expanded geometry, other thrust values, and exhaust pollutant re-entrainment.

Learning Objective:

1. Understand the effectiveness of predicting flight line improvements and the resulting effect on personnel exposure to thermal and chemical stimulus prior to installation using computational fluid dynamics.

Wednesday, 05/08/2019

10:30 AM

Brasilia 1

[S-51] PANEL: U.S. NAVY AEROMEDICAL DISPOSITION – WILSON DISEASE IN A NAVY PILOT

Sponsored by Society of U.S. Naval Flight Surgeons

Chair: Kai Yan Cheng

Co-Chair: Joseph LaVan

PANEL OVERVIEW: Wilson disease is an autoimmune recessive disorder of copper metabolism due to an impairment of cellular copper transport. The result of the dysfunction causes an abnormal accumulation of copper throughout the body, including the liver, brain, and cornea. Predominately, patients present with hepatic, neurologic, and psychiatric symptoms. Due to the rarity of the disease, patients may be initially misdiagnosed with a more common condition. If left untreated Wilson disease is eventually fatal due to cirrhosis and progressive neurologic deficits. Therefore, it is important for aeromedical providers to be familiar with this disease and consider screening in the appropriate clinical context. This session will cover a case of a Navy pilot with neurologic and psychiatric symptoms who was evaluated at the Naval Aerospace Medical Institute (NAMI). This panel will highlight the clinical complexity of Wilson Disease and its impact to safety of flight and the mission.

[259] HEPATIC COMPLICATIONS OF WILSON DISEASE

Ian Porter, Kai Cheng, Edwin Park

Naval Aerospace Medical Institute, Pensacola, FL, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This presentation is from the internal medicine perspective. It is part of a combined Wilson disease case panel and is meant to inform the aviation community on the diagnosis, safety, and mission impact on flight of this disease. **BACKGROUND:** Wilson disease is a multi-organ disorder which is inherited in an autosomal recessive (AR) manner. Common clinical manifestations involve the liver, neurological,

and psychiatric organ systems in addition to clinical exam findings in the skin and eyes. This disease can present a challenging disposition in aviation medicine. **CASE PRESENTATION:** Wilson disease has an AR hereditary pattern with the prevalence estimated to be 1 per every 30,000 live births. Age of diagnosis varies from 5-35 years old with a mean age of 13 years. Clinical manifestations in the liver are common in the 18-84% range. Signs and symptoms include abdominal pain secondary to acute hepatitis or liver failure, jaundice, hepatomegaly, cirrhotic liver sequela such as ascites and splenomegaly. Common lab findings are low serum ceruloplasmin, elevated aminotransferases, coagulopathy and Coombs-negative hemolytic anemia. Differential diagnosis for this disease can include hepatitis, other hereditary disorders such as alpha-1 antitrypsin and hemochromatosis, and alcohol misuse. Prognosis can vary depending on disease burden upon presentation which can include death secondary to liver failure. **DISCUSSION:** Wilson disease can present a challenging disposition in aviation medicine since it is rare, and age of diagnosis can vary. The motivation for this panel presentation was the presentation and diagnosis of this disease at the Naval Aerospace Medical Institute (NAMI), Pensacola, FL. Although rare, this case underscores the pertinence and importance of being prepared to manage this disease. Per the Manual of the Medical Department U.S. Navy a history of Wilson Disease is disqualifying for duty involving flight and a waiver is on a case by case basis. Untreated disease can be fatal with an estimated mortality of 95% for patients presenting with liver failure. Treatment can include the need for dialysis, chelating agents, and liver transplant all of which in addition to clinical manifestations, impose a heavy burden on flight safety.

Learning Objectives:

1. Understand how Wilson Disease poses risk to the liver and related organ systems.
2. Learn about diagnosis and prognosis of Wilson Disease.
3. Relate clinical disease burden to the flight environment and how it impacts aviation screening, the mission, and human performance.

[260] NEUROLOGIC PRESENTATION OF WILSON DISEASE IN A NAVAL AVIATOR

Sean Haight, Edwin Park

Naval Aerospace Medical Institute, Pensacola, FL, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This presentation is from the Neurology perspective. It is part of a combined Wilson disease case panel and is meant to inform the aviation community on the diagnosis, safety, and mission impact on flight of this disease. **BACKGROUND:** Wilson disease is a multi-organ disorder which is inherited in an autosomal recessive (AR) manner. Common clinical manifestations involve the liver, neurological, and psychiatric organ systems in addition to clinical exam findings in the skin and eyes. This disease can present a challenging disposition in aviation medicine. **CASE PRESENTATION:** Wilson disease has an AR hereditary pattern with the prevalence estimated to be 1 per every 30,000 live births. Age of diagnosis varies from 5-35 years old with a mean age of 13 years. Neurological diagnosis can be difficult due to the myriad ways it can present. Symptoms can be very subtle or rapidly progressive resulting in severe disability within months. The majority of Wilson neurologic symptoms fall into one of five categories: dysarthric, dystonic, tremulous, pseudosclerotic, or parkinsonian. As the disease progresses complex combinations of neurologic signs and symptoms may be present. Symptoms depend upon where the copper deposits in the central nervous system with the most common locations being basal ganglia and midbrain. **DISCUSSION:** Wilson disease can present a challenging disposition in aviation medicine since it is rare, and age of diagnosis can vary. The motivation for this panel presentation was the presentation and diagnosis of this disease at the Naval Aerospace Medical Institute (NAMI), Pensacola, FL. Although rare, this case underscores the pertinence and importance of being prepared to manage this disease. The current standing of the FAA is that Wilson disease is managed on a case by case basis. Given the many potential neurologic symptoms of untreated Wilson disease it is obvious that good treatment compliance is required before any FAA waiver can be considered. Treatment can include the need for dialysis, chelating agents, and liver transplant all of which in addition to clinical manifestations, impose a heavy burden on flight safety.

Learning Objectives:

1. Understand the complex combinations of neurologic signs and symptoms of Wilson Disease.
2. Understand the neurologic pathology of Wilson Disease.
3. Relate clinical disease burden to the flight environment and how it impacts aviation screening, the mission, and human performance.

[261] OPHTHALMOLOGIC IMPLICATIONS OF WILSON DISEASE

Jeremy McCullough

Naval Aerospace Medical Institute, Pensacola, FL, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This presentation is from an ophthalmologic perspective and is part of a combined Wilson disease case panel meant to inform the aviation community on the diagnosis, safety, and mission impact on flight of this disease. **BACKGROUND:** Wilson disease, also called hepatolenticular degeneration, is an autosomal recessive mutation of copper metabolism due to mutation of the ATP7B gene in chromosome 13. This genetic mutation causes excessive levels of copper in the body. Clinical manifestations include copper deposition in the liver, central nervous system, skin, and eyes. Prognosis varies greatly depending on the extent and location of copper deposition. **CASE PRESENTATION:** The ocular findings for patients with Wilson disease include sunflower cataracts and Kayser-Fleischer (KF) rings. The presence of a Kayser-Fleischer ring is pathognomonic for a diagnosis of Wilson disease. The KF rings are visible to the naked eye and on slit lamp examination. A KF ring may appear greenish-yellow to golden-brown and is located in the corneal limbus due to copper deposition in the Descemet membrane. Due to their location, these rings do not generally affect visual acuity. KF rings are seen in 95% of patients presenting with neurological complaints and 65% with liver involvement. Sunflower cataracts are a rare ocular finding of Wilson disease that occurs in approximately 1.2% of patients. They are caused by deposition of copper in the anterior capsule of the lens and normally do not impact visual acuity. Kayser-Fleischer rings and sunflower cataracts will typically resolve with penicillamine therapy. **DISCUSSION:** A diagnosis of Wilson disease is considered disqualifying for naval aviation with waivers considered on a case-by-case basis. The disposition is not related to ophthalmic findings of Kayser-Fleischer rings or sunflower cataracts, given they rarely impact visual acuity. Hepatic and neurologic involvement have a greater impact on fitness for flight. If left untreated Wilson disease has a significant mortality rate. Treatment options include dialysis and liver transplant, which pose a significant risk to naval aviators and increase the difficulty of disposition for flight status.

Learning Objective:

1. Understand the aeromedical implications of Wilson's Disease on the military aviator.

[262] PSYCHIATRIC COMPLICATIONS OF WILSON DISEASE

Erik Anderson, Kai Cheng, William McDonald

Naval Aerospace Medical Institute, Pensacola, FL, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This presentation is from the psychiatric perspective. It is part of a combined Wilson's disease case panel and is meant to inform the aviation community on the diagnosis, safety, and mission impact on flight of this disease. **BACKGROUND:** Wilson's disease is a multi-organ disorder which is inherited in an autosomal recessive (AR) manner. Common clinical manifestations involve the liver, neurological, and psychiatric organ systems in addition to clinical exam findings in the skin and eyes. This disease can present a challenging disposition in aviation medicine. **CASE PRESENTATION:** With hepatic cell death due to copper accumulation, copper is increasingly released into the serum and deposited in other tissues including the CNS. On pathology the brain may appear grossly normal, but in advanced disease the putamen, caudate nucleus, and frontal lobes may show degeneration and discoloration, along with pathognomonic formation of Opalski cells in the globus pallidus. Although women are more likely to develop acute liver failure, men have been shown to be at greater risk of developing neuropsychiatric disease from these degenerative changes. The progressive psychiatric manifestations include depression (20-30%), personality changes, irritability, disinhibition, and psychosis. These symptoms may precede recognition of hepatic or neurologic

disease despite the prerequisite accumulation of copper in those tissues, and as such psychiatric symptoms are often misattributed and diagnosis delayed. Differential diagnoses include depression, bipolar disorder, schizophrenia, dementia, and substance abuse, but pathognomonic Kayser-Fleischer rings and a positive 1st-degree relative should raise suspicion when presented with unexplained psychiatric changes. **DISCUSSION:** Wilson disease is rare (1 in 30,000) and highly variable in age of diagnosis and clinical manifestation, but if recognized early and adequately treated prior to developing liver failure or advanced neurologic disease, the patient can have symptom resolution and a normal life expectancy. Treatment includes a low copper diet, zinc salts, and chelating agents, but may require dialysis and liver transplantation with advanced disease. The Navy Aeromedical Reference & Waiver Guide does not currently contain recommendations for Wilson disease, zinc supplements, or chelation, and as such the aeromedical disposition should be considered on a case-by-case basis concurrent with the FAA approach.

Learning Objectives:

1. Understand how Wilson Disease poses risk to the liver and related organ systems.
2. Learn about diagnosis and prognosis of Wilson disease.
3. Relate clinical disease burden to the flight environment and how it impacts aviation screening, the mission, and human performance.

[263] RADIOLOGY IN WILSON DISEASE "I CU ON MRI!"

Michael Kaselis

Naval Aerospace Medical Institute, Pensacola, FL, USA

(Education - Case Study: Clinical / Human Performance)

BACKGROUND: Wilson disease is a condition arising from defective incorporation of copper into ceruloplasmin and impaired biliary excretion resulting in abnormal accumulation in various tissues, particularly in the liver and brain. The condition is genetic, autosomal recessive, caused by a defective ATPase copper transporting beta-poly-peptide (ATP7B) gene located on chromosome 13q14.3-q21.1. As a result, copper accumulates throughout the brain with particular tendency to extensively damage the bilateral basal ganglia. Characteristic brain lesions are caused by accumulation of copper, chronic ischemia, vasculopathy and/or demyelination. Diagnosis of Wilson Disease is made by a low serum ceruloplasmin levels, Kayser-Fleischer rings, and an elevated urinary copper excretion. However, brain imaging may be prudent to exclude other etiologies known to cause neurologic deficits. Brain MRI is the modality of choice and often are abnormal particularly in patients with neuropsychiatric symptoms. Findings may include abnormal T-2 signals in the basal ganglia, brainstem, and white matter. **CASE PRESENTATION:** The subject is a 28yo Navy pilot with a history of major depression who developed psychomotor agitation that was attributed to a SSRI-induced akathisia. Upon further laboratory evaluation the member was found to have a low serum ceruloplasmin level of 6.7mg/dL suspicious for Wilson Disease. A non-contrast MRI of the brain showed bilateral symmetric linear lateral putaminal T2 hyperintensity and symmetric hyperintensity of the thalami / posterior limb of the internal capsule. There was no evidence of herniation, hydrocephalus, or acute ischemia. These findings are compatible with a clinical history of Wilson Disease. **DISCUSSION:** Wilson disease can present a challenging disposition in aviation medicine since it is uncommon and the age of diagnosis and clinical presentation can vary. Though the diagnosis is made by clinical features and laboratory findings, additional tests to include a brain imaging may be necessary to exclude other pathologies. It is therefore important for clinicians to be aware of MRI findings and the differentials. Per the Manual of the Medical Department U.S. Navy a history of Wilson Disease is disqualifying for duty involving flight and a waiver is on a case by case basis. Brain imaging is an important tool that can aid in aeromedical dispositions and management.

Learning Objectives:

1. Clinical Presentation, epidemiology and pathophysiology of Wilson disease.
2. Imaging recommendations and common findings.
3. Differential diagnosis.

Wednesday, 05/08/2019

10:30 AM

Brasilia 2

[S-52] SLIDE: G-LOC: FROM FUGE TO FLIGHT

Chair: Rob Monberg

Co-Chair: Mari Metzler

10:30 AM

[264] PULMONARY TRAPPING OF GAS AS INFLUENCED BY +Gz LOAD AND PRESSURIZATION OF THE ABDOMINAL AND LEG PORTIONS OF THE OF THE ANTI-G SUIT

Mikael Gronkvist¹, Per Gustafsson², Ola Eiken¹

¹Royal Institute of Technology (KTH), Stockholm, Sweden; ²Central Hospital, Skövde, Sweden

(Original Research)

INTRODUCTION: Increased gravito-inertial load in the head-to-foot direction (+Gz) and inflation of an anti-G suit (AGS) affects ventilation distribution in the lungs, functional residual capacity (FRC), and volume of trapped gas (VTG). We reasoned that the AGS effects might be due to increased intra-thoracic blood volume, predominantly resulting from lower limb compression and/or to basilar lung compression due to elevation of the diaphragm resulting from abdominal compression. The aim was to differentiate AGS effects induced by the abdominal and leg portions of the suit. **METHODS:** Healthy men (n=11), equipped with a full coverage AGS, modified to allow separate or combined inflation of the abdominal (ABD) and leg (LEG) portion of the suit, performed a multiple breath washout of 4% sulfur hexafluoride at 1, +2 and +3Gz, without AGS inflation and at +2 and +3Gz with separate and combined inflation to 12 kPa of the ABD and LEG. VTG was calculated from inert gas mobilized using three vital capacity breaths at the end of the tidal breathing washout. Lung clearance index (LCI) was used to assess overall ventilation distribution. **RESULTS:** Gz elevation without AGS, increased LCI by 9% and 17%, FRC by 6% and VTG by 40% and 104% at +2 and +3Gz, respectively. At +2 and +3Gz, separate compression of LEG and ABD reduced FRC and induced a slight increase in VTG but did not further affect LCI. Combined LEG and ABD compression caused a substantial reduction in FRC and increase in VTG compared to either factor alone, but did not further affect LCI. **CONCLUSION:** That, at increased G load, LCI was unaffected by combined LEG and ABD compression despite a marked increase in VTG might indicate substantial basilar airway closures masking any additional deterioration in ventilation distribution.

Learning Objective:

1. Effects of the abdominal and leg bladders of an anti-G suit on lung function.

10:45 AM

[265] CARDIOVASCULAR ADAPTATIONS TO 5 WEEKS OF +Gz EXPOSURES IN THE RELAXED STATE

Ola Eiken¹, Michael Keramidis², Hakan Skoldefors², Roger Kolegard²

¹Royal Institute of Technology (KTH), Stockholm, Sweden;

²Environmental Physiology, Royal Institute of Technology (KTH), Stockholm, Sweden

(Original Research)

INTRODUCTION: Despite decades of experience from high-G exposures in aircraft and centrifuges, information is scarce regarding primary cardiovascular adaptations to +Gz loads in relaxed humans. Thus, effects of G-training are typically evaluated after regimens that are confounded by concomitant use of anti-G straining maneuvers, anti-G suits and pressure breathing. Accordingly, the aim was to evaluate cardiovascular adaptations to repeated +Gz exposures in the relaxed state. **METHODS:** Eleven men underwent 5 weeks of centrifuge G training, consisting of 15 x 40 min +Gz exposures at G levels corresponding to 60-80% of their individual relaxed G-level tolerance. Before and after the training regimen, relaxed G-level tolerance was investigated during rapid and gradual onset rate G exposures (ROR, GOR), and cardiovascular responses were investigated during orthostatic provocation, vascular pressure-distension tests, and during local cold stress.

RESULTS: The G training resulted in: (i) a 13% increase in relaxed ROR G tolerance ($p < 0.01$), but no change GOR G tolerance, (ii) increased pressure resistance in the arteries and arterioles of the leg ($p < 0.01$), (iii) increased total peripheral blood-flow resistance under basal resting conditions and during both orthostatic provocation and local cold stress ($p < 0.05$).

DISCUSSION: The results suggest +Gz adaptation via enhanced myogenic reactivity in dependent arteries/arterioles. Presumably this reflects local adaptations to high transmural pressures, resulting from the +Gz-induced exaggeration of the intravascular hydrostatic pressure gradients.

Learning Objectives:

1. The audience will learn about cardiovascular adaptations to +Gz loads in relaxed humans.

11:00 AM

[266] DETERMINATION OF DEGRADED PHYSIOLOGIC STATE DURING +Gz-STRESS USING THE HOLISTIC MODULAR AIRCREW PHYSIOLOGIC STATUS (HMAPS) MONITORING SYSTEM

Barry Shender¹, Jessica Anderson², Phillip Whitley³, Jeremy Beer⁴
¹Naval Air Warfare Center Aircraft Division, Patuxent River, MD, USA;
²Athena GTX, Johnston, IA, USA; ³Criterion Analysis, Miami, FL, USA;
⁴KBRwyle Science & Space, Brooks City-Base, TX, USA

(Original Research)

INTRODUCTION: To detect and predict the onset of in-flight "physiological episodes," the US Navy is developing HMAPS, a real-time physiologic monitoring/warning system that unobtrusively estimates aircrew vital and cognitive status. **METHODS:** HMAPS is an open-architecture, body-mounted, aircraft-independent system that measures pulse oximetry (SpO₂), pulse rate (PR), ECG, acceleration, barometric pressure, temperature, and humidity. It derives respiration rate and heart rate complexity. HMAPS uses these data as inputs to three prediction-detection algorithms. A cognitive impairment index (CI) estimates cerebral reserve and relates it to SpO₂ and multi-task performance. A Summary State (SS) index fuses the vital signs to estimate overall status. CI and SS have 5-point scales where 5 indicates the most degradation. A G-fatigue (G-F) index based on heart rate and G-dose estimates severity of exposure from 100% (no fatigue) to 0%. Trials were conducted at KBRwyle's Brooks City-Base, TX, human centrifuge. Eight volunteers (24-41 yr; 1 female) gave their informed consent and were exposed to a gradual onset run to +7.5Gz (0.1G/s; followed by four rapid onset (6G/s, ROR) exposures to +5Gz for 30s, +6Gz for 30s, +7Gz for 20s, +7.5Gz for 20s; then a 140s "Woody" simulated aerial combat maneuver profile, which simulates the +Gz-stress of repeated 1 vs. 1 F/A-18 passes. Then, the ROR sequence was repeated. A minimum 2-min rest separated the runs. Subjects wore an anti-G suit and performed anti-G straining maneuvers. They reported their light loss (LL) after each run as percent loss of peripheral and central vision. **RESULTS:** To determine how well the indices reflected reported symptoms, mean±1 SD of indices were compared to reported LL. +5Gz ROR responses were: 1st run: 0% LL, CI=3.3±0.5, SS=3.3±1.2, G-F=89.0±0.8, PR=126±18, SpO₂=85±8; 2nd run: 0% LL, CI=3.1±0.4, SS=3.0±1.4, G-F=88.4±1.3, PR=127±17, SpO₂=89±8. +7.5Gz ROR responses were: 1st run: LL ranged from 0 to 50%, CI=4.1±0.4, SS=4.0±0.8, G-F=61.4±6.1, PR=141±20, SpO₂=86±7; 2nd run: LL ranged from 0 to 100%, CI=4.2±0.4, SS=4.7±0.5, G-F=59.2±2.3, PR=146±14, SpO₂=91±5. The Woody responses were: LL ranged from 0 to 100%, CI=4.3±0.5, SS=4.8±0.5, G-F=61.6±23.9, PR=147±17, SpO₂=79±8.

DISCUSSION: The indices appear to track with the increased stress of higher +Gz-loads and fatigue, as reflected by LL and G-dose. Additional centrifuge and altitude chamber tests are on-going to refine the algorithms.

Learning Objective:

1. To understanding how the HMAPS system detects increasing stress relevant to fast jet high +Gz exposures.

11:15 AM

[267] 5th GENERATION AIRCRAFT ANTI-G-STRAINING MANEUVER (AGSM) HEAD-UP DISPLAY (HUD) ASSESSMENT PROGRAM CHALLENGES

Thomas Massa
 U.S. Air Force, Yorktown, VA, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Since the early 1990s, a successful program to assess pilot AGSM performance using analog HUD tape review during the G-Awareness exercise and tactical phases of flight has been the gold standard to critique pilot AGSM technique and continuity in both legacy (e.g. F-15, F-16) and now 5th generation aircraft (e.g. F-22, F-35). To continue identifying AGSM deficiencies that can lead to degraded performance and/or G-Induced Loss of Consciousness (GLOC), it is important for Aerospace medical professionals to understand the challenges of digital AGSM HUD assessment in modern day fighter aircraft. This presentation will identify program challenges with assessing digital 5th generation aircraft HUD audio/video hot mic to enable medical professionals to provide valuable AGSM performance feedback to pilots and mitigate potential GLOC mishaps. **OVERVIEW:** Air Force Pamphlet 11-419, G-Awareness for Aircrew directs pilots to use aircraft hot mic audio during the G-awareness exercise so the AGSM can be reviewed during debrief. For legacy aircraft, this process is effective at providing recognizable breath by breath audible feedback as a debriefing tool for the instructor, pilot, and Aeromedical specialist. However, 5th generation fighter aircraft use personal computer debriefing systems integrated with autonomic logistics information system program computers for HUD debrief. The playback audio is dependent on how the pilot adjusts the aircraft volume settings and how the data transfers to the debriefing software system which is often inconsistent as an assessment tool. A series of AGSM HUD review assessment techniques were developed for specialists to use as a checklist while assessing 5th generation HUD AGSM breathing components to standardize the practice and overcome assessment difficulties. **DISCUSSION:** Incorporating solutions to effectively review digital AGSM HUD reviews are critical to the future of flight safety and mitigation of GLOC. Educating and training Aerospace Medicine personnel (e.g. Flight Surgeons, Physiologists) on the limitations of proper AGSM assessment reinforces sound AGSM techniques and helps minimize pilot performance execution error regardless of what generation fighter is flown. This type of specific training is key to building a cadre of medical professionals capable of providing timely and effective AGSM performance critiques for pilots.

Learning Objective:

1. The participant will be able to understand Head-Up Display objective techniques to help them assess pilot Anti-G-Straining Maneuver performance in 5th generation fighter aircraft.

11:30 AM

[268] G-LOC DUE TO THE PUSH-PULL EFFECT IN A FATAL U.S. AIR FORCE THUNDERBIRD MISHAP

Mari Metzler
 U.S. Air Force, Panama City, FL, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: On 4 April 2018, the U.S. Air Force Aerial Demonstration Team (known as the Thunderbirds) suffered their first fatal mishap in 36 years. **BACKGROUND:** The ultimate cause of the mishap was G-induced loss of consciousness (G-LOC) due to a reduced +Gz tolerance brought about by sustained -Gz prior to pulling +Gz, a phenomenon known as the push-pull effect, after the flight control inputs necessary to cause it. **CASE PRESENTATION:** The Mishap Pilot (MP), a 34-year-old male with no flight-disqualifying medical conditions, was practicing a precise aerial maneuver known as a "high bomb burst rejoin" at a training area near Las Vegas, NV, when the mishap occurred. This maneuver required the MP to pull the mishap aircraft (MA), an F-16C, into a vertical pull known as an Immelmann, followed by sustained inverted flight (-1Gz), 22 seconds in this case. The inverted flight was then followed by a descending half loop known as a Split-S, whereby the MP pulled the MA immediately from inverted flight at -2.06 Gz towards the ground, pulling a maximum of +8.56 Gz in less than 5 seconds. At this point, the MP suffered G-LOC, as evidenced by minimal flight control inputs for 5 seconds, which was recorded by the MA crash-survivable memory unit (CSMU). Immediately following this, the CSMU recorded a change in throttle settings (from IDLE to MIL power), an aft stick pull, and a MA left roll, indicating the MP was again in control of the MA and attempting to recover. Unfortunately, the recovery maneuver was interrupted by contact with the ground. The MA impacted at 419 knots calibrated airspeed, 57 degrees nose low, in 89 degrees of left bank and a descent rate of 39,750 feet per minute. There

was no attempt to eject, and the MP was killed instantly on impact. This G-LOC was most likely a result of reduced +Gz tolerance, since it was preceded by prolonged -Gz, an example of the push-pull effect. **DISCUSSION:** The risks of +Gz exposure are well known among military, air racing, and aerobatic aircraft communities. Somewhat less well known are the adverse effects of -Gz when followed immediately by +Gz. The push-pull effect has a parasympathetic-like effect that greatly reduces +Gz tolerance. This tragic mishap represents an opportunity to educate high-performance aircrew about the deleterious effects of the push-pull effect.

Learning Objective:

1. The audience will learn about events that led to the first fatal Thunderbird mishap in 36 years.

11:45 AM

[269] AUTOMATED GROUND COLLISION AVOIDANCE SYSTEM: THE NAVY AND MARINE CORPS' RISK MITIGATION TOOL FOR CFIT AND G-LOC

Amanda Lippert, Michael Lippert

Marine Aviation Weapons and Tactics Squadron One, Yuma, AZ, USA

Endorsed by: Aerospace Physiology Society

(Education - Program / Process Review Proposal)

BACKGROUND: Automated Ground Collision Avoidance Systems (AGCAS) is the product of more than two decades of technical research and development by multiple agencies, including NASA and Air Force Research Labs (AFRL). After a 2006 SECDEF mandate to implement the system in all capable operational fighters, it was fielded in 2014 in USAF F-16s, and within a year had saved at least one pilot and aircraft. Efforts to field it in Navy and Marine Corps aircraft, however, were abandoned in 2011, until 2016, when a renewed interest in the technology from fleet aviators led to current programs of record for the F/A-18 Hornet family and the F-35B and C. **OVERVIEW:** The genesis of nascent AGCAS efforts in Naval Aviation and range of potential technical solutions are discussed as well as the expected path forward for the technology. **DISCUSSION:** In 2016, a trend of fatal Class A mishaps in Naval Aviation was noted to have similar conditions as recent U.S. Air Force flights that were saved using AGCAS technology. This prompted a major effort to canvas the U.S. Navy and Marine Corps F/A-18 community on the desire to implement the technology, and to address misperceptions regarding the maturity and capability of AGCAS in an effort to fuel the generation of an acquisition requirement. In 2017, the Marine Corps' Operational Advisory Group listed this capability gap as the number one requirement, which ultimately drove the need to investigate the implementation of an AGCAS-like system into the F/A-18. Other considerations, such as automating the Terrain Avoidance Warning System (TAWS), were also explored. In FY19, AGCAS became an official program of record for the F/A-18 platform for the Navy and Marine Corps. With AGCAS being fielded in FY19 and FY20 for the F-35A and F-35B, respectively, it is clear that this technology will remain a mitigation for G-LOC and CFIT for the generations of Naval Aviators to come.

Learning Objectives:

1. Explain the basic workings of the various Automated Ground Collision Avoidance Systems (AGCAS) available for U.S. Navy and Marine Corps F/A-18 and F-35 platforms.
2. Describe how AGCAS will function to save aircrew lives in the event of imminent Controlled Flight Into Terrain (CFIT) or G-Induced Loss of Consciousness (G-LOC).

Wednesday, 05/08/2019

10:30 AM

Brasilia 3

[S-53] PANEL: AEROSPACE MEDICINE BOARD REVIEW SERIES #2

Sponsored by The American Society of Aerospace Medicine Specialists

Chair: Timothy Burkhart

PANEL OVERVIEW: This panel will provide an opportunity for various aerospace medicine topics to be presented in a board review

fashion. Topics may include subjects within the areas of the flight environment, clinical aerospace medicine, and operational aerospace medicine.

[270] PATHOPHYSIOLOGY OF THE CARDIOVASCULAR SYSTEM FOR AEROSPACE MEDICINE

Gabriel Gizaw

US Navy, Pensacola, FL, USA

(Education - Tutorial Proposal)

INTRODUCTION: As we continue to plan a more extended duration spaceflight mission, we should review cardiovascular system capability from the pathophysiology perspective. Without the appropriate mitigation to counterbalance the impact of microgravity using aerobic and resistive exercise, the outcome can be costly among our astronauts (Callini, 2017) (Hughson, 2018). **BACKGROUND / LITERATURE REVIEW:** Cardiovascular disease remains the number one killer around the globe especially in developed nations. The pursuit of a space mission to Mars will remain a challenge if not countered by argues daily resistance exercise regimen. On earth, the condition impacted economically for those invested in the profession as flyers for the military or commercial by being grounded temporarily or permanently (Hughson, 2018). **CASE DESCRIPTION:** Long duration spaceflight studies among astronauts showed accelerated atherosclerosis compared to non-travel while in space travel and after return without the bias of physical athleticism (FAA, 2017). More studies are underway to ascertain further and alter the progression of the pathology (Callini, 2017). In order to better understand this type of pathology and others, we need to first review physiologic input from ventricular pressure-volume loop, contractility and frank-starling curves shift to gravitational change. This finding will help us to answer NASA's working group for predicting long-duration mission solutions (Hughson, 2018). **OPERATIONAL / CLINICAL RELEVANCE:** The discussion focus on earth in understanding the pathophysiology effect of flight among pilots in the military or civilian in mitigating risk, appropriate diagnostic test, monitor condition and consider reinstatement of flight status under closer observation (Callini, 2017).

Learning Objectives:

1. As we continue to plan a more extended duration spaceflight mission, we should review cardiovascular system capability from the pathophysiology perspective. Without the appropriate mitigation to counterbalance the impact of microgravity using aerobic and resistive exercise, the outcome can be costly among our astronauts (Callini, 2017) (Hughson, 2018).
2. Long duration spaceflight studies among astronauts showed accelerated atherosclerosis compared to non-travel while in space travel and after return without the bias of physical athleticism (FAA, 2017).
3. Understanding the pathophysiology effect of flight among pilots in the military or civilian in mitigating risk, appropriate diagnostic test, monitor condition and consider reinstatement of flight status under closer observation (Callini, 2017).

[S-53a] AEROSPACE MEDICINE EPIDEMIOLOGY & BIostatISTICS REVIEW

Jameson Voss

McLean, VA, USA

(Education - Tutorial)

INTRODUCTION: Epidemiology and biostatistics are core competencies for aerospace medicine professionals. The skills are often learned in academic settings and so real world applications within aerospace medicine practice are sometimes easy to miss. **TOPIC:** This session will focus on classic topics such as 1) definitions, importance, significance, variance, and confidence) 2) study designs, limitations, and analysis, and 3) screening test characteristics, interpretation, and implementation. **APPLICATION:** All topics will be woven together with a specific example about implementing a screening program for obstructive sleep apnea among pilot applicants. The amount of interaction during the session will achieve significance. Although there will be selection bias among the subpopulation choosing to attend, the counts of participant engagement are still expected to follow a Poisson distribution. Causal connections to

participant learning will be robust while any association with participant sleeping would be spurious.

Learning Objective:

1. Participants will synthesize classic epidemiology and biostatistics topics for application in sleep apnea screening.

[S-53b] SORTING OUT VERTIGO IN THE AVIATOR

David G. Schall

FAA, Civil Aerospace Medical Institute Oklahoma City, OK, USA

(Education – Tutorial)

INTRODUCTION: Accurate evaluation and treatment of the Vertiginous flyer is critical in assessing whether they may safely return to flying duties. Misdiagnosis is common and can have adverse effects to the career aviator. The age of our aviators continues to increase and along with this so does the range of differential diagnoses that may be causing vertigo in the aviator. New conditions, such as Migrainous Vertigo, are diagnosed more frequently. You can't diagnose what you have never heard of. **APPLICATION:** Having an understanding of the presentation, physical findings and available testing now used in the evaluation of vertigo is essential to the flight surgeon of today.

RESOURCES:

Kerber KA. Vertigo and Dizziness in the Emergency Department. Emerg Med Clin N Am. 2009; 27:39–50.

Labuguen RH. Initial Evaluation of Vertigo. Am Fam Phys. January 15, 2006, Volume 73, Number 2.

Radtke A, Nehauser H, et al. Vestibular Migraine. Neurology 2012; 79:1607–1614.

Thompson TL, Amedee R. Vertigo: A Review of Common Peripheral and Central Vestibular Disorders. Ochsner J. 2009; 9:20–26.

Learning Objectives:

1. The participant will be able provide a differential diagnosis as too the most likely cause of Vertigo in an airman.
2. The participant will be able to understand treatment modalities available in the management of vertigo.
3. The participant will be able to recommend an aeromedical disposition for Airmen with a diagnosis of vertigo.

Wednesday, 05/08/2019

10:30 AM

Brasilia 4

[S-54] SLIDE: OH CHIT! I'VE BEEN DQ'ED

Chair: Susan Fondy

Co-Chair: Deborah White

10:30 AM

[271] DECENTRALIZED ASSESSMENTS AND RECOMMENDATIONS, CENTRALIZED REVIEWS AND DISPOSITIONS

Raymond King

Federal Aviation Administration, Washington, DC, USA

(Original Research)

INTRODUCTION: Medically screening personnel for high-risk occupations is a relatively straightforward endeavor. The true challenges start when a job applicant, having received a tentative job offer, is identified as having a potentially medically disqualifying condition. In the case of a psychiatric condition, a prescribed psychological assessment process can help determine the proper disposition for the job applicant. Very often, however, the applicant does not live close to the centralized medical authority and in any case, the centralized authority may not be able to assess applicants face to face. Therefore, psychologists in local communities must be relied upon. The problem of equal risk for applicants must be assured, despite the reliance on multiple assessors. One way to increase fairness is to have review professionals receive the reports and the raw data that informed their recommendation (of medically qualified or disqualified). **METHODS:** There were 382 applicants for Federal Aviation Administration (FAA) Air Traffic Control Specialist (ATCS) positions who were referred for additional assessment after failing to be cleared with the Minnesota Multiphasic Personality

Inventory-2 (MMPI-2). These 382 were offered the opportunity, at the FAA's expense, to undergo additional assessment to arrive at a determination of their medical fitness. The rate of agreement between the assessment psychologists and one of the centralized psychologists (the author) was calculated. **RESULTS:**

Assessment Psychologist Recommendation	Review Psychologist Determination	
Qualified	Qualified	246 (64.4%)
Qualified	Disqualified	33 (8.6%)
Disqualified	Qualified	3 (0.8%)
Disqualified	Disqualified	94 (24.6%)
Inconclusive		6 (1.6%)

Psychologists who performed assessments arrived at a recommendation that was accepted after review in 89% of cases.

DISCUSSION: While the number of disagreements is relatively small, the minority 11% points out the value of centralized review. Centralized review helps assure fairness by minimizing the situation of an applicant being deemed incorrectly medically unfit and helps assure safety by minimizing the situation of an applicant being found medically fit when they are not. Moreover, it resolves those situations where the assessment psychologist cannot arrive at a recommendation.

Learning Objective:

1. Participants will appreciate the value of centralized review of assessments that are done in a decentralized fashion.

10:45 AM

[272] HEALTH TRENDS IN CAREER HELICOPTER AND TILTROTOR PILOTS

John Crowley¹, Angelia Cost², William Dodson³, Dustin Huber⁴

¹US Army Aeromedical Research Laboratory, Fort Rucker, AL, USA;

²Armed Forces Health Surveillance Branch, Falls Church, VA, USA;

³USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA; ⁴Naval Medical Research Unit-Dayton, Wright-Patterson AFB, OH, USA

(Original Research)

INTRODUCTION: The purpose of this project was to identify any adverse health effects associated with aviation career exposure to helicopters or tiltrotor aircraft, using an epidemiological approach and a thorough review of the literature. **METHODS:** First, the published literature was searched for reports or studies of health problems attributed to flying helicopters or tiltrotor aircraft. Then, a retrospective epidemiological study of helicopter pilots, tiltrotor pilots, and control groups from the U.S. Army, Navy and Air Force was conducted. The study utilized the U.S. Defense Medical Surveillance System (DMSS), which contains data on service member demographics, employment, and medical care. Health care data from 1998 – 2015 was matched to exposure data (i.e., accumulated flying hours) obtained from each service's aviation record-keeping agencies. Comparison groups were determined to be a) non-flying officers and b) aircrew not flying helicopters or tiltrotor aircraft. **RESULTS:** Phase I. Literature Review: Recent health data on U.S. Army helicopter pilots suggests that musculoskeletal health problems, mostly spinal, account for >38% of all diagnoses over the past decade. Most helicopter aircrew, internationally, experience aviation-related low back pain, although the etiology is unclear. Also common is neck pain, which appears to be related to head-supported mass (e.g., night vision goggles). Noise exposure is common in the military but is a known hazard in aviation. Other health-related problems were less-well documented. No information regarding health problems in tiltrotor pilots was located. Phase II: Epidemiological Study. There was no statistically significant risk of any of the conditions investigated among the helicopter pilots compared to the non-flying officers, except for "Metabolic Syndrome." Compared to the fixed-wing pilots, helicopter pilots and tiltrotor pilots were at increased risk of Lumbago, Metabolic Syndrome, and Hyperlipidemia. Most outcomes were significantly less common among the helicopter pilots compared to the unexposed cohorts. **DISCUSSION:** Musculoskeletal problems are classically associated with flying helicopters. This analysis

confirmed a higher rate of low back pain (lumbago) in helicopter pilots, compared to fixed-wing pilots. Potential explanations for this, the apparent excess in metabolic syndrome and hyperlipidemia, and the lack of aeromedical discussion of tiltrotor pilots, will be discussed.

Learning Objective:

1. The audience will learn about the health effects of career-long exposure to the helicopter or tiltrotor aircraft environment.

11:00 AM

[273] Medical disqualification among civil aviation personnel, Colombia, 2015-2017

Maria Angelita Salamanca¹, Diana Judith Monroy², Claudia Liliana Olarte¹

¹Civil Aviation Authority of Colombia, Bogota, Colombia;

²National University Of Colombia, Bogota, Colombia

(Original Research)

INTRODUCTION: The aeromedical certification process must guarantee meets the psychophysical conditions among license holder for aviation performance, according to ICAO; in some cases, it is possible that the license holder ceases to exercise the aeronautical activities because of the pathologies that diminishes psychophysical aptitude, prevents him from exercising them in safety conditions. The technological and scientific advances have allowed to decrease the medical disqualification among aeronautical personnel, because they generally enjoy good health, probably due to the so-called "healthy worker" effect and they have the possibility of opting for a waiver. Among the causes of medical disqualification found by European studies are cardiovascular, otorhinolaryngological, neurological, musculoskeletal and psychiatric, mainly. **METHODS:** This is a cross-sectional descriptive study. The data was taken from the medical disqualification database of the Civil Aviation Authority of Colombia for the years 2015, 2016 and 2017. The causes of medical disqualification was grouped as psychiatric, organs of the senses (otolaryngology and ophthalmology), musculoskeletal, cardiovascular, neurological, oncological and others. The analysis included descriptive statistics and was performed with the Epi Info software. **RESULTS:** In the years 2015 to 2017, there were 83 medical disqualifications among civil aviation personnel of Colombia. 48.2% corresponded to flight attendants, 21.7% to line transport pilots and 14.5% to commercial airplane pilots. The main cause was psychiatric (34.9%), followed by diseases of the sense organs (15.7%), musculoskeletal diseases (13.3%) and neurological origin (13.3%). The psychiatric causes were anxiety and mixed anxiety and depression disorders, psychoactive substance use and bipolar affective disorder. The organs of the senses causes were mainly disorders of the vestibular system, optic diseases. Chronic lumbalgias were the most frequent as the osteomuscular causes. Among the neurological causes were seizures and cerebrovascular events mainly. **DISCUSSION:** The causes of medical disqualification found among the civil aviation personnel of Colombia are similar to those evidenced in other studies. Although aeromedical certification for flight attendants is not required in most countries, this study shows that this group presents medical disqualification more frequently, followed by pilots. It is important to focus on mental health promotion.

Learning Objective:

1. To determine the prevalence of the causes of medical disqualification among civil aviation personnel of Colombia between the years 2015 to 2017.

11:15 AM

[274] TOP MEDICAL DISQUALIFIERS OF UNIFORMED SERVICE COMMISSIONING PROGRAMS

Kenneth Kuhn, Glenn Dowling, Michael Rappa, Ernest Sullivent, Walter Dalitsch

Department of Defense Medical Examination Review Board, Colorado Springs, CO, USA

(Original Research)

The Department of Defense Medical Examination Board (DoDMERB), a division of the Defense Health Agency, conducts medical screening evaluations and determines medical qualification (Q) or disqualification (DQ) for approximately 95% of applicants to commissioning programs of the U.S. Uniformed Services, to include all five Service

Academies, all Reserve Officer Training Corps programs, the Uniformed Services University of the Health Sciences, the U.S. Public Health Service, and other programs as assigned by the Assistant Secretary of Defense for Health Affairs. For the armed services, the overwhelming majority officers going on to flight training arise from this screening pool. Department of Defense Instruction 6130.03, "Medical Standards for Appointment, Enlistment, or Induction into the Military Services," provides the framework and standards for Q/DQ decisions. For the years 2015-2017, DoDMERB processed a total of 132,665 commissioning program applications and applied 39,930 DQs, representing approximately 0.3 DQs per application processed. The five most frequent medical disqualifiers, accounting for 25% of all DQs, were: asthma, atopic dermatitis or eczema, food allergy, shoulder instability, and learning disorders (e.g., Attention Deficit Hyperactivity Disorder). The top three mental health categories (learning, anxiety, and mood disorders), if combined, would account for 9% of all DQs and represent the most frequently encountered disqualifier. Discussion will include criteria for Q/DQ, differences in disqualifying conditions by commissioning program and year group, and final disposition as manifest by waiver approval or denial by condition and commissioning program.

Learning Objectives:

1. Identify the most frequently applied medical disqualifiers for U.S. Uniformed Service Commissioning Programs.
2. Understand the criteria associated with the most frequently applied medical disqualifiers.
3. Understand rates at which medical waivers are granted for the most frequently applied medical disqualifiers by commissioning program.

11:30 AM

[275] CONTINUOUS SUBCUTANEOUS GLUCOSE MONITORING PROTOCOLS FOR FLIGHT SAFETY PROCEDURES INVOLVING INSULIN-TREATED PILOTS

Felice Strollo¹, Giovanna Strollo², Andrea Mambro³, Sandro Gentile⁴, Melchor J. Antuñano⁵

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⁵FAA Civil Aerospace Medical Institute (CAMI), Oklahoma City, OK, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Insulin-treated pilots are commonly assessed as unfit for safety reasons in fear of sudden hypoglycemia-related incapacitation. Due to the high prevalence of diabetes mellitus (DM) above 40 years of age, this causes huge monetary investment losses to all involved stakeholders. However, in some countries pilots are allowed to fly on insulin, provided their glucose levels are kept high enough at take-off, in-flight, and at landing, which raises some criticism as hyperglycemia is expected to increase the risk of DM complications. **OVERVIEW:** Evidence accumulated on the accuracy of subcutaneous sensor-based continuous glucose monitoring (CGM) has allowed reliable algorithms to be published for everyday glucose management during the last decade and many patients who chose to use sensors for treatment decision making dramatically reduced their hypoglycemic event rate and severity. Moreover, through real time cloud-based data sharing with glucose trend alarms, parents of insulin dependent children can now face up to any school emergencies directly from their work-place. All of the above can represent a suitable solution for flight personnel too. **DISCUSSION:** Evidence-based operational recommendations might then be released for pilots on insulin to favor aware decision making during flight. This would be expected to break down psychological, as well as, privacy-related barriers often hindering effective pilot to AME relationships by giving credit for working experience and by boosting self-esteem, both of which represent human factors known to positively influence performance and flight safety. Nevertheless, long-lasting trust always relies on thorough verification: in compliance with this principle a suitable solution to be discussed might be to keep all flight phases under control by making off-line preflight, as well as, online inflight CGM readings confidentially available to the co-pilot and/or authorized specifically trained personnel on ground. We therefore suggest to adopt CGM for civil aviation to realize a long-sighted and cost-effective compromise between trust and safety requirements of respect for all involved stakeholders,

including an ever-aging, yet skillful, pilot population whose long-lasting professional training would otherwise be unwisely spoilt despite the huge amount of resources originally committed to it.

Learning Objectives:

1. The participant will learn how recent progress in technology may reduce hypoglycemia-related inflight incapacitation risk in insulin treated pilots.
2. The audience will also learn how diabetes epidemiology and pathophysiology may affect the ageing pilot population.
3. A possible updated and evidence-based protocol allowing insulin treated pilots to fly safe and well will be proposed and discussed with the audience.

11:45 AM

[276] WHAT YOU NEED TO KNOW ABOUT THE BALDRIGE EXCELLENCE FRAMEWORK TO MONITOR AEROSPACE MEDICINE OPERATIONAL EXCELLENCE

Mary Ann Orzech

Retired USAF, Albuquerque, NM, USA

(Education - Tutorial Proposal)

INTRODUCTION: In order to sustain operational excellence within aerospace medicine operations, it is critical to understand and evaluate the processes and results using a proven framework. **TOPIC:** Many national organizations use the Baldrige Excellence Framework to improve their processes and attain sustainable results. The Baldrige framework helps health care organizations answer three questions: 1. Is your organization doing as well as it could? 2. How do you know? 3. What and how should your organization improve or change? Furthermore, the Baldrige Framework helps healthcare organizations explore how they are accomplishing what is important to their mission. This framework is in the form of questions. The questions represent seven critical aspects of managing and performance: 1. Leadership; 2. Strategy; 3. Customers; 4. Measurement, Analysis, and Knowledge Management; 5. Workforce; 6. Operations; 7. Results. The Baldrige Framework can support aerospace medicine operations to assess and improve their processes along four dimensions: Approach, Deployment, Learning and Integration. This framework leads you to examine your results from three viewpoints: external (How do your customers and stakeholders view you?) internal (How efficient and effective are your operations?) and the future (Is your organization learning and developing?). **APPLICATION:** How aerospace medicine operational programs can use this proven and systematic framework to evaluate performance will be discussed. The Baldrige framework is another resource that can be applied to clinical operations to evaluate, improve and sustain performance. **RESOURCE:** Baldrige Performance Excellence Program. 2017. 2017-2018 Baldrige Excellence Framework (Health Care): A Systems Approach to Improving Your Organization's Performance. Gaithersburg, MD: U.S. Department of Commerce, National Institute of Standards and Technology. <https://www.nist.gov/baldrige>

Learning Objectives:

1. The participants will be able to understand the components of the Baldrige Excellence Framework.
2. The participants will be able to apply the framework to the aerospace medicine operational programs.

Wednesday, 05/08/2019

10:30 AM

Brasilia 5

[S-55] PANEL: "TRAIN THE WAY YOU FIGHT": OPERATIONAL APPLICATIONS OF TRAINING AND RESEARCH IN AEROMEDICAL EVACUATION

Sponsored by Aerospace Nursing and Allied Health Professions Society

Chair: Tami Averett-Brauer

Co-Chair: Sarah Johnson

PANEL OVERVIEW: This education panel will cover several aspects of evidence-based training used to design and deliver vital training in

both the aeromedical evacuation (AE) and Critical Care Air Transport Team courses conducted at the U.S. Air Force School of Aerospace Medicine. It will also include examples of research conducted at the U.S. Air Force School of Aerospace Medicine En Route Care Research Division that directly feed into the ongoing training curricula and operational practices of both AE and Critical Care Air Transport personnel. It will conclude with an operational exemplar of the creative collaboration between the En Route Care Training and Aeromedical Research Departments in response to a requirement to increase training production of critical care teams. By discussing this in a panel format, we can illustrate the linkage between training and research, thereby advancing both evidence-based training and evidence-based practice among the many disciplines involved in en route care. Training for these unique aerospace environments requires creativity, diligence, and knowledge generated through research to replicate the AE practice environments, as well as incorporate changes in learning technologies for modern learners. Presentations: A. Education: Flight Nurse and Aeromedical Evacuation Technician Training at the U.S. Air Force School of Aerospace Medicine B. Education Process: Operational Use of Medical Equipment in the Aeromedical Environment – Lessons Learned from Research C. Education: Critical Care Air Transport Team Training at the U.S. Air Force School of Aerospace Medicine D. Research: Noise Immune Stethoscope – Application of Research in the Operational Setting E. Education Process: It Takes a Village: The U.S. Air Force School of Aerospace Medicine Collaborates for Training Surge.

[277] FLIGHT NURSE AND AEROMEDICAL EVACUATION TECHNICIAN TRAINING AT THE USAF SCHOOL OF AEROSPACE MEDICINE

Sarah Johnson

USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Aerospace medical professionals have surely heard of, and may even be familiar with, en route care and the jobs of flight nurses and aeromedical evacuation technicians. What they may not be acquainted with is the rigorous training these professionals go through to obtain their qualifications. This presentation will introduce and familiarize aerospace medical professionals, particularly those who deal with en route care, with the training completed by aeromedical evacuation crewmembers. **OVERVIEW:** Training for flight nurses and aeromedical evacuation technicians in the en route care environment has evolved tremendously over the last decade. The Flight Nurse/Aeromedical Evacuation Technician course at the U.S. Air Force School of Aerospace Medicine has recently been overhauled and improved to train its students. Future aeromedical evacuation crewmembers enrolled in the Flight Nurse/Aeromedical Evacuation Technician course are now training the way they fight. Gone are the long days of PowerPoint presentations and hours of in-class lectures. Students are now learning in reality-based simulations in either the fuselage of a C-130H or C-17A. These simulations now account for 50% of their learning experience. The simulations presented to students are based on real world patients, allowing them to be exposed to what is currently occurring on the battlefield. Not only are the medical aspects of the simulations based on realism, but the environmental aspects are as well. Students are exposed to poor light conditions and loud noises much like actual flying conditions. This presentation will dive into the training that has been validated, in depth, to produce quality aeromedical evacuation crewmembers. **DISCUSSION:** Being able to provide reality-based simulations in a high-stress, low-threat learning environment for students allows for the convergence of operational application and education and training. By learning and understanding the training undertaken by aeromedical evacuation crewmembers, aerospace medical professionals will identify the abilities of those who have been afforded the opportunity to care for our nation's sick and injured at altitude. This is part of the "Train the Way You Fight": Operational Applications of Training and Research in AE.

Learning Objectives:

1. List two examples of simulation use in the U.S. Air Force Flight Nurse and Aeromedical Evacuation Technician course.
2. Trace the evolution of training for aeromedical evacuation crewmembers.

[278] OPERATIONAL USE OF MEDICAL EQUIPMENT IN THE AEROMEDICAL ENVIRONMENT – LESSONS LEARNED FROM RESEARCH

Tamara Averett-Brauer

USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Education - Program / Process Review Proposal)

BACKGROUND: The actual en route care transport environment imposes a number of in-flight stressors, for which the impact on clinical outcomes is not yet fully understood. In particular, stressors of hypoxia and hypoxia, as well as temperature, humidity, vibration, and noise, can challenge clinical care during flight. The U.S. Air Force School of Aerospace Medicine (USAFSAM) provides research activities generating knowledge and technologies to improve en route care for the Joint Force, now and in the future. **OVERVIEW:** The airborne transport environment presents unique challenges to the use of medical equipment not necessarily envisioned by the equipment designers or manufacturers. This presentation will review several lessons learned from the USAFSAM En Route Care (ERC) Research Division about the performance of medical equipment in the operational aeromedical environment. It will also present the process of improving our understanding of the biodynamics of the transport airframes and ground vehicles. **DISCUSSION:** The goals of the USAFSAM ERC Research Division include 1) conduct clinical performance validation of medical devices in aeromedical operational conditions and 2) better understand the various stressors of the flight environment to reduce their impacts, both on patients and providers. Evaluations are triggered by users who request an operational evaluation of medical devices or have questions about certain topics. The ERC Research Division is able to quickly perform an assessment and provide feedback. On other occasions, more complex plans are required, for example, to evaluate vibration profiles of the C-130 in flight. Lessons learned from these evaluations are fed to the requesting organization, such as the Air Mobility Command, and also the actual end users, aeromedical evacuation crews and Critical Care Air Transport Teams. Examples to be discussed include findings regarding mechanical ventilator operations at altitude and vibration profiles of airframes (C-130) and ambulance bus. The utility of this information allows operational teams to better plan for patient placement either in the airframe or the ground transport vehicle. En route care is a broadly applicable topic across the international and civilian membership of the Aerospace Medical Association. This panel presentation reinforces the link between en route care operators, training, and research in pursuit of improved clinical care.

Learning Objective:

1. Describe at least two lessons learned from the USAFSAM En Route Care Research Division about the performance of medical equipment in the operational environment.

[279] CRITICAL CARE AIR TRANSPORT TEAM TRAINING AT THE USA AIR FORCE SCHOOL OF AEROSPACE MEDICINE

Sadie Hackler

USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Education - Program / Process Review Proposal)

BACKGROUND: The U.S. Air Force's Critical Care Air Transport Team (CCATT) is a team that many aerospace medical professionals ought to know. This unit of experts is able to maintain and enhance the standard of care to critically ill and injured individuals in the en route care system. This presentation will introduce and familiarize aerospace medical specialists, particularly those who deal with en route care, with the training completed by CCATT members. **OVERVIEW:** In the en route care system, CCATT is able to complete a unique mission. This team of experts comprises a critical care physician, critical care nurse, and a cardiopulmonary technician. These individuals are all experienced in their respective fields prior to applying for CCATT Initial training. Once selected, they attend a 10-day didactic and simulation-intensive course at the U.S. Air Force School of Aerospace Medicine, where they are exposed to reality-based simulations while utilizing fuselage trainers of a C-17, C-130, and a refitted 767 used to simulate a KC-135. These simulations and

experiences allow students to train the way they fight, both in the environment they are exposed to and the types of patients they will be caring for. Successful completion of this CCATT Initial course does not validate their skills as a future CCATT member. This validation occurs at CCATT Advanced in Cincinnati, OH. At this advanced course, which must be reaccomplished every 3 yr, students are exposed to even more in-depth didactic information and intensive simulations. This presentation will dive into the training that has been validated to produce quality CCATT members. **DISCUSSION:** Being able to provide reality-based simulations in a high-stress, low-threat learning environment for students allows for the convergence of operational application and education and training. By learning and understanding the training undertaken by CCATT members, aerospace medical professionals will identify the abilities of those who have been afforded the opportunity to care for our nation's critically ill and injured at altitude. This is part of the "Train the Way You Fight": Operational Applications of Training and Research in AE.

Learning Objectives:

1. Identify two differences between the Critical Care Air Transport Team Initial and Critical Care Air Transport Team Advanced courses.
2. List two examples of simulation use in the U.S. Air Force Critical Care Air Transport Team Initial course.

[280] CHARACTERIZATION OF NOISE AND VIBRATION TRANSMISSION PATHWAYS AFFECTING EN ROUTE PATIENT AUSCULTATION

Brittany Fouts, Charles Harding, Kayla Eaton, Melissa Wilson, Suzanne Smith, Ben Steinhauer, Eric Thompson, Abigail Juhl
Air Force Research Laboratory, Wright-Patterson AFB, OH, USA

(Original Research)

INTRODUCTION: Stethoscopes are the primary diagnostic tool for patient auscultation and triage to assess cardiovascular, respiratory, and gastrointestinal systems. Unfortunately, high noise levels associated with en route care (ERC) hinder the use of traditional auscultation equipment. ERC is characterized by several transmission pathways through which ambient noise and vibration (both structure-borne and airborne) may hinder effective auscultation. Noise and vibration may travel directly to the provider's ears. Noise may produce both noise and vibration in the stethoscope that can affect hearing. Structure-borne and airborne vibration may be transmitted from the patient's body to the stethoscope. It is currently unknown how these pathways compromise effective auscultation, and how best to mitigate the problem. **METHODS:** A multi-phased approach is being used in this foundational research to identify and characterize noise and vibration transmission pathways. Phase I involves measuring noise and vibration on the body of a litter patient and a provider in the simulated ERC noise environment (C-130, C17). Phase II repeats the Phase I noise and vibration measurements collected on the provider in the simulated ERC vibration environment (C-130, C-17). Phase III replicates Phase II to evaluate dampening materials that can effectively reduce the transmission of structure-borne vibration to the provider. **RESULTS:** Preliminary results will be reported in this presentation. Findings from this study will be used to inform on the effects of ambient aircraft noise on patient auscultation while eliminating any effects of structure-borne vibration during simulated ERC transport. The results will provide foundational information on vibration and noise-dampening materials, filtering and noise cancellation, leading to the ability of providers to auscultate in high noise environments. **DISCUSSION:** During ERC, it may be necessary for personnel to auscultate cardiopulmonary and gastrointestinal systems to identify abnormalities. In current operations, auscultation is hindered by noise and possibly vibration. The goal of this research is to better understand the mechanisms that hinder auscultation for developing effective mitigation strategies. Providing ERC personnel with the ability to accurately identify and deliver timely medical intervention may significantly reduce the number of preventable battlefield deaths, improving patient outcomes.

Learning Objectives:

1. The participant will be able to understand how environmental factors hinder patient auscultation.
2. The participant will be able to understand the different noise and vibration transmission pathways prevalent in the En Route Care environment.

[281] IT TAKES A VILLAGE: THE U.S. AIR FORCE SCHOOL OF AEROSPACE MEDICINE COLLABORATES FOR TRAINING SURGE

Daniel Bevington

USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Challenges with the global evacuation of patients require multiple levels of cooperation and collaboration in both training and research. The U.S. Air Force School of Aerospace Medicine (USAFSAM) provides vital education and training to the aeromedical evacuation (AE) crews and Critical Care Air Transport Teams (CCATTs) that are central to the U.S. en route care system. Preparing for the future requires continual process evaluation and improvement, which drive changes to training curricula and delivery. Research that is closely tied to the end user and the education and training faculty ensures timely, relevant evidence to support education and training initiatives. **OVERVIEW:** AE and CCATT training and en route care research are conducted at USAFSAM. This presentation will describe an operational exemplar of the creative collaboration between the En Route Care Training and Aeromedical Research Departments in response to short-notice requirement to increase training production of critical care teams. **DISCUSSION:** USAFSAM has provided AE training for over 75 yr and continues to evolve and respond to real-world operational readiness demands and changes in healthcare delivery. Evidence-based training requires a close connection with the operational stakeholder as well as the knowledge-generating communities of research to ensure up-to-date and relevant technologies and strategies are part of training solutions. This presentation will describe the cooperation and collaboration between both training and research groups to successfully meet the challenge as well as to describe lessons learned in the process. The traditional CCATT training pipeline consists of a 2-wk initial course followed by a 2-wk validation course. When presented with a challenge to increase production of critical care teams, the training and research departments collaborated to adapt the curriculum and modify timing and faculty schedules to accommodate the increased throughput. Challenges associated with increased class size and fewer training days will be described. Additionally, different medical specialties were included in the training than had been the traditional practice, so observations and lessons from the CCATT cadre will be shared. USAFSAM successfully met the challenge, but it took the whole village. Civilian and international members of the aeromedical community will appreciate these lessons learned.

Learning Objective:

1. The audience will learn about collaborative efforts between the En Route Care Training and Aeromedical Research Departments in response to a short-notice requirement to increase training production of critical care teams.

Wednesday, 05/08/2019
Brasilia 6

10:30 AM**[S-56] PANEL: GRAND ROUNDS II**

*Sponsored by The American Society of Aerospace
Medicine Specialists*

Chair: Mark Coakwell**Co-Chairs: Edgar Rodriguez, Richard Allnutt**

PANEL OVERVIEW: This panel will consist of pairs of Aerospace Medicine residents presenting clinical cases of aeromedical interest or significance. During their residency practicum years, residents conduct evaluations of patients with diverse medical problems. Residents prepare and present a case report based on a patient encounter undertaken during their practicum experience. One resident from each pair presents the history of the presented problem. The other resident presents the physical findings and a discussion of the aeromedical policies associated with the condition. Learning Aerospace Medicine at the specialist level involves understanding the impact of medical conditions on aircrew health and mission accomplishment. The cases presented will not only be of academic interest but will also illustrate aeromedical decision making in the operational environment.

[S-56a] COULD WE HAVE PREDICTED THIS?

Eric Petersen, Amy Kreykes

University of Texas Medical Branch, Galveston, TX, USA

(Education - Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report describes an airline transport pilot with a history of two public intoxication offenses, a DUI, and slowly increasing alcohol consumption who sustained multiple injuries after an alcohol-related motorcycle accident. **BACKGROUND/LITERATURE REVIEW:** Unintentional injury is the third leading cause of death in the USA and is the leading cause of death for those aged 1-44. Alcohol use is a factor in approximately 33% of trauma-related hospital visits.¹ It is estimated that at least 1 in 10 people will be involved in an alcohol-related crashes in their lifetimes, and intoxicated patients with previous DUIs are 62% more likely to be involved in fatal crashes than those without previous convictions.^{2,3} Screening positive for alcohol misuse is associated with a 2-to-3 fold increased risk of trauma, and the short Alcohol Use Disorders Identification Test (AUDIT-C) can help identify patients who are hazardous drinkers or have alcohol use disorders.^{4,5} Elevated baseline AUDIT-C scores and increasing scores over time correlate to increased risk for future traumas, with positive AUDIT-C scores and engagement in injury-related risk behaviors providing the most robust behavioral and psychological predictors of future trauma.⁵⁻⁸ Additionally, neurocognitive deficits are highly prevalent in DUI recidivists, with a prevalence up to 73%.⁹ **CASE PRESENTATION:** A 54-year-old male airline transport pilot with a history of two public intoxication offenses, a DUI, and slowly increasing alcohol consumption sustained multiple traumatic injuries after crashing his motorcycle into a curb while acutely intoxicated. He was un-helmeted and was amnesic to the event but admitted at the scene to consuming 6 beverages before the accident. His injuries included a left sided SAH, a 4mm left falxine SDH, a C1 lateral mass fracture, bilateral 1st rib fractures with left 2nd-4th rib fractures, a small left hemothorax, a left scapular fracture, and a left mid-shaft clavicle fracture. After conservative management of his mild TBI and ORIF of his left clavicle fracture, he made a full recovery with no focal neurologic deficits, post-traumatic seizures, or orthopedic limitations. He is currently in the process of seeking special issuance for his TBI and orthopedic injuries in the setting of substance abuse. **OPERATIONAL/CLINICAL RELEVANCE:** Pilots are not exempt from non-aviation traumatic accidents, and the subsequent injuries, such as TBI, can prove to be substantial barriers to medical re-certification. In some cases, traumatic injuries can end the careers of promising young aviators. Injury prevention should be considered a priority in the mind of aeromedical providers, and attention should be paid to behavioral characteristics and changes that could herald increased risk for future trauma.

Learning Objective:

1. Understand the need for incorporating injury prevention strategies, such as monitoring changes in alcohol intake over time, into aeromedical practice.

[S-56b] DOWN AND OUT ON THE FLIGHT LINE

Laura S. Ball, Nathan H. Kwan

U.S. Army School of Aviation Medicine, Ft. Rucker, AL

(Education - Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report describes a US Army Air Traffic Controller (ATC) who presented for return to duty after a previous behavioral health issue. **BACKGROUND/LITERATURE REVIEW:** This patient was cleared by aeromedical psychology for flight duties after a two year grounding following treatment for a behavioral health diagnosis. **CASE PRESENTATION:** A 32-year-old active duty service member ATC with 14 years military service presents to the aviation medicine clinic for evaluation. He was grounded for approximately two years after diagnosis and treatment for a behavioral health disorder that included suicidal ideation. Currently he denies any symptoms or medication use and has been cleared by aeromedical psychology to return to flight duties. The case presentation will include aeromedical disposition and a discussion of Tri-Service/FAA aeromedical regulations related to the case. **OPERATIONAL/CLINICAL RELEVANCE:** Psychiatric conditions can have a serious impact on safety of flight. Pursuit of waivers and return to duty requires a thorough review of past medical history, stability of the condition, and appropriate waivable medication use as necessary.

Learning Objectives:

1. Understand diagnosis and treatment criteria for the discussed psychiatric disorder.
2. Determine how to aeromedically disposition the discussed psychiatric condition.

[S-56c] MAJOR DEPRESSIVE DISORDER

Diego Vasquez¹, Pin-Huei Lai²

¹4th Air Brigade, Punta Arenas Songshan, Taiwan; ²Air Force Base Command, Taipei, Taiwan

(Education - Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report describes an active duty military pilot candidate with history of major depressive disorder in full remission. **BACKGROUND / LITERATURE REVIEW:** Commonly practitioners of aerospace medicine have a good understanding of how the both normal and abnormal physiology may be affected by the stresses of flight. Life support systems are specifically designed to counter these threats. Psychological resiliency is more difficult to measure. Medical selection standards help select healthy, fit aircrew whose mental and physical constitutions are most adaptable and resilient to these stresses. However, without a high index of suspicion and effective screening, a significant mental illness may present subtly and go unrecognized for prolonged periods of time. The diagnosis of depression in the primary care setting may be delayed if compounded by concurrent physical illness and tendency of aircrew to mask or minimize their symptoms during flight screening. **CASE PRESENTATION:** The subject is a 28-year-old female pilot candidate presenting for her first USAF aeromedical consultation service (ACS) evaluation. Her past history revealed a diagnosis of adjustment disorder with depressed mood prompting a multi-day evaluation to clearly define the condition severity and risk assessment. **OPERATIONAL / CLINICAL RELEVANCE:** Depressive disorders may present with somatic and/or emotional symptoms. Emotional symptoms may include psychomotor retardation, distraction, and indecision. Occurrence of these degrades the performance of experienced pilots as well as pilot candidates who have not acquired learned reflexive behaviors. In addition, the time constrained and highly stressful environment of undergraduate pilot training carries a significant risk of exacerbation of the condition and delays in the training. However, it is not unreasonable to consider a waiver in situations where the condition is temporally remote and the candidate demonstrates resiliency.

Learning Objective:

1. Review the aeromedical policies of the US Department of Defense, Federal Aviation Authority, and international aviation standards for depressive disorders.

[S-56d] HYPOGONADISM IN AN AIR FORCE COMBAT CONTROLLER

Winton P. D. Laslie, Ross C. Semeniuk

USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Education - Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report discusses the aeromedical significance of an Air Force combat controller diagnosed with secondary male hypogonadism and treated with daily transdermal testosterone gel. **BACKGROUND/LITERATURE REVIEW:** Male hypogonadism affects both spermatogenesis and testosterone generation. Primary hypogonadism occurs with gonadal dysfunction, while secondary hypogonadism represents dysfunction of the hypothalamic or pituitary glands. In recent years, male hypogonadism has received increasing attention due to direct-to-consumer advertising. Affected patients are increasingly likely to present with quality-of-life issues encountered with decreased energy, decreased libido, erectile dysfunction, decreased muscle mass, gynecomastia, and infertility. **CASE PRESENTATION:** A 34-yr-old male Air Force combat controller presented to a Flight Medicine clinic with a 6-mo history of decreased energy, low libido, and less frequent spontaneous erections. He was able to sustain an erection for satisfactory sexual activity, but reported reduced tumescence. Medical history revealed previous consumption of an oral testosterone enhancement supplement as well as recent recreational anabolic steroid supplementation. The

controller was experiencing increased chronic stressors but was not clinically depressed. He denied any lower urinary tract symptoms and had no history of sexually transmitted infections. Follicle-stimulating hormone and luteinizing hormone values were normal, but his total serum testosterone level was low. Magnetic resonance imaging of the brain ruled out pituitary adenoma. A Urology consultant concluded the hypogonadism was secondary to recent anabolic steroid usage, and the patient was started on intramuscular testosterone supplementation with noticeable improvement of fatigue. He was transitioned from an intramuscular testosterone formulation to transdermal therapy in preparation for an operational deployment. An aeromedical waiver was approved following demonstrated stability on prescriptive dosing. **OPERATIONAL/CLINICAL RELEVANCE:** Both primary and secondary male hypogonadism present aeromedical concerns related to symptoms such as decreases in energy, muscle mass, and bone mineral density, as well as depression. Transdermal and intramuscular testosterone formulations provide therapeutic benefit, but the side-effect profile of exogenous hormones must also be considered. Emotional lability, increased venous thromboembolism, and worsened obstructive sleep apnea are potential adverse effects from therapeutic medication. A discussion regarding the unauthorized use of exogenous hormone supplementation in a regulated occupation is essential. Aeromedical waiver is not recommended until demonstrated stability on a prescribed dosing regimen and laboratory documentation confirming a therapeutic testosterone level. Periodic reevaluation and aeromedical reviews are recommended for aircrew undergoing long-term therapy.

Learning Objective:

1. Understand implications and safety concerns of male hypogonadism and transdermal hormone replacement therapy in the non-pilot aircrew population.

[S-56e] DIFFUSE LARGE B-CELL LYMPHOMA

Harvinder Sahota

17 Wing Air Force, Gorakhpur, India

(Education: Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report describes an active duty military pilot with history of diffuse large B-Cell Lymphoma (DLBCL), currently in remission. **BACKGROUND/LITERATURE REVIEW:** NHL is a diverse group of lymphoid malignancies and can range from aggressive to more indolent in behavior. Recent classifications have taken into account genetic information as well as cell morphology to better characterize the behavior of these neoplasms in individual patients. Additionally, it is also recognized that there is a continuum between leukemias and lymphomas and that they can represent the same disease entity. Abnormal immunologic status, certain viruses and bacteria, occupational exposures, and history of prior lymphoma have all been attributed to an increased risk of NHL. Presentation can include fever, weight loss, and sweats (B symptoms). Often, a patient will be asymptomatic except for an enlarging lymphatic mass. There is an estimated 1 in 47 lifetime risk of being diagnosed with NHL, with approximately 75% of cases diagnosed at age 75 or older. While the incidence of the disease has been increasing, so has the efficacy of the therapies, imparting a 5-year survival rate of 68.1%. 2 Diffuse large B Cell lymphoma is the most common histologic subtype of non-Hodgkin lymphoma accounting for approximately 25% of NHL cases. **CASE PRESENTATION:** The subject is a 38-year-old male pilot presenting for his first USAF aeromedical consultation service (ACS) evaluation since remission after treatment with chemotherapy and consolidated radiation therapy. He initially presented with a complaint of chronic cough and subsequent investigation revealed an anterior mediastinal mass. Past history revealed a diagnosis of adjustment disorder with depressed mood prompting a multi-day evaluation to clearly define the condition severity and risk assessment. **OPERATIONAL/CLINICAL RELEVANCE:** As with most illnesses, aeromedical concerns of NHL are based upon the disease as well as the treatment. The most common presentation of NHL is asymptomatic, peripheral lymphadenopathy. Given the rarity of CNS and cardiac involvement the risk of sudden incapacitation is unlikely. However, initial manifestations can include neurological symptoms due to central nervous system involvement and spinal cord compression due to mass effect. In addition, significant treatment related fatigue may persist for years after remission and includes complication risks to pulmonary and cardiac function.

Learning Objectives:

1. Review the aeromedical policies of the US Department of Defense, Federal Aviation Authority, and international aviation standards for non-Hodgkin's Lymphoma.
2. Understand the systemic complexities of the aeromedical risk assessment posed by the treatment as well as the disease process.

[S-56f] HYPOTHYROIDISM AND RHABDOMYOLYSIS IN AN AVIATOR

Andrew Long, David Navel
USAF School of Aerospace Medicine, Wright-Patterson AFB,
OH, USA

(Education - Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report describes an aviator in the U.S. Air Force who presented with multiple lab abnormalities related to hypothyroidism and statin use. **BACKGROUND/LITERATURE REVIEW:** Hypothyroidism is a relatively common diagnosis impacting 4.6% of the general population in the USA. In addition to fatigue and symptomatic complaints, metabolic abnormalities and elevation of creatine kinase (CK) are common. However, concurrent statin use in a hypothyroid state may lead to extreme elevations of CK and rhabdomyolysis which can impact the patient. **CASE PRESENTATION:** A 36-yr-old male aviator with a past medical history of renal calculi and mildly elevated serum creatinine presented for routine follow-up after starting a statin medication for hypercholesterolemia. His liver enzymes were elevated and the statin medication was consequently stopped. When his enzymes remained mildly elevated, further testing revealed a markedly elevated CK level of 6700 U/L. The patient also noted generalized fatigue and a marked reduction in his ability to perform anaerobic exercises. Concurrent thyroid studies revealed a thyroid stimulating hormone (TSH) level >100 mIU/mL, undetectable T3 levels, and a positive thyroperoxidase antibody level. After starting thyroid replacement therapy, his TSH normalized as did his CK, muscle enzymes, liver enzymes, cholesterol levels, and creatinine. **OPERATIONAL/CLINICAL RELEVANCE:** Aeromedical concerns with hypothyroidism include its insidious onset, fatigue, reduced cognitive ability, muscle weakness, weight abnormalities, and significant constipation, among other symptoms. Metabolic abnormalities can worsen weakness, affect renal and liver function, and increase cardiac risk factors. Statins are common, aeromedically acceptable medications that can lead to significant elevations of CK in hypothyroid aviators. Thyroid replacement therapy may help return a member to an asymptomatic euthyroid state, but swift recognition and appropriate management of this clinical picture are necessary to ensure safety in all aviators.

Learning Objective:

1. Understand that elevations in CK, among other metabolic abnormalities, can be caused by hypothyroidism, statin use, or both, and review the aeromedical concerns and guidelines related to hypothyroidism in the pilot population.

Wednesday, 05/08/2019

10:30 AM

Brasilia 7

[S-57] SLIDE: SUIT UP FOR SPACE

Chair: Michael Gallagher

Co-Chair: Judith Hayes

10:30 AM

[283] APPROACH TO ASTRONAUT FITNESS STANDARD RECOMMENDATIONS FOR ISS AND EXPLORATION MISSION TASKS

Meghan Downs, Jason Norcross, Andrew Abercromby,
Richard Scheuring, Alan Feiveson
NASA Johnson Space Center, Houston, TX, USA

(Original Research)

INTRODUCTION: Compared to ISS missions, exploration missions will include partial gravity EVAs that will likely be more physically and cognitively demanding and frequent. Furthermore, vehicles will land in

water upon return to Earth with the potential need for unaided egress. Current astronaut aerobic fitness and muscle strength standards are based on 0g EVA physical demand and need to be updated for exploration mission tasks. Valid exploration standards will help support mission task performance without undue fatigue and are critical for informing exploration exercise hardware and environmental control and life support systems (ECLSS). **METHODS:** A team consisting of subject matter experts (SMEs) from the medical and life science communities at NASA Johnson Space Center was established to develop evidence-based recommendations for aerobic fitness and muscle strength standards specific to exploration-class mission tasks, that inform requirements, provide risk-based decision making tools to future exploration programs, and protect crew health and performance on future missions. Confidence in these recommended standards was evaluated based on SME discussion and interpretation of available data and knowledge of future mission task demands. Necessary forward work was identified in cases where lack of relevant data precluded evidence-based standard recommendations or risk-based decision making tools. **RESULTS:** SMEs developed preliminary aerobic fitness and muscle-strength standards and risk-based decision making tools for exploration mission tasks. Characterizing the metabolic costs and strength requirements for moving and ambulating in an EVA suit and establishing realistic times for EVA task completion for partial gravity environments are still needed. **DISCUSSION:** The proposed standard recommendations are targeted to reduce the risk of fatigue induced errors during EVA, provide crew with performance capability targets for rapidly egressing Orion unaided, and to provide future programs with risk-based decision making tools to make informed decisions regarding human performance capabilities. All standards, with the exception of 0g EVA, were developed using analog data in healthy individuals in 1g and need to be validated in deconditioned crew upon immediate return from spaceflight.

Learning Objective:

1. The audience will learn about the approach to developing standards for muscle strength and aerobic fitness for exploration class space-flight missions.

10:45 AM

[284] MOBILE LOWER BODY NEGATIVE PRESSURE SUIT AS AN INTEGRATED COUNTERMEASURE

Lonnie Petersen, Neeki Ashari, Johan Petersen, Alan Hargens
University of California, San Diego, San Diego, CA, USA

(Original Research)

INTRODUCTION: Because all aspects of human physiology are affected by long-duration spaceflight, an integrated countermeasure approach is warranted. Combined effects of mechanical unloading and chronic cephalad fluid shift result in well-described musculoskeletal and cardiovascular deconditioning. More recently, Spaceflight-Associated Neuro-ocular Syndrome (SANS) was identified; while exact pathophysiology remains unknown, lack of habitual reduction in intracranial volume and pressure (ICP) associated with upright postures on Earth are likely significant factors. In neurosurgical patients we recently demonstrated that lower body negative pressure (LBNP) simulates gravity and that 20 mmHg LBNP is optimal level to safely lower ICP. Moreover, 8-hour daily LBNP during bedrest reduced early ocular changes associated with SANS. Aim of this study was to develop and test a mobile LBNP-suit (LBNP-trousers and attached vest) to induce caudal fluid shift. Because the vacuum also pulls the subject into the Suit, a mechanical force is generated under the feet and distributed along the entire body axis by the vest **METHODS:** Axial loading was recorded using force sensors (Tekscan, USA) placed inside the Suit under feet and over shoulders. Caudal fluid shift was estimated from internal jugular venous cross-sectional diameter (IJVa) using ultrasounds (GE, USA). **RESULTS:** Relative to the body weight (BW) when standing upright, increments of 10 mmHg LBNP from 0 to 40 mmHg whilst supine, induced axial loading corresponding to 0%; 28%; 68%; 107%, and 135% BW, respectively. Twenty mmHg LBNP was chosen in subsequent testing and whilst supine reduced IJVa by 39% (from 0.66 to 0.40 cm²). During cephalad venous congestion by 6° head-down tilt, IJVa was reduced by 45% (from 1.52 to 0.84 cm²) simultaneously relieving subjective feeling of head-congestion. During 3 hours of

supine rest at 20 mmHg LBNP, temperature and humidity in the Suit were unchanged (23.2 ± 1 C; 47.6 ± 2.6 %, respectively).

DISCUSSION: We suggest that daily use of LBNP-suit will reintroduce fluid and pressure variability to help prevent SANS, maintain cardiovascular health and provide mechanical loading to maintain postural muscle-groups, bone density and intervertebral disc health. Wearing the LBNP-suit during exercise may increase efficacy to better maintain $\text{VO}_2\text{-max}$, which is particularly important for planetary exploration where currently used ISS-exercise devices cannot be accommodated.

Learning Objective:

1. The participant will get a better understanding of the significance of integrative approach to exercise and fluid shift countermeasures to maintain human physiology during long duration spaceflight.

11:00 AM

[285] ANALYSIS OF DCS TREATMENT FEASIBILITY USING A VARIABLE PRESSURE LAUNCH/ENTRY SUIT AS A CONTINGENCY OPTION AFTER LOSS OF SPACECRAFT ATMOSPHERE

Michael Greene¹, Shane E. Jacobs²

¹University of British Columbia, Vancouver, British Columbia, Canada; ²David Clark Company Incorporated, Worcester, MA, USA

(Original Research)

INTRODUCTION: The risk of serious decompression sickness (DCS) resulting from loss of spacecraft atmosphere (LOA) has previously been estimated. Although mitigation is possible, the risk remains non-zero. LOA during Earth-Moon transit may require up to 144 hours of pressure suit operations, introducing design and operational constraints that differ considerably from previous pressure suits or EVA spacesuits. The ability to treat DCS symptoms inflight introduces further design challenges. This work investigates the feasibility of DCS treatment in this paradigm and reviews the operational and engineering implications. **METHODS:** Three different scenarios of LOA-induced DCS were considered: a transient LOA secondary to a large leak (0.25 inch hole), a permanent LOA (nominal ops), and a permanent LOA with early suit over-pressurization. Each were simulated in the context of the current Orion operational concept with regards to atmosphere and anticipated cabin depress profile. Probability of DCS symptom resolution (P(SR)) was estimated using the previously derived Hypobaric DCS Treatment Model, with ΔP calculated from a Three Region Well-Stirred Tissue (3RWT) bubble dynamics model. Simulated time to symptom onset (Ts) was variable (avg. 105 mins) and ambulation during hypobaric exposure was considered. Engineering analysis was conducted and analogies drawn from experiences with the development and testing of the Orion Crew Survival System (OCSS).

RESULTS: Maintaining 8psia at 100% FiO₂ following LOA resulted in an eventual halt and regression of bubble growth with a P(SR) of 87% (at 8hrs, Ts=105 mins, with ambulation). If cabin atmosphere was not restored and psia dropped to 4.3, bubble growth returned, but again eventually slowed and regressed over time (P(SR) = 75% at 17hrs). If the leak is resolved within the 8-h period, psid of 8 (psia=22.7) resulted in P(SR) of greater than 95%. Similarly, if the suit was over-pressurized (12psid/psia) within 2-4hrs after LOA, P(SR) exceeded 95%.

DISCUSSION: Analysis reveals the utility of a launch/entry pressure suit as an off-nominal contingency option in DCS management, particularly in the event of transient LOA. In that event, the suit may effectively act as a hyperbaric chamber, well before definitive care would otherwise be available. Maintaining suit pressure within current design limits resulted in eventual bubble regression (via the O₂ window), despite increased N₂ tension that resulted from lack of prebreathe.

Learning Objectives:

1. Review relevant DCS models and understand how they can be applied to the analysis of vehicle, spacesuit and mission design.
2. Understand how DCS risk and management considerations factor into suit pressure requirements and review other factors that determine optimal suit pressure.

11:15 AM

[286] FATIGUE IN ANALOG ASTRONAUTS WEARING A RESTRICTIVE EXOSKELETON

Lucas Rehnberg¹, Nils Kaufmann², Bonnie Posselt³, Rochelle Velho⁴, Andreas Zoller⁵, Stefan Dobrovoly⁶

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³Austrian Space Forum, Innsbruck, Austria; ⁴Heart of England NHS Trust and University of Warwick, Warwick, United Kingdom;

⁵Medical Faculty, University Ulm, Ulm, Germany; ⁶Austrian Space Forum, Innsbruck, Austria

(Original Research)

INTRODUCTION: As human exploration of space advances, there is a greater emphasis on how humans will cope in extreme environments. Analog missions are a useful tool for testing new technologies and evaluating human performance safely for these conditions. Physical fatigue is considered a critical factor for the success of Mars missions, however, there is minimal literature on physiological changes during Extra Vehicular Activities (EVAs) on Mars analog missions. The Austrian Space Forum, in the AMADEE-18 mission in Oman, utilized the Aouda Space Suit Simulator, with an exoskeleton providing physical resistance to movement, as a mimic of a pressurized space suit. Analog Astronauts (AA) were tested using handgrip dynamometry to determine the impact of EVAs on fatigue levels. **METHOD:** 15 members of the AMADEE-18 mission participated in the study, 6 AAs and 9 Field Crew (FC). Subjects used a handgrip dynamometer to measure mean handgrip strength, as maximal volitional contraction (MVC), twice a day over the four-week duration of the mission. The AA group was divided into those undertaking an EVA that day (AAEVA) and those not (AAnonEVA). Morning readings of the AAs were compared with their afternoon readings, as well as over the course of the mission. The remaining FC subjects acted as a control group. Dual statistical approaches were used. **RESULTS:** Following an EVA, the MVC of AAEVA decreased by 0.8 lb (0.75%; 103.9 to 103.1 lb, $p=0.71$). In contrast, an increase of 2.5 lb (2.46%; 105.0 to 107.5lb) and 3.4 lb (3.75%; 92.1 to 95.5 lb) was seen among AAnonEVA and the remaining FC respectively, the latter being significant ($p<0.05$). Over the mission duration, there was a 3.8 lb (3.5 %; 108.3 to 104.5 lb, $p=0.10$) reduction in the MVC values in morning/pre-EVA readings and of 3.5lb (3.2%; 107.9 to 104.4 lb, $p=0.29$) in afternoon/post-EVA readings among AAs. The mean heart rate of the 6 AAs increased by 51.6 % (68.7-104.2 bpm) during peak exertion whilst on EVA. **DISCUSSION:** It is difficult to replicate the reduced gravitational field and physiological effects of deconditioning on exploration missions. However, our data shows that in fit and healthy AAs, fatigue increases after performing an EVA and throughout the mission. Confounding issues that may have influenced the degree of fatigue include the substantial suit mass, as well as high environmental temperatures. Future work should assess the effects of physical fatigue on psychomotor performance during EVAs.

Learning Objectives:

1. Analog astronauts (AA) conducting repeated extra vehicular activities (EVAs) suffer physical fatigue. This highlights that repeated EVAs could potentially affect astronauts ability to carry out operations in future missions to Mars.
2. High fidelity Mars Analog missions, such as AMADEE 18, have shown to be a reliable method of conducting physiological research in AAs and form an essential part of the roadmap of human space exploration.

11:30 AM

[287] MEDICAL SUPPORT FOR INTRA-VEHICULAR SPACESUIT DEVELOPMENT

David Broadwell¹, Ted Southern²

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(Education - Program / Process Review Proposal)

INTRODUCTION: The advent of commercial sub-orbital, and eventually orbital, spaceflight has also created requirements and opportunities for the development of novel personal protective gear. An intra-vehicular activity (IVA) spacesuit provides protection in the event of cabin depressurization and is the current standard for orbital launches

and landings. This paper describes the medical support for human testing of a pressurized commercial IVA suit in micro-gravity. The suit developer's goal is to create an affordable, lightweight, and high-performance IVA suit which can operate at safe pressures for suborbital or orbital flight, adjust to a wide range of sizes, accommodate a large range of motion, and adapt to a variety of vehicles and missions. **TOPIC:** The suit's developer, Final Frontier Design, conducted two microgravity flight test campaigns in 2017 with the suit pressurized. These tests were performed on two different aircraft equipped for zero-g parabolic flight maneuvers. One series was supported by NASA and required NASA Institutional Review Board approval. Amongst the many challenges faced by the suit developer, the creation of medical safety criteria for the test program was a priority. This presentation will discuss the process used to develop the test monitoring and test termination criteria for the program. **APPLICATIONS:** Human research in environmentally hazardous situations is especially challenging when done outside large academic or government institutions. The process described in this presentation shows how study design, with appropriate medical input, can result in successful results for companies in the commercial space sector.

Learning Objective:

- Attendees will become familiar with the risk assessment and management for IVA suit testing in the entrepreneurial commercial space sector.

11:45 AM

[288] PHYSIOLOGICAL RESPONSES IN MICROGRAVITY WHILE WEARING AN INTRA-VEHICULAR ACTIVITY PRESSURIZED SPACESUIT

Heather Wright Beatty¹, Andrew Law¹, Ted Southern², Michael Gallagher³

¹National Research Council Canada, Ottawa, Ontario, Canada;

²Final Frontier Design, Brooklyn, NY, USA; ³Association of Spaceflight Professionals, Inc., Tampa, FL, USA

(Original Research)

INTRODUCTION: Development of a novel intravehicular activity (IVA) spacesuit is key to ensuring the safety of spaceflight participants during the launch and landing phases of suborbital and orbital flight. The Stratos spacesuit, developed by Final Frontier Design, was designed to provide safety and comfort to the wearer along with superior manual dexterity compared to other spacesuits. Evaluating the physiological responses of a suited individual under pressure in a microgravity environment is important for validation, prior to future space missions. **METHODS:** Physiological data was recorded from 6 participants during 3 parabolic flights (1 pressurized IVA Stratos spacesuit participant and 1 unsuited participant per flight) on the National Research Council of Canada's Falcon 20 modified aircraft. Each flight consisted of 10-12 parabolas, with 18-22 seconds of microgravity per parabola. Participants wore an Equivital monitor to measure heart rate and heart rate variability (from a 2-lead electrocardiogram), respiratory rate, and skin temperature. Stratos-suited participants also wore an oxygen saturation (SpO₂) sensor on the finger and ingested a BodyCAP visceral temperature pill. Physiological parameters were recorded continuously, but segmented for resting baseline (10 min prior to 1st parabola), pre-parabola (5 min prior to 1st parabola), each parabola, and post-parabola resting (5 min following last parabola). **RESULTS:** Heart rate was significantly higher at resting baseline for suited (95.2 ± 5.2 bpm) compared to unsuited (79.4 ± 4.2 bpm) participants (p<0.05), and remained ~5-10 bpm higher for suited participants during parabolas. Respiratory rate decreased during the flight from resting baseline to post-parabolas for both suited (20 to 14 breaths·min⁻¹) and unsuited (21 to 17 breaths·min⁻¹) participants. Skin temperature increased steadily for suited participants (pre-parabola 35.5 ± 0.9°C to post-parabolas 36.0 ± 0.3°C) but remained stable for unsuited participants (pre-parabola 33.3 ± 0.8°C to post-parabolas 33.4 ± 0.8°C). Suited participant's SpO₂ remained normal for the duration of the flight (Min: 96.5%, Max: 99.9%). **DISCUSSION:** Spacesuit pressurization and encapsulation may have resulted in the elevated heart rates and skin temperatures, in addition to spacesuit air, for suited compared to unsuited participants. Adequate spacesuit air flow and supply ensured the safety of spacesuit occupants.

Learning Objectives:

- To understand the variables associated with safety while wearing a pressurized spacesuit during flight.
- The audience will gain an appreciation for the physiological measures which can be monitored for human spacesuit occupant safety.
- To learn about microgravity physiological monitoring and the limitations associated with such research.

Wednesday, 05/08/2019

10:30 AM

Miranda 5/7

[S-58] SLIDE: OCCUPATIONAL HEALTH

Chair: Ryan Mayes

Co-Chair: David C. Miller

10:30 AM

[289] ENVIRONMENTAL AND OCCUPATIONAL HEALTH CHALLENGES DURING THE INTRODUCTION OF THE F35 LIGHTNING INTO UK SERVICE

Gareth Bean

Royal Air Force, RAF High Wycombe, United Kingdom

(Education - Program / Process Review Proposal)

ENVIRONMENTAL AND OCCUPATIONAL HEALTH CHALLENGES DURING THE INTRODUCTION OF THE F35 LIGHTNING INTO UK SERVICE

BACKGROUND: The introduction of any new aircraft type has the potential to generate health risks, ranging from engine noise levels, through engineering support processes such as surface finishing and component cleaning, to aircraft post-crash management hazards. This presentation will describe the environmental and occupational health challenges presented during the introduction of the F35 Lightning aircraft into UK service.

OVERVIEW: The introduction of any new aircraft type has the potential to generate health risks, ranging from engine noise levels, through engineering support processes such as surface finishing and component cleaning, to aircraft post-crash management hazards. Similarly, differences in national standards and nomenclature regarding health and safety management can often lead to significant differences in the management of hazards and consequent risks. The introduction of the F35 Lightning into RAF service generated a number of challenges with regard to environmental and occupational health, both in relation to aircraft operations, and the establishment of appropriate infrastructure and engineering support in the firm base. Environmental Health and Occupational Hygiene support was provided to the receiving airbase by unit preventative medicine personnel, with input from specialist monitoring teams at the RAF Centre of Aviation Medicine and the Command Environmental Health Team at HQ AIR. A multi-disciplinary approach, with engagement with multiple civilian and military agencies helped ensure the management and mitigation of a wide range of issues. **DISCUSSION:** Preventative medicine support is an essential element in managing engineering hazards and risks, and in reducing the likelihood and incidence of occupational ill-health. The presentation is of interest to those responsible for the health of personnel involved in aircraft operations and engineering.

Learning Objective:

- The audience will learn about the environmental and occupational health challenges presented in introducing a new aircraft type.

10:45 AM

[290] MUSCULOSKELETAL COMPLAINTS QUESTIONNAIRE FOR FAST JET AIRCREW – DOMAIN AND DEFINITION GENERATION FOR A PROSPECTIVE MONITORING AND SURVEILLANCE TOOL

James Wallace¹, Peter Osmotherly², Phil Newman³, Wayne Spratford³, Tim Gabbett⁴

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(Original Research)

INTRODUCTION: Currently there is no valid and reliable tool for the epidemiological surveillance and monitoring of musculoskeletal (MSK) complaints amongst Fast Jet Aircrew (FJA). Within the current FJA literature there is variability in the definitions used to discriminate a recordable MSK complaint or injury, and what domains should be considered when determining overall severity. The objective of this study was to generate definitions and domains that could be used for the Musculoskeletal Complaints Questionnaire for Fast Jet Aircrew (MCQFJA).

METHODS: 18 experts were invited to participate in a modified Delphi study. Experts were those who were: a) the primary/contact author of research published with in last 5 years pertaining to MSK complaints/injury amongst FJA, b) involved with the topic with the NATO Aircrew Neck Pain Working Group, or c) identified by a member of the recent NATO Aircrew Neck Pain Working Group. In round one, participants were asked to list the words/descriptors of what constituted a MSK complaint, what definitions of recordable injury should be captured, and what domains are important for determining overall severity of a MSK complaint in FJA. Responses were synthesized and returned to participants for round two where they were asked to indicate their level of agreement and rank in order of importance. Results were returned to participants for round 3 where they indicated their level of agreement in an effort reach consensus. Consensus was considered to be achieved when agreement was >75%. **RESULTS:** Eleven experts responded to round one, and nine responded to rounds two and three. Consensus was achieved for: 8 words/descriptors as to what constitutes a MSK complaint, 6 separate definitions of a recordable injury, and 14 domains that are important for determining the overall severity of a MSK complaint.

DISCUSSION: The results of this Delphi study have identified the descriptors, definitions, and domains that will be incorporated into a MSK complaints questionnaire for FJA. Such a tool will be important for future prospective epidemiological studies. Future work will involve the refinement of the tool with FJA, and a prospective study for validation, item reduction, and evaluation of the psychometric properties.

Learning Objectives:

1. Learn about important developments to advance our knowledge regarding the epidemiology of musculoskeletal complaints and injuries amongst fast jet aircrew.
2. Provide understanding of the Delphi process used to collate and reach consensus of expert opinion.
3. Learn how expert consensus has been used to develop a new tool for surveying musculoskeletal pain and injuries amongst Fast Jet Aircrew.

11:00 AM**[291] NECK FORCES IN COMBAT JET PILOTS - APPLICATION OF OPENSIM MODELLING TO CALCULATE DYNAMIC CERVICAL SPINE LOADS**

Wayne Spratford, Phillip Newman
University of Canberra, Bruce, Australia

(Original Research)

INTRODUCTION: Prevalence of flight-related neck pain in fast jet aircrew is reportedly as high as 95%, sometimes affecting fitness to fly and longevity of active service. Whilst many studies have investigated neck kinematics and EMG of cervical musculature in different helmeted postures, there is a need to determine head on neck and cervical joint moments in simulated flight positions to help determine pilot peak and cumulative workloads. Quantifying this will help inflight load monitoring to be calculated, allowing for risk predictions and pre-conditioning strategies to be better informed. **METHODS:** Three-dimensional trajectory data was collected using a VICON Motion Capture System from RAAF fast jet pilots performing common aerial combat head checks. Pilots were seated in an F/A-18A ejection seat. Opensim software was then used to derive cervical joint kinematics and moments based on trajectory data. Further models were developed to account for varying Gz profiles and 2 helmet types (HGU-55/P and JHMCS). **RESULTS:** Peak ROM of cervical spine was found to be 27 degrees cervical rotation, 48 degrees extension and 33 degrees lateral flexion. Moments were highest at C7 vertebral segment, and both peak and cumulative sum of moments were highest in the extension hold position. The JHMCS helmet was associated with up to 20% more load at C7 than the HGU-55/P helmet. Every unit

increase of Gz added approximately 10% to calculated loads at C7 for the JHMCS and 11% for the HGU-55/P helmet and demonstrated a linear relationship with average moments at each cervical segment. **DISCUSSION:** It is possible to estimate neck forces associated with aerial combat head check movements using Opensim. Quantifying neck forces dynamically is an important step towards workload monitoring for combat pilots. Further research is needed to examine relationships between workload and neck injury patterns.

Learning Objective:

1. The audience will gain information about the load the cervical vertebrae undergo during simulated flying conditions.

11:15 AM**[292] NECK FORCES IN COMBAT JET PILOTS - MACHINE LEARNER ALGORITHM VERSUS VIDEO ANALYSIS FOR HEAD POSITION COUNTS IN AERIAL COMBAT MANOEUVRES**

Jeremy Witchalls¹, Phil Newman¹, Wayne Spratford¹, James Wallace²
¹*University of Canberra, Bruce, A.C.T, Australia;* ²*RAAF Institute of Aviation Medicine & University of Canberra, Williamtown, N.S.W, Australia*

(Original Research)

INTRODUCTION: Aerial combat maneuvers involve frequent "head checks" above or behind the line of flight. Some head check positions are more physically demanding than others and may contribute to pilot neck pain. This study developed an automated system to interpret head-mounted inertial sensor data to reliably count each head check and classify the type. **METHODS:** Video footage of the pilot and head position co-ordinates relative to the instrument panel were obtained from helmet-mounted sensors during 42 F/A-18A sorties, involving 7 pilots. 6 common head postures were selected for classification- Neutral, Extension Hold, Check Right, Check Left, Quadrant Right, Quadrant Left. Four machine learner algorithms, logistic regression (LR), Naïve Bayes (NB), K Nearest Neighbour (kNN) and Adaptive Boosting (Adaboost) were trained to discriminate head motions based on head co-ordinates and labelled data of one 2-minute sample. The trained machine learners were then tested on unlabelled data. Two human classifiers independently identified 127 random timepoints in a series of flight videos and classified the head posture, while blinded from each other's results. Percent Exact Agreement (PEA) and Percent Close Agreement (PCA) were determined. The machine learning algorithm classification was compared to the human classifiers' classification for these points. **RESULTS:** Classification accuracy of the machine learners was: LR 2.0%, NB 3.2%, kNN 96.8%, Adaboost 100%. Human classifiers demonstrated 89% PEA and 99% PCA between humans. Human classification demonstrated 59% PEA and 87.4% PCA with the Adaboost classification. **DISCUSSION:** A machine classifier can reliably and accurately classify and count head checks from head-mounted inertial sensors. Human classifiers can also reliably classify head checks when reviewing video footage. Differences in agreement between human and machine are likely a combination of higher sensitivity of the machine learner using numeric variations in head co-ordinates as opposed to human classifiers responding to visual cues in footage prone to parallax error. Automation of this system will enable efficient workload monitoring, make technical review and training more feasible, and enable access to immediate post-flight summaries of workload.

Learning Objectives:

1. The audience will learn about the use of machine learning to classify and count head check movements during fast jet air combat training sorties.
2. The audience will understand the relative reliability of humans and machine algorithm for classification and counting of head check movements during fast jet air combat training sorties.
3. The audience will understand the potential use of classification and counting of head check movements during fast jet air combat training sorties for quantifying aircrew neck workload.

11:30 AM**[293] THE VALUE OF THE FINGERTIP-TO-FLOOR TEST IN THE MEDICAL CONTROL EXAMINATION FOR SWISS AIR FORCE PILOTS**

Ursula Heggli
Aeromedical Center Swiss Air Forces, Dubendorf, Switzerland

(Original Research)

INTRODUCTION: The fingertip-to-floor test (FTF) is a frequent used diagnostic tool to check the spine mobility, hip joint and ischiocrural musculature status. In previous publications it has been described with a good validity and as a good follow-up control tool to evaluate the therapy in radiculopathy. The following question is coming up, if the FTF test is a good tool to evaluate general low back pain. **METHOD:** In the years 1993 to 2018 we have collected retrospectively FTF data of 31 randomly picked Swiss air force pilots (mean age 45 ± 5 years) and divided the data in three groups: no back pain (NBP, n=9), specific back pain with lumbar disc herniation (SBP, n=5) and unspecific back pain (UBP, n=17). Statistical comparison (Levene and t- test) between the groups was made using the SPSS program. **RESULTS:** The groups of the SBP and UBP showed significant higher mean values compared to the NBP group ($p < 0.001$). Also, the variability is higher in the back pain groups than it's shown in the NBP group. Only two of the NBP group had values over 10cm, compared to the other two groups (SBP: all; UBP: 6). Three pilots of the SBP group had several times a value over 30cm, independently of back pain at this time. All the pilots of this group had at any time a value of at least 10 cm. **DISCUSSION:** The aim of this study was to evaluate the FTF test in the clinical practical approach in flight aeromedical evaluation. The FTF test is not a specific test but can be used as a screening tool to evaluate the functional low back status. The progress of FTF test shows higher values and variability if the pilot had a lumbar disc herniation or unspecific back pain than without any back pain within the last 25 years. Further studies are needed to give more insights about the concrete relation between the progress of the fingertip- to- floor test and back pain in military pilots

Learning Objective:

1. What is the value of the fingertip- to- floor test in the annual examination of military pilots.

11:45 AM**[294] SPEECH RECOGNITION OF COCHLEAR IMPLANT USERS INSIDE A NOISY HELICOPTER ENVIRONMENT**

Juliana Caldeira¹, Maria Valéria Goffi-Gomez², Rui Imamura², Ricardo Bento²

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(Original Research)

INTRODUCTION: Although the cochlear implant (CI) user meets audiometric thresholds for the criteria required for pilots, the speech recognition through the radio in the aircraft noise condition may not be sufficient for good communication. Rules for 1st class pilots are given in the International Civil Aviation Organization (ICAO) manual. Objectives: (1) to assess if CI users, who reach thresholds required by the ICAO also achieve speech recognition levels good for radio communication in the noise situation of the helicopter cockpit; (2) to evaluate if noise attenuation features optimize the speech recognition of CI users; (3) evaluate whether radio communication affects the speech recognition of CI users. **METHODS:** We evaluated the performance of 12 CI users with post-lingual deafness, who met ICAO audiometric criteria, and three normal hearing (control) pilots in intelligibility tests. We performed tests with sentences, numbers and disyllables in different situations: in the quiet (sound proof booth), in the helicopter with the engine off (radio tests), in the helicopter with the engine running, without and with activation of the anti-noise system of the headphones and in the helicopter (engine turned on) through the direct connection of the speech processor of the CI to the aircraft's radio system. This study was approved by the Ethics Committee of the University of São Paulo - School of Medicine (294.148/2013). **RESULTS:** We observed significant differences for all tests performed when we compared scores in quiet and in the noisy environment of the helicopter with engine turned on. We found a significant improvement in the results for numbers and disyllables when we reduced the exposure to noise by the direct cable connection between the CI and the aircraft radio system. We also observed a significant worsening in the disyllabic speech perception in the helicopter even with the engine off (quiet). **DISCUSSION:** This was a pioneering study testing the speech intelligibility of CI users inside the noisy environment of an aircraft. Results were based on the statistical analysis of the group and individual

analyzes with adjustments in the map of the implant according to the noise band of aircrafts could show more promising results.

Learning Objective:

1. The audience will realize that pilots with experience and countless hours of flight, can suffer hearing loss at a certain stage of their career, and the high cost of training and the flight experience are factors that justify the attempt to rehabilitate pilots to keep them active.

Wednesday, 05/08/2019**2:00 PM****Brasilia 1**

[S-59] PANEL: ASKING THE RIGHT QUESTIONS: AEROMEDICAL RESEARCH AND PILOT-PHYSICIANS

Sponsored by the International Association of Military Flight Surgeon Pilots

Chair: Joe Zhang**Co-Chair: William Smith**

PANEL OVERVIEW: Multidisciplinary aeromedical research continually strives to optimize human and aircraft performance in aerospace endeavors. By maintaining dual qualification in both their assigned aircraft and as clinicians, civilian and military Pilot-Physicians are subject matter experts in the integration of Human and Weapon Systems performance for their respective aircraft and those with similar capabilities. As a result, Pilot-Physicians play an integral role helping aeromedical research teams determine the most relevant operational questions and answer them. This panel will present case studies from both military and civilian organizations that demonstrate how pilot-physicians help identify important operational questions. The presentations will demonstrate how these questions were used to develop specific aeromedical research projects, and how results from these research efforts were used to improve operational capability, thus contributing to the body of Aerospace Medicine knowledge and Human Performance optimization.

[295] A MULTIDISCIPLINARY TEAM AND COMPREHENSIVE REVIEW PROCESS TO REVIEW PHYSIOLOGICAL EPISODES IN U.S. NAVY F/A-18 AND T-45's

Robert Krause¹, Kris M. Belland², Timothy R. Oeltmann³, James T. Gilson⁴, Daniel L. Immeker⁴

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(Education - Program / Process Review Proposal)

BACKGROUND: In Spring of 2017 there were operational risk management questions raised by U.S. Navy Instructor Pilots in regard to increases in airborne Physiological Episodes (PEs) in both the T-45 and F/A-18 aircrew. This led the Vice Chief of Naval Operations to direct a "comprehensive review of the facts, circumstances, and processes surrounding recent PEs...to include how these issues have been addressed." A team was chosen across disciplines of engineering, surface warfare, submarine warfare, aviation, legal and Aerospace Medicine. A core team and two specialized teams – medical and engineering set about to look at the problem of PEs from all angles and to offer a fresh perspective from what was already being done. This presentation will discuss the medical team's involvement in this process and how we came to our conclusions and recommendations. **OVERVIEW:** Physiologic Episodes occur when aircrew become physically or cognitively impaired while airborne and experience decreased performance due to a variety of factors. In 2010, the number of F/A-18 hazard reports related to hypoxia began increasing. Various organizations within the Naval Aviation Enterprise began to gather additional data and investigate. As this effort expanded in response to continued reporting, the Naval Air Systems Command established a Physiological Episode Team and an Integrated Project Team, which included the Aeromedical Crisis Action Team. In June 2017, approximately 100 Aviators, Flight Officers, Flight Surgeons,

Aviation Physiologists, Engineers and Various Flag and Medical Officers were interviewed from Naval Air Systems Command (NAVAIR), BUMED, Naval Safety Center, Naval Medical Research Unit - Dayton (NAMRU-D), Naval Aerospace Medical Institute (NAMI) and Naval Air Station Oceana. **DISCUSSION:** Complex problems require robust multidisciplinary teams to break them down. The comprehensive review was an approach to look at the PEs from both the 30,000-ft view and the deck plates. The PE problem is important to the Aeromedical community as a whole and directly affects those elements who fly the high performance aircraft of today and those of the future. These efforts have led to a cohesive strategy to address PEs by correcting deficiencies in engineering, human systems integration, and research.

Learning Objectives:

1. The audience will learn how the Navy's use of a comprehensive review broke down the complex problems associated with the increase in physiologic episodes in the T-45 and F/A-18.
2. The audience will understand the reasons for utilizing a multidisciplinary team, led by a submarine officer to help understand an aviation problem.
3. The audience will understand how the comprehensive review contributed to the building of the Root Cause and Corrective Action team and the main branches to be explored to include the focus of research.

[296] WORKLOAD ANALYSIS FOLLOWING CREW SIZE REDUCTION AUGMENTED BY AUTOMATION

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(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: The workload and crew coordination impact of automating a variety of Combat System Officer (CSO) tasks is unknown and must be quantified to ensure mission effectiveness as new model C-130s reduce their CSO crew members from two to one. **BACKGROUND:** Military and civil aviation has seen crew positions such as radio operators, flight engineers and navigators removed from the aircraft as new technology was developed to accomplish their tasks while maintaining or enhancing safety. Often these transitions had to overcome considerable opposition which required careful analysis and experimentation. The 1920s through the 1960s saw technology drive the most change in crew composition such as the introduction of reliable radios and navigational beacons replacing radio operators and navigators. The 1960s through the 1980s was a revolutionary period in microprocessor innovation, aviation psychology, mishap analysis, and crew resource management that resulted in the two person flight deck now utilized throughout commercial aviation. Military aviation benefitted from all of these advances however additional crew members have remained, or been added, because of military unique tasks and workload. The aircraft crew composition debate within the military continues with each new aircraft, technological advance and mission. **CASE PRESENTATION:** This effort focuses on the transition from older C-130 models to the newest J model configuration. As part of an overall aircraft crew reduction from eight to five the CSO positions were reduced from two to one. The 71st Human Performance Wing is assisting the C-130 program office with a workload analysis aimed at ensuring the newly automated CSO tasks appropriately offset enough workload safely operate with a single CSO. Workload analysis strategies, results, and implications will be presented. Counterintuitive aspects of the relationship between automation of tasks, crew composition size, and overall workload will be discussed.

DISCUSSION: The most contentious debate in modern aircraft (and spacecraft) design is crew composition and the breakdown of responsibilities and resulting workloads. Extremes range from automating everything to an unwavering belief that humans provide a necessary creative edge in problem solving. Understanding the relationships between automation, crew composition, workload, and mission effectiveness is essential.

Learning Objectives:

1. Understand the potential for a counterintuitive relationship between automation and crew composition.
2. Understand current efforts to study automation and workload in the MC-130J.

[297] ENCOURAGING AIRCREW TO SEEK TREATMENT BY OVERCOMING AEROMEDICAL MISCONCEPTIONS THROUGH PROACTIVE EDUCATION

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(Education - Program / Process Review Proposal)

BACKGROUND: Fear of aeromedical disqualification has a negative effect on patient disclosure and can jeopardize safety of flight and the overall health of aviators. This fear prevents patients from seeking treatment for conditions they assume will end their careers. Many of these non-disclosed conditions are not disqualifying but are hidden due to the patient's misconception of the medical regulation. Some conditions, particularly mental health conditions, which could have been safely managed are allowed to develop to the point of disqualification, because the aviator incorrectly feared that seeking treatment would have disqualified them. When an aviator in our Wing self-identified with depressive disorder after hiding it for some time, the misinformation among aircrew about disqualifying conditions was brought to the forefront. This pilot was convinced his flying career would be over if he ever got treatment. **OVERVIEW:** At the time the gap in understanding by aircrew was identified, a brief survey was distributed to the aircrew in the Wing to ask crew members to identify the medical conditions that were of interest to them. The responses were examined and a series of short educational briefings were created to provide information in an informal setting that might allow them to understand that treatment was an option and the flying career might not be over. The briefings were designed to address the conditions from both the perspective of the USAF and the FAA because most of the target audience were both military and civilian pilots. **DISCUSSION:** Proactive use of education programs could be an effective tool in overcoming the medical misconceptions of aircrew members. Aircrew do not know the treatments available for many conditions that would allow them to return to flying status when stable. They also tend to assume the worst and get much of their medical advice from the rumor mill rather than trained clinicians. Pilot Physicians are in an excellent position to know the common misconceptions of their fellow aviators and to use briefings and annual physicals as opportunities to educate aircrew on the approved treatments and waiver potential of commonly misperceived conditions such as depression, anxiety, and neuropathy. By opening the lines of communication and providing this information proactively, we hope to assist more aviators to get the treatment they require, ensuring increased fitness to fly both in military and civilian spheres.

Learning Objective:

1. The audience will learn about a system of briefing aimed at aviators designed to address common misconceptions about health issues and maintaining flying status in the USAF and the FAA.

[298] OVERVIEW OF TRANSPORTABLE RECOMPRESSION CHAMBER SYSTEM USE ON NAVAL AIRCRAFT CARRIERS IN RESPONSE TO U.S. NAVY PHYSIOLOGIC EPISODES

Roderick Borgia¹, Grant Wallace¹, Leisa Deutsch², Terrence Hoelt¹

¹Naval Air Forces, Coronado, CA, USA; ²Naval Aerospace Medicine Institute, Pensacola, FL, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Physiological Episodes (PE) in Naval Aviation have been identified as the number one safety concern and priority by Naval Aviation leadership. Although the exact etiology and pathophysiology are not yet fully understood, hyperbaric oxygen therapy has become one of the mainstays of treatment. Timely access to recompression chambers can be challenging in austere or remote environments. **OVERVIEW:** Navy tactical aircraft operate worldwide and Physiological Events occur unpredictably - anytime, anywhere. The Navy has developed clinical practice guidelines to assess and treat the aircrew according to their events and symptoms. Although ground level oxygen (GLO) is commonly administered and is sufficient treatment for many of

these events, hyperbaric oxygen therapy has become a standard of care for those aviators whose symptoms do not resolve after two hours of GLO. Both military and civilian chambers have been used to treat these patients, and for the most part, they have been readily available in diverse places across the globe. The Naval Aircraft Carrier is a unique environment as a center of tactical aircraft operations that also finds itself in remote locations without access to these chambers. To fill this gapped capability, the U.S. Navy began to deploy Transportable Recompression Chamber Systems (TRCS) on deployed carriers to augment the timeliness of treatment. The logistical and manning challenges of implementing these chambers on the carrier will be discussed with experiences shared from the initial deployment on the USS Carl Vinson in 2016. Future sustainability and options will also be presented. **DISCUSSION:** TRCS use on carriers is a novel approach to addressing PEs in aerospace medicine and brings medical treatment to the operational front lines. It is essential that aerospace medical providers have an awareness and working knowledge of chamber use as it relates to PE treatment as these same issues affect multiple services and international partners. The shared knowledge and collaboration of aerospace medicine is essential to the future care of aircrew affected by PEs.

Learning Objective:

1. The participant will learn about the benefits and challenges of transportable recompression chambers on aircraft carriers as it relates to Physiologic Episode treatment of aircrew.

[299] THE AIRLINE FLIGHT SURGEON-PILOT

Carlos Salicrup Diaz de Leon

Colegio Mexicano de Medicina Aeroespacial / Aeromexico, Mexico City, Mexico

(Education - Program / Process Review Proposal)

BACKGROUND: There are just a few airline flight surgeon-pilots, contracted as full time pilots that happens to be doctors and rarely by the double designation. The civilian flight surgeon-pilot have to make their way as aviation medical examiners, ER doctors, associations advisors, airline safety and human factors departments, some in a high position in these departments reporting to the airline president or CEO, or even in civilian aviation authorities, having the chance to stay in flying duties. **OVERVIEW:** In every flight we are asked about aerospace related medical counselling, ending talking about fatigue and safety issues, looking with an aerospace medical critical eye our environment, experiencing in our own body the effects of a full-time flying schedule, constant jet lag, hotel facilities in the terms of fatigue avoidance, and schedules that may influence fatigue. We fight to have a balance between company savings, safety and crew health, since every decision may directly affect our own life and colleagues life. In several flights where there is not an appropriate health professional to manage an inflight medical emergency we may have to step out of the cockpit (3-4 pilot crew) to quickly medically assist a passenger or a crew member, considering not to compromise safety for the life of one person, this may be an issue speaking about regulations, on the other hand to take the decision to stay in the cockpit during a transoceanic flight and to deviate a big heavy jet full of fuel and passengers to an alternate airport located in cities or islands with lack of state of the art medical facilities, or to land at airports with severe cold weather situations. We must manage if we may take 10-15 minutes to step out of the cockpit an initiate the care of a passenger or advice a flight attendant from our seat, or to deviate to an alternate and to take the safety risks of a medical deviation, that statistically most of the times may not be justified. **DISCUSSION:** Since we are the ones using the on board medical equipment, we have some influence in modifying its contents, we get involved in survival training, and in colleagues health promotion, since we are part of the pilot group, they have the full confidence to approach us and talk about concerns that may not be revealed to any other aviation health provider, being this the essence of the flight surgeon-pilot. Airlines and aviation authorities have the unique opportunity to benefit from this duality.

Learning Objectives:

1. The audience will learn about the airline Flight Surgeon Pilot.

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2:00 PM

Brasilia 2

[S-60] PANEL: USA AIR FORCE SPECIAL OPERATIONS REMOTE WARRIORS

Chair: Lillian Prince

PANEL OVERVIEW: This panel presents the results from two 2018 occupational health surveys given to the U.S. Air Force (USAF) Special Operations Command remotely piloted aircraft (RPA) and distributed common ground system Intelligence communities. The surveys were conducted by USAF School of Aerospace Medicine researchers to identify the unique characteristics of the special operations remote combat operational environment and how it affects the overall health of airmen. We will provide a broad-spectrum snapshot of occupational health for these USAF remote special operations warriors. The first presentation gives overarching findings on stress indices of burnout, psychological distress, and post-traumatic stress disorder (PTSD), as well as key individual (i.e., alcohol, tobacco, and caffeine use, sleep and exercise) and organizational (i.e., role stress, cohesion, job satisfaction) health attributes often associated with stress and stress management. The second presentation examines key demographic, occupational, and health risk factors for burnout components and psychological distress to include generational differences, work schedule, exposure to combat, role issues, relational issues, and negative health habits. The third presentation addresses combat exposure, specifically the types and amount of combat exposure experienced by RPA operators, and the relationship with PTSD symptom expression within this population. The fourth presentation examines the same combat exposure considerations and relationships to PTSD symptom expression albeit among special operations distributed common ground system personnel. The fifth presentation gives a psychological review of the reported moral issues and spirituality and their relationship with psychological distress and PTSD in remote operations.

[300] RATES OF OCCUPATIONAL STRESS OUTCOMES AND NEGATIVE HEALTH AND RESILIENCY FACTORS AMONG USA AIR FORCE SPECIAL OPERATIONS REMOTE WARRIORS

Lillian Prince¹, Tanya Goodman², Michael Tryon³, Wayne Chappelle³

¹Prince Research and Analytic Solutions, LLC, Birmingham, AL, USA;

²Neurostat Analytical Solutions, LLC, Alexandria, VA, USA;

³USAF School of Aerospace Medicine, Dayton, OH, USA

(Original Research)

INTRODUCTION: U.S. Air Force special operations involve highly trained personnel postured for rapid engagement and precision operations. Established rates of burnout, psychological distress, and post-traumatic stress disorder (PTSD) symptom expression among remote warriors within the conventional forces raise questions as to these rates among special operations counterparts. Organizational health indicators such as role stress and job satisfaction are also points of concern. **METHODS:** The current study included 158 RPA warfighters and 200 distributed common ground system operators engaged in Air Force special operations. Participants responded to an anonymous occupational health survey hosted on a non-military online platform. Measures included the Maslach Burnout Inventory, the Outcome Questionnaire, and the PTSD Checklist for DSM-5 [Diagnostic and Statistical Manual of Mental Disorders, 5th Edition]. Participants were also asked to respond to an array of items regarding health behaviors associated with resiliency. **RESULTS:** Among those sampled, 23-27% reported role conflict, 25-28% reported role overload, 18-23% reported low levels of unit cohesion, and 14% reported low job satisfaction. Approximately 27-33% experienced emotional exhaustion, 11-21% experienced psychological distress, 20% experienced interpersonal relationship distress, and 24-27% experienced social role distress. PTSD symptom expression ranged from 5-8%. Endorsements of negative health behaviors were also assessed. **DISCUSSION:** With approximately one in four remote warriors endorsing role conflict and role overload, and one in five reporting low organizational cohesion, findings suggest a need for streamlined tasking and promotion of team building. Notably high rates of negative psychological health indicators including emotional exhaustion, psychological distress,

relational distress, and PTSD symptom expression point to a need for focused outreach in the areas of mental health service, conflict resolution, effective communication, relationship building, and energy management. Prevalence of negative health behaviors, such as excess stimulant and alcohol consumption and inadequate exercise, detracts from effective energy management, exacerbates stress, negatively affects sleep, and diminishes overall resiliency. Interventions designed to promote a healthier lifestyle can be cultivated to promote resiliency and well-being among remote warriors in the special operations arena.

Learning Objectives:

1. The participant will be able to understand the prevalence and significance of organizational health factors (i.e. role concerns, unit cohesion and job satisfaction) within this population.
2. The participant will be able to understand the nature and rates of psychological health indicators (i.e. emotional exhaustion, psychological distress, relational distress, and PTSD) within this population.
3. The participant will be able to understand the nature and rates of negative health behaviors endorsed by this population.

[301] RISK FACTORS FOR PSYCHOLOGICAL DISTRESS AND BURNOUT AMONG AIR FORCE SPECIAL OPERATIONS REMOTE COMMUNITY

Tyler Mulhearn¹, Lillian Prince², Tanya Goodman¹, Anna Frise¹, Wayne Chappelle³

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(Original Research)

INTRODUCTION: The recent proliferation of remote warfare has drastically increased the demand for remotely piloted aircraft and intelligence operators. In addition, the nature of the missions conducted by personnel within the remote community involves its own unique stressors. The need to monitor psychological distress and burnout as well as their associated risk factors are critical to the success and livelihood of these individuals. **METHODS:** Remotely piloted aircraft personnel and intelligence personnel responded to an occupational health survey that included questions related to demographics, occupational factors, and combat factors. The Outcome Questionnaire (OQ-45.2), a 45-item measure assessing difficulties in interpersonal relationships, social roles, and overall quality of life, was used to assess psychological distress among participants. The Maslach Burnout Inventory (MBI), a 16-item measure, was used to assess components of burnout among participants. Contingency tables were created to assess the relative risk of various demographic, occupational, and health factors on psychological distress and burnout. Analysis of variance tests were conducted to assess differences between age groups. **RESULTS:** With respect to operational risk factors, overall, role conflict, role ambiguity, and a desire to leave the career field were all associated with greater risk of psychological distress and burnout. Turning to occupational and role factors, low levels of job satisfaction and high levels of operational stress placed individuals at greater risk of psychological distress and burnout. Finally, among the health risk factors, increased caffeine and alcohol use increased risk for psychological distress and burnout. **DISCUSSION:** A variety of demographic, occupational, and health factors were found to be associated with higher levels of psychological distress and burnout. The results of this study further clarify potential risk factors for negative psychological outcomes among individuals working in the Air Force special operations remote community. The descriptive nature of this study allows military psychologists and practitioners to understand factors that may make individuals more likely to experience psychological distress and burnout. Interventions designed to mitigate the impact of potential risk factors can be designed to improve the health and well-being of remotely piloted aircraft operators as well as intelligence operators.

Learning Objectives:

1. The participant will be able to understand associated risk factors of psychological distress.
2. The participant will be able to understand associated risk factors of burnout.

[302] COMBAT RELATED RISK FACTORS FOR PTSD AMONG USAF REMOTELY PILOTED AIRCRAFT WARFIGHTERS

Wayne Chappelle¹, Tanya Goodman²

¹USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA; ²Neurostat Analytical Solutions, LLC, Alexandria, VA, USA

(Original Research)

INTRODUCTION: USAF remotely piloted aircraft (RPA) weapon strike warfighters represent a unique group of military personnel engaged in continuous, around-the-clock missions. Although physically separated from the battlefield, understanding the prevalence and combat-related risk factors post-traumatic stress disorder (PTSD) among such warfighters is critical to early intervention and the effective delivery of mental health care for this community. **METHODS:** A total of 114 USAF Special Operations RPA warfighters who witnessed and/or participated in the act of killing via weapon strike missions over the past 12 months participated in the study. Participants completed an anonymous web-based comprehensive psychological health assessment. Measures included the PTSD Checklist for the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5) and a questionnaire regarding the type of real-time weapon strike outcomes they were involved in during the course of their duties. **RESULTS:** A total of 5% of participants met the criteria for PTSD as a result of witnessing and/or sense of responsibility for killing. The number of events in which RPA warfighters witnessed civilian bystanders as well as U.S., allied, or friendly forces being injured or killed were significant predictors of PTSD. Weapon strikes with expected/anticipated versus unexpected/unanticipated collateral damage and outcomes was also assessed for elevating the risk for PTSD. In addition, the number of events in which RPA warfighters felt a sense of responsibility for the injury or death of civilian bystanders, as well as U.S. or allied forces were significant predictors of PTSD. **DISCUSSION:** RPA warfighters are involved in various types of weapon strike missions and exposure to combat-related events that include witnessing and sharing in the responsibility for killing. The findings of this study shed light on the prevalence of and risk factors for meeting PTSD. The results of this study suggest that specific types of exposure and participation in missions with specific outcomes (and having a sense of responsibility in the act of killing), albeit via electronic, remote means, are associated with an increased risk for developing PTSD. In particular, the risk for PTSD was greatest as the number of combat-related events with civilian casualties increased.

Learning Objectives:

1. The audience will understand the rate of those within AFSOC RPA operators which, when screened, meet PTSD criteria.
2. The audience will understand the nature of combat exposure events most associated with meeting PTSD criteria within this population.

[303] COMBAT RISK FACTORS FOR POST-TRAUMATIC STRESS DISORDER SYMPTOM EXPRESSION AMONG USA AIR FORCE DISTRIBUTED COMMON GROUND SYSTEM OPERATORS

Tanya Goodman¹, Wayne Chappelle², Lillian Prince³

¹Neurostat Analytical Solutions, LLC, Alexandria, VA, USA; ²USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA; ³Prince Research and Analytics, LLC, Birmingham, AL, USA

(Original Research)

INTRODUCTION: U.S. Air Force distributed common ground system (DCGS) operators vicariously experience the combat environment on a day-to-day basis. The unique "deployed-in-garrison" work environment of the DCGS intelligence operator, along with the reported fatigue, operational stress, and psychological distress, makes this an important operational community to better understand, particularly regarding combat exposure and post-traumatic stress. The prevalence and expression of post-traumatic stress disorder (PTSD) symptoms among intelligence operators exposed to battlefield trauma via remote, electronic warfare are particularly relevant and critical to the effective delivery of mental health care of this population. **METHODS:** The current study included 200 special operations DCGS intelligence operators with real-time exposure to at least one traumatic event. Participants completed

paper-and-pencil self-report occupational health assessments. The surveys were anonymous and collected, scored, securely stored, and analyzed by a group of third-party researchers. Measures included the PTSD Checklist for DSM-5 [Diagnostic and Statistical Manual of Mental Disorders, 5th Edition] and a sequence on the type of military events (exposure in real time) participants were involved in during the course of their operational combat missions. The study was reviewed and granted exemption by the Air Force Research Laboratory Institutional Review Board. **RESULTS:** The percentage of DCGS intelligence operators who met the PTSD symptom criteria outlined in the DSM-5 was similar to previous studies of DCGS intelligence operators. The number of events in which intelligence operators witnessed civilian casualties as a result of enemy force actions was a significant predictor of post-traumatic stress symptom expression. In addition, the number of events in which operators felt a sense of shared responsibility in such casualties, or in allied casualties (e.g. in ability to prevent such casualties) were also significant predictors of post-traumatic stress symptom expression. **DISCUSSION:** The results of this study suggest that specific types of exposure and participation in missions with specific outcomes, albeit via electronic, remote means, are associated with an increased risk for meeting PTSD symptom criteria.

Learning Objective:

1. The audience will learn about the prevalence and expression of post-traumatic stress disorder (PTSD) symptoms among intelligence operators exposed to battlefield trauma via remote, electronic warfare.

[304] THE RELATIONSHIP BETWEEN OPERATIONAL AND COMBAT STRESS AND MORAL AND SPIRITUAL WELL-BEING

Anna Frise¹, Lillian Prince²

¹*Neurostat Analytical Solutions, LLC, Alexandria, VA, USA;* ²*Prince Research and Analytical Solutions, LLC, Birmingham, AL, USA*

(Original Research)

INTRODUCTION: High levels of stress have been shown to impact job satisfaction, mental wellness, and overall well-being. U.S. Air Force Special Operations Command remote warriors work in high-stress environments and are exposed to potentially traumatic events that can contribute to anxiety and other mental health problems. This study seeks to determine the impact of high occupational and combat-related stress on moral beliefs, social and emotional functioning, and a sense of purpose in special operations units. **METHODS:** Remote warriors from the Air Force Special Operations Command were asked to complete an anonymous survey that included the Outcome Questionnaire 45.2, the PTSD Checklist for DSM-5, and questions assessing moral injury. The Spiritual Well-Being Scale was also used in this survey, with particular focus on its subcomponents of existential and religious well-being. Responses to the scales were used to identify relationships between indicators of social and emotional functioning as they relate to aspects of spiritual well-being. The voluntary and informed consent of participants was obtained. This study was reviewed and granted exemption by the Air Force Research Laboratory Institutional Review Board. **RESULTS:** Existential well-being was found to be a protective factor against psychological distress. Those who endorsed high satisfaction with life and who were confident about their purpose in life, as measured by the Spiritual Well-Being Scale, were less likely to endorse high levels of psychological stress on the Outcome Questionnaire 45.2. Those with high existential well-being were also less likely to report feeling that their moral beliefs had been violated by their experiences with remote combat or combat support. **DISCUSSION:** Existential well-being contributes to psychological resilience in special operations units. Life satisfaction and sense of purpose are related to positive coping with stress and the ability to better manage reactions to combat experiences. Mental wellness is an important component of overall health and is essential for remote warriors to carry out their mission. Future research should examine the impact of interventions and education that are focused on increasing existential well-being and how this impacts psychological resiliency.

Learning Objective:

1. The audience will learn about the contribution of existential well-being, life satisfaction, and sense of purpose to psychological resilience and positive coping with stress in special operations units exposed to combat.

Wednesday, 05/08/2019

2:00 PM

Brasilia 3

[S-61] PANEL: A LOOK BACK ON THE EVOLUTION OF THE HUMAN VISUAL SYSTEM IN MILITARY AVIATION

Chair: Michelle Sinagra

Co-Chair: Amanda Lippert

PANEL OVERVIEW: The study of visual illusions predates the field of aerospace medicine. As the demands of the flight environment exceeded our natural sensory capabilities, the eyes and body encountered scenarios for which learned responses were required. The role of applied psychophysiology interventions became a focal point for optimizing human performance across the field of aviation in military operations. Here, we review the wide variety of challenges to the human visual system in flight, from the basics of visual illusions to the intricacies of modern sensor technology. To ensure aviators can meet and overcome these challenges, pilot selection methods have historically included a variety of visual acuity examinations, including the adaptation of Robert Barany's advancements in utilizing optokinetic nystagmus (OKN) as a form of the vestibulo-ocular reflex (VOR). However, advancements in technology have enabled the development of Night Vision Devices and even elective surgeries such as LASIK and PRK as means for improving the visual capabilities of military aviators over the past 90 years. At the turn of the 21st century, the Joint Helmet Mounted Cueing System was developed as a U.S. Air Force and U.S. Navy initiative optimizing visual acquisition of targets in support of enemy detection and weapons employment while transport and rotary wing aircraft transitioned to glass cockpits. Additionally, next generation aviators of Remotely Piloted Aircraft have taken their seat in the Ground Control Station producing a mission that relies on visual dominance, but also an understanding of visual illusions and other factors influencing visual acuity from a remote perspective. While engineers develop these new devices to combine with high-performance aircraft for use in high-risk operations, human cognitive capabilities have remained static. Therefore, reviewing these seminal discoveries of the human visual system in aerospace medicine serves as a refresher to better posture practitioners and researchers alike as virtual reality devices/environments, and eye tracking technology are recruited to explore concepts like OKN and other human system responses to better support future military operations across the globe.

[305] THE AEROMEDICAL USE AND POTENTIAL FOR OPTOKINETIC NYSTAGMUS IN RESEARCH AND TREATMENT

Imani Murph, Tracy Christaldi, Jon French

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(Education - Tutorial Proposal)

Physiological nystagmus is a complex, involuntary ocular reflex that is characterized by alternating smooth pursuit eye movement in one direction followed by a fast saccadic recovery movement in the return direction. The vestibular system monitors the movements of the head and coordinates the muscles of the eyes to stabilize the retinal image on the fovea through visual and spinal afferents. Optokinetic nystagmus is a form of this vestibular ocular reflex (VOR) that was used by Robert Barany as a window into the vestibular system and to subsequently win the Nobel prize in 1915. He went on to introduce the OKN drum as a clinical tool in 1921 and to gauge motion sickness sensitivity for pilot selection. The drum rotates black and white stripe patterns in front of a pilot's stationary head and the eyes involuntarily track the stripes, creating the nystagmus as the eyes attempt to temporarily stabilize the moving image. Since Barany's day, OKN has been induced by drums of different sizes in front of and surrounding the pilot, by off-axis tilt chairs and by rotating rooms. In spite of intense research efforts for over 100 years, the numerous underlying anatomical substrates have only partially been revealed. The search has been fruitful in advancing our understanding of VOR in general and clinically because many medical conditions, including head trauma, result in

nystagmus. OKN may provide a means to better understand the perceived motion that results in the vestibular illusion of vection that, in turn, leads to vection induced motion sickness, and another important symptom of motion sickness, called sopite. In addition to the history of the aeromedically important uses of nystagmus, in keeping with the panel's theme, we will describe our work that may provide another window into the vestibular ocular system using virtual reality goggles to reliably and rapidly create a nystagmus. The VR-OKN is easily manipulated and measured through the use of an embedded eye tracker. The software for the VR allows practically any kind of OKN stimuli of different patterns and sizes, from off axis to simple tracking motions, to be programmed quickly and tested. There is evidence that asymmetrical optokinetic eye movements may be diagnostic of mTBI. We will also suggest future uses of VR-OKN in indicating motion sensitivity, in simulator sickness and in vestibular research.

Learning Objective:

1. The audience will learn about the merit of the vestibular ocular reflex of nystagmus in research and other aeromedically relevant settings; motion sickness and concussion, throughout history including virtual reality applications.

[306] THE HISTORY OF NIGHT VISION DEVICE (NVD) USE IN THE USA MILITARY

James Salassi

US Navy, Camp Pendleton, CA, USA

(Education - Tutorial Proposal)

This presentation will start with a concise background of photoreceptor functionality, then address the concept of NVD operation, and lastly will proceed into the historical advances of NVD use in the military. The image intensifier tube is an electro-optical device used to detect and intensify energy in the visible and near infrared (IR) region of the electromagnetic spectrum. Reflected energy from the terrain enters the night vision Goggle (NVG), becomes accelerated and intensified, and an image forms for operator photoreception. Intensifier tube technology was developed in the 1930's (Generation 0; GEN 0) with IR viewers and matured in the 1980's and 90's with GEN III advancements in technology, size and weight. The GEN 0 night viewers were plagued with several ergonomic constraints. GEN I devices produced a significant increase in gain yet had high power requirements and were extremely sensitive to blooming. GEN II upgrades produced the first head-mounted system that significantly reduced issues with minification and blooming, which offset its slightly lower image gain and shorter device lifespan. GEN III technology not only broadened the spectral sensitivity of the device, but also pinpointed a peak sensitivity in an area that more closely matched the energy available in the night sky, thereby maximizing warfighter perception and lethality. Environmental limitations in operator perception remain consistent from GEN 0 until present: illumination, terrain contrast, and atmospheric obscuration. Advancements in white phosphor NVDs match with or exceeded the performance seen in the traditional green variant of the GEN III device and appear to be a popular, novel choice amongst pilots and aircrew members.

Learning Objectives:

1. The audience will be able to accurately describe the basic pathway of a photon to the brain (phototransduction cascade) during the night environment.
2. The audience will understand the main environmental factors that impact night vision device function and operator perception.
3. The audience will gain a better appreciation of where the NVD technology has come from and how we have improved perception throughout history.

[307] MODERN CORNEAL REFRACTIVE SURGERY – AN EVOLUTION

Vikas Kumar

U. S. Air Force, Valdosta, GA, USA

(Education - Tutorial Proposal)

INTRODUCTION: This presentation will start with a brief history of modern refractive surgery highlighting the major advances in its implementation and involvement of all the researchers that made it

possible, then will proceed to introduction of PRK and LASIK in the field of aviation. Specifically, military aviation. Finally, will proceed into highlighting the Air Force procedures for aviators and aircrew ending with a brief discussion on future improvements. **TOPIC:** All crews rely on their visual system to successfully complete the mission. Over time many aviators develop degraded visual acuity requiring some form of corrective lenses. Most services issue eyeglasses, while soft contact lenses and corrective eye surgeries are optional methods for achieving optimal visual acuity. Here, we will review the history of modern refractive surgery highlighting the major advances in its implementation and discoveries of some of the key researchers that made it possible. It all began in 1949 when Jose Ignacio Barraquer, MD from Columbia, regarded as the "Father of Modern Refractive Surgery", introduced the concepts and principles of lamellar corneal surgery. In 1968, Dr. Mani Lal Bhaumik and his team at University of California, developed a carbon-dioxide laser also known as the Excimer Laser, a cornerstone development for the future of Laser in Situ Keratomileusis (LASIK). Furthermore, the introduction of lasers in refractive surgeries is attributed to Rangaswamy Srinivasan. In 1980, he discovered that an ultraviolet Excimer laser could carve living tissue in a precise manner with no thermal damage to the surrounding area. The first Federal Drug Administration (FDA) trial of the laser was in 1989 with approval of laser to perform a refractive procedure known as Photorefractive Keratectomy (PRK) in 1995. PRK improves visual acuity by altering the curvature of the cornea through a series of laser pulses. However, according to FAA, reported PRK issues such as post-operative pain, prolonged healing period and increased risk of infection led to acceptance Laser in situ Keratomileusis (LASIK). The presentation will highlight the differences between PRK and LASIK and delve into benefits of one over the other as a preference by surgeons in military, general as well as commercial aviation. In addition, medical ophthalmology standards for military aviators and aircrew will also be discussed.

Learning Objectives:

1. Examine the history of corneal refractive surgery in military, general and commercial aviation.
2. Identify advantages and disadvantages of different types of corneal refractive surgeries.

[308] A HISTORICAL PATH OF HELMET MOUNTED DISPLAYS AND THE JOINT HELMET MOUNTED CUEING SYSTEM

Diane Pietila

U.S. Navy, Iwakuni, Armed Forces - Pacific, USA

(Education - Program / Process Review Proposal)

BACKGROUND: This presentation will describe the history of visual integration of helmet-mounted display (HMD) and the Joint Helmet Mounted Cueing System (JHMCS). The HMD was developed to allow the pilot to retain aircraft and weapon information while looking off boresight. **OVERVIEW:** Early reports of HMD described several critical HMD issues: symbol stabilization, inadequate definitions, undefined symbol drive laws, helmet considerations, display latency and field of view (FOV) vs. resolution tradeoff requirements. The JHMCS is a U.S. Air Force and U.S. Navy HMD Program that began in 1997 with flight testing in the early 2000's. The two-way interface design projects visual targeting and heads up display (HUD) information onto the visor. With this magnetic head tracking technology pilots can cue high off-boresight weapons and sensors creating a targeting device based upon head movements eliminating the need to look into the cockpit or maneuvering the aircraft when engaging enemy aircraft and ground targets during air combat. The system integration of HUD and other data can be presented as monocular display. Users of the JHMCS continue to be challenged by pilot symbology misrepresentation, restricted FOV, and helmet weight that can lead to musculoskeletal fatigue affecting the critical alignment of the optical system with the user's eye. **DISCUSSION:** Continued human systems integration improvements over the last 20 plus years has improved situational awareness, increased lethality and survivability by reducing time in the threat environment. This area is advancing rapidly and is of broad interest across military organizations.

Learning Objective:

1. Describe how the integration of the helmet mounted cueing system reduces head movements in pilots.

[309] VISUAL CONSIDERATIONS FOR REMOTELY PILOTED AIRCRAFT OPERATORS

Gabriela Poston

U.S. Air Force, Holloman AFB, NM, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Remotely Piloted Aircraft (RPA) operators perform within a unique environment devoid of vital sensory cues (i.e., vibration, change to ambient noise, vestibular, and even sense of smell) that provide warnings of impending hazards to aircraft performance. As a result, RPA pilots and sensor operators rely solely on the technology and equipment within the Ground Control Station (GCS) to provide orientation cues. **OVERVIEW:** Though RPA pilots and operators perform within the GCS, they are not immune to visual illusions and spatial disorientation. Two visual illusions specific to the RPA community are: the vection illusion and video ghosting. **DISCUSSION:** Each of these illusions may cause the pilot to lose control without capability of recovering the aircraft, a prime safety concern. In addition to the threats of common visual illusions, RPA crews face visual fatigue syndrome due to the increased workload of their conscious-focal system. Therefore, training of RPA operators should seek to prepare them for their unique physiological challenges just as well as their psychological challenges.

Learning Objectives:

1. -Know the visual challenges Remotely Piloted Aircraft (RPA) operators face in the Ground Control Station (GCS) -Know the visual illusions specific to RPA operators ♣ Describe vection illusion ♣ Describe video ghosting.
2. Know the causes of visual fatigue syndrome for RPA operators ♣ Identify visual systems utilized in RPA operations.

Wednesday, 05/08/2019**2:00 PM****Brasilia 4****[S-62] SLIDE: PILOT SCREENING FOR SUCCESS****Chair: Matthew Doubrava****Co-Chair: Alex Garbino****2:00 PM****[310] CEREBRAL ANEURYSM SCREENING OF APPLICANTS FOR FLIGHT DUTY – A CRUCIAL PROCEDURE TO SAVE LIVES**Hans-Juergen Noblé¹, Sven Kuehn¹, Heinz Knopf¹, Philipp Walther¹, Sven-Erik Soenksen¹, Ulrich Wörner²¹German Air Force Center of Aerospace Medicine Fuerstenfeldbruck, Fuerstenfeldbruck, Germany; ²Bundeswehrzentral Krankenhaus Koblenz, Koblenz, Germany*(Education - Tutorial Proposal)*

INTRODUCTION: Early detection of cerebral arterial aneurysms can save lives. In order to prevent fatal consequences in aerospace due to spontaneous subarachnoid hemorrhage, it is crucial to minimize this risk by a regulated screening. **TOPIC:** Every year there are about 16,000 spontaneous subarachnoid hemorrhages in Germany. Many result in sudden incapacitation with immediate unconsciousness and the resulting inability to act. Since it can be assumed that the number of unrecognized aneurysm carriers in aircraft crews is comparable to the normal collective of the population, it is highly relevant to detect aneurysms of the skull base arteries in advance. This is especially important for first time applicants for flight duty as well as for active pilots. On the one hand for safety reasons to avoid disastrous aircraft accidents, on the other hand for prognostic reasons to keep aneurysm carriers healthy. **APPLICATION:** With the 3T MRI, which has been available for two and a half years in the radiology department of the German Air Force Center of Aerospace Medicine, it is possible to have a non-invasive overview of the skull base arteries (Time of flight – MR-Angiography) in highest resolution and with little effort. Preformed aneurysms can thus be detected very reliably. With new sequence protocols it has been possible to find a total of four aneurysm carriers in more than 1000 examinations within the scope of applicant screening over the last two and a half years. Furthermore, this may also affect

manned spaceflight to a considerable extent, especially since an increased vulnerability of aneurysms in microgravity cannot be ruled out.

Learning Objectives:

1. The participant will be able to understand the positive value of screening for microaneurysms in aerospace medicine.
2. The audience will learn something about MRI techniques.
3. The audience will learn something about the potential danger of subarachnoidal hemorrhages.

2:15 PM**[311] CEREBRAL CAVERNOMA REVISITED**

Tania Jagathesan, Michael O'Brien

Civil Aviation Authority, Gatwick, United Kingdom

(Original Research)

INTRODUCTION: Cerebral cavernomas are clusters of abnormal blood vessels in the brain. The risk of complications, namely intracranial hemorrhage and seizures, can have implications on medical certification. **METHODS:** A search of the UK Civil Aviation Authority medical records database from 1990 to 2018 was undertaken for individuals with a reported diagnosis of cerebral cavernoma. **RESULTS:** There were four cases of cerebral cavernoma. Three were male and one was female. The age at diagnosis ranged from 39 to 50 years. None had experienced seizures. All cases showed radiological evidence of previous hemorrhage. **DISCUSSION:** Recent medical literature regarding the complication risks of cerebral cavernoma allows us to revisit a historic certificatory policy. A new certificatory policy for cavernomas is proposed and its application to our cases is considered.

Learning Objective:

1. The participant will be able to understand complication risks of cerebral cavernomas and the basis for a proposed certificatory policy.

[312] NEUROCYSTICERCOSIS A NEW HAZARD FOR AIRLINE PILOTS?

David Schall

FAA, Oklahoma City, OK, USA

WITHDRAWN**2:30 PM****[313] PREVALENCE AND RISK FACTORS FOR INSOMNIA AND OBSTRUCTIVE SLEEP APNEA IN ACTIVE DUTY USA ARMY PERSONNEL**John Caldwell¹, Joseph Knapik², Tracie Shing¹, Joseph Kardouni³, Harris Lieberman³¹Oak Ridge Associated Universities/US Army Research Institute of Environmental Medicine, Natick, MA, USA; ²Henry M Jackson Foundation/US Army Research Institute of Environmental Medicine, Natick, MA, USA; ³US Army Research Institute of Environmental Medicine, Natick, MA, USA*(Original Research)*

INTRODUCTION: The incidence of insomnia and obstructive sleep apnea (OSA) in the US military has risen dramatically over the past 15-20 years. The rise is due to various factors, one of which may be the large number of deployments to Iraq and Afghanistan and the associated combat exposure. Both sleep quality and sleep quantity are adversely impacted by deployments, but no definitive longitudinal evidence has directly associated deployment with sleep disorders. **METHODS:** Using information from the Total Army Injury and Health Outcomes Database, the incidence of insomnia and OSA in the entire active US Army population

from 1997-2011 was assessed; the association between insomnia/OSA and deployment and combat exposure was evaluated; and the degree to which this association was influenced by relevant comorbid conditions was examined by conducting multivariable Poisson regressions and mediation analyses – a technique that estimates the effects of additional variables.

RESULTS: From 2003-2011, incidence of insomnia and OSA increased 652% and 600%, respectively. Soldiers who deployed were at about twice the risk of insomnia (relative risk (RR)=2.06, 95% confidence interval (95%CI)=2.04-2.08) and OSA (RR=2.14, 95%CI=2.11-2.17) compared to non-deployed counterparts. Combat exposure increased insomnia risk (RR=1.20, 95%CI=1.19-1.22) but not OSA risk (RR=1.00, 95%CI=0.98-1.02). Various comorbid medical conditions, such as posttraumatic stress disorder and traumatic brain injury, mediated a portion of the associations observed. **DISCUSSION:** Increases in medical encounters of soldiers for insomnia and OSA exceeded those in US civilians. These dramatic upwards trends are due in part to the increased operational tempo since 2001, as deployment and combat exposure were independently associated with insomnia while deployment alone was associated with OSA. These issues should be aggressively addressed to optimize operational performance and the mental and physical health status of soldiers.

Learning Objective:

1. Understand the extent of insomnia and sleep apnea within the active-duty U.S. Army and factors associated with these disorders.

2:45 PM

[314] GERMANWINGS: IMPACT IN AEROMEDICAL DISPOSITION. A COMPARISON STUDY

Francisco Rios-Tejada, Almudena Rodriguez, Almudena Rodriguez, Dolores Perez-Chao, Francisco Torrero, Pilar Guillen
AESAs, Madrid, Spain

(Original Research)

INTRODUCTION: The Germanwings (GW) tragedy has meant a clear turning point in aviation safety. Before GW the aviation medical community acknowledge that commonly spread problems, such as depression, social relationships, and financial difficulties are among other causes that might lead to a suicide attempt. After GW, EASA, AsMA, EAAP, ESAM, ICASM and many other aviation organizations provided recommendations trying to cope with the problem and several States campaigned and promoted a better safety culture, by enhancing the training of AMEs in mental health issues. We will review the actual impact of Psychiatric (PSQ) and Psychological (PSC) problems in the aviation community by comparing the number of denials for such reasons before and after GW tragedy. **METHODS:** AESA database collection of physicals during 2013-14 and 2016-17 has been analyzed in order to evaluate the mental health status of the professional aviation community by comparing two years before GW and two years after GW. **RESULTS:** A total of 18,389 physicals during 2013-14 and 23,171 during 2016-17 have been reviewed. In the period 2013-14, a total of 729 initial exams were performed (3.96% of the total Class 1 exams), and in the period 2016-17, a total of 1,695 initial exams were performed (7.31% of the total Class 1 exams), which leads to an increase of 132.5% (absolute) and a 84.59% (relative). The total number of denials in Class 1 initial exams in 2013-14 were 146 out of 729 (20.02%) against 214 out of 1,695 (12.62%) in 2016-17, which means a decrease of 36.96%. In relation to denials due to PSQ and PSC problems in initial exams, we found 20 (2.74%) out of 729, in 2013-14, and 80 (4.72%) out of 1,695, in 2016-17. If we account for the total increase number of physicals against number of denials due to PSC and PSQ problems by comparing those two periods of time, we figure out an increase of 132% of physicals against 300% of denials, which means an increase of 72,26%. **DISCUSSION:** As we expected we found and increasing number of physicals by comparing both periods of time pre and post GW. Those physicals have been followed by an increasing global number of denials. If we consider the increasing percentage of physicals comparing both periods, we found that the percent of denials due to PSQ or PSC disorders is more than three times higher after GW. Impact of GW tragedy over the final results of the mental health evaluation of candidates seems to be associated.

Learning Objective:

1. Participants will have knowledge about the potential impact of the Germanwings tragedy in the evaluation of the mental health status of aircrews.

3:00 PM

[315] ADOPTING GLI-2012 FOR PULMONARY FUNCTION TESTING REDUCES UNNECESSARY REFERRALS TO A PULMONARY SPECIALIST

Yara Wingelaar-Jagt, Erik Frijters, Erik Staudt
Center for Man in Aviation, Soesterberg, Netherlands

(Original Research)

INTRODUCTION: EASA and RNLAf regulations state that an FEV1/FVC <0.7 in pulmonary function testing (PFT) requires evaluation by a pulmonary specialist. However, research has shown that this fixed lower limit of normal (LLN) leads to under- and over diagnosing in respectively younger and older adults. In 2012 the Global Lung Initiative introduced a dataset (GLI-2012) including Z-scores for the LLN, independent of age, height, sex and ethnicity. The GLI-2012 suggests a LLN-2.5 for screening purposes and a LLN-5 for clinical diagnosing (Z-score of -1.96 and -1.64 respectively). Our hypothesis is that adopting the GLI-2012 for screening of aircrew will decrease the number of referrals, while maintaining screening accuracy. **METHODS:** This retrospective study was performed at the Center for Man in Aviation and was endorsed by the Medical Ethics Committee. Pulmonary history, PFT and referral data from applicants with FEV1/FVC <0.7 in aeromedical examinations performed between 2012 and 2017 were collected and their Z-scores were calculated. Statistical analysis using Pearson's chi-square and Fisher's exact tests were performed using IBM SPSS version 23. Statistical significance was assumed with $\alpha < 0.05$.

RESULTS: Of the 2076 applicants, 92 individuals have a FEV1/FVC <0.7. None were declared unfit because of their pulmonary function. Using the GLI-2012 LLN-5 or LLN-2.5, respectively 63 (68%) and 34 (37%) subjects would have been referred (with $\chi^2 < 0.000$). Of the applicants that would not have been referred using the LLN-5 and LLN-2.5, respectively 7 out of 29 (24%) and 10 out of 58 (17%) were diagnosed with mild pulmonary pathology. **DISCUSSION:** Without missing any disqualifying diagnoses, adopting the GLI-2012 reduces the number of referrals to a pulmonary specialist by 32% (LLN-5) and 63% (LLN-2.5). This suggests adopting the GLI-2012 will be a safe reference set for pulmonary screening of aircrew, whilst reducing the number of unnecessary referrals and thereby reducing costs and uncertainty. Future research should include controls (with FEV1/FVC >0.7) and a sub analysis of specific groups (such as adolescents or ethnic populations) to investigate the effects of adopting the GLI-2012 on them.

Learning Objectives:

1. The participant will learn about the effects of implementing a new lung function reference set (GLI-2012) and LLN on the number of referrals to a pulmonary specialist.
2. The participant will understand the limitations of using a fixed cut-off value for FEV1/FVC.

DISCUSSION: OPEN Q&A

Wednesday, 05/08/2019
Brasilia 5

2:00 PM

[S-63] SLIDE: TECH ADVANCES IN TRAVEL MEDICINE

Chair: Kris Belland

2:00 PM

[316] DEFENSE POW/MIA ACCOUNTING AGENCY MEDICAL READINESS PROGRAM

Thomas Hoffman¹, Keith Harris², Matthew Scully³, Austin Chhoeu⁴, Rick Flores⁵, Gregorio Saldana⁶

¹Defense POW/MIA Accounting Agency (DPAA), Joint Base Pearl Harbor Hickam (JBPHH), HI, USA; ²Defense POW/MIA Accounting Agency (DPAA), Joint Base Pearl Harbor Hickam (JBPHH), HI, USA; ³Defense POW/MIA Accounting Agency (DPAA), Joint Base Pearl Harbor Hickam (JBPHH), HI, USA; ⁴US Army Inspector General, Arlington, VA, USA; ⁵Defense POW/MIA Accounting Agency (DPAA), Joint Base Pearl Harbor Hickam (JBPHH), Reunion; ⁶Defense POW/MIA Accounting Agency (DPAA), Joint Base Pearl Harbor Hickam (JBPHH), HI, USA

*(Education - Program / Process Review Proposal)***Defense POW/MIA Accounting Agency (DPAA) Medical Readiness Program**

BACKGROUND: Aerospace medical professionals train to support the flight environment. The principles and skills needed to support operators in the flight environment apply to operations in remote and austere environments as well. This presentation shows how Aerospace Medicine practices are applied to the DPAA medical readiness program to mitigate risk to field operations in search of our missing DoD personnel around the world and how lessons learned from this program can advance aerospace medicine practices. **OVERVIEW:** The DPAA mission is to provide the fullest possible accounting for our missing personnel to their families and the nation. DPAA investigates missing personnel records and information from all sources; develops case histories; negotiates with host nations; coordinates with US and foreign governments, private contractors, and NGO's; sends investigation and recovery teams to remote and austere locations around the world; recovers evidence and osseous material; analyzes the recovered evidence; and identifies missing personnel utilizing the most modern forensic techniques available. Missions are to some of the most remote locations on earth, including high altitudes in India and Burma (usually aircraft crashes), ice bergs, remote jungles, mountainsides, and underwater shipwrecks. Personnel performing field operations include active duty service members from all services, government employees, contractors, volunteers, and partners from other nations. The DPAA Surgeon Directorate (SG) developed the Agency medical readiness program to ensure personnel are medically ready at all times to conduct DPAA field operations. The program includes continuous medical readiness tracking via an Agency Mission Medical Readiness Center (MMRC), pre-mission screening, mission Disease and Injury (D&I) reporting and tracking, and post mission follow-up. **DISCUSSION:** Personnel medical readiness is essential to mitigate risk in field operations. Establishing and monitoring mission medical readiness applies to all participating mission personnel and is a core function in aerospace medicine and human performance. The practices developed at DPAA may help advance medical readiness standardization across US government organizations, as well as our national and international partners. The DPAA medical readiness program literally crosses all borders and frontiers, both in personnel and mission locations.

Learning Objectives:

1. The audience will learn about the DPAA medical readiness screening criteria and the references used to develop that criteria.
2. The audience will learn about the DPAA medical readiness processes and how they were developed.
3. The audience will learn about the metrics reported in the DPAA medical readiness program.

2:15 PM**[317] DIFFERENCES IN CRITICAL CARE TRANSPORT TIMES BETWEEN GROUND, HELICOPTER VFR AND HELICOPTER IFR TRANSPORTS**

Collin Davis¹, Leah Thomas², Jason Cohen³, Tovy Kamine⁴

¹Northeastern University, Boston, MA, USA; ²Northeastern University, Boston, MA, USA; ³Brigham and Women's Hospital, Boston, MA, USA; ⁴Portsmouth Regional Hospital, Portsmouth, NH, USA

(Original Research)

INTRODUCTION: In helicopter critical care and emergency medical services (HEMS) transportation, organizations aim for efficiency of the dispatch process in order to provide patients with the best possible outcome. Most HEMS organizations in the USA do not provide transport under Instrument Flight Rules (IFR), as the equipment and training for IFR HEMS flight is time and cost-intensive. Boston MedFlight (BMF) provides IFR HEMS transport—we set out to determine when IFR helicopter transport was superior to ground transport in terms of response time to sending facility. **METHODS:** We developed a process map of the dispatch process, beginning from the answering of the phone call to the helicopter in flight. We then determined critical points in the dispatch process that could be timed. We also calculated a variety of time differences to determine the length of processes in the dispatch: time from receiving a call to crew acceptance, time from receiving a call

to vehicle enroute, etc. We compared median time differences between Visual Flight Rules (VFR) flight and IFR flight, between IFR flight and ground transport, and between VFR and Ground for these points using a Mann-Whitney U test. **RESULTS:** Data was collected from 37 Ground calls, 8 IFR calls, and 69 VFR calls. The median (minutes:seconds) (interquartile range) times from dispatch answering the phone to wheels up were: Ground: 9:39 (6:59-14:14; VFR: 12:28 (10:42-15:55; IFR 20:14 (16:55-31:14). Ground v. VFR p: 0.02; VFR v. IFR and Ground v. IFR p= 0.001. The median (interquartile range) times from pilot acceptance to enroute for flights were: VFR: 0:35 (0:16-1:07; IFR: 3:27.5 (1:26-4:00), p=0.002 **DISCUSSION:** IFR conditions resulted in significantly increased response times over both VFR flight and ground transport. This increase was both in the time from dispatch calling to pilot acceptance as well as from pilot acceptance to enroute. The increase is most likely a result of a prolonged weather check and the filing of the IFR flight plan. As weather is an uncontrollable aspect of flying, and strict safety standards are in place, there does not seem to be an obvious solution to reducing this time increase. Though there are many factors that affect a patient's outcome, it is possible that the extra time for IFR transportation may make a difference in their outcome. For some transports it might make sense to change dispatch algorithms to acknowledge the time delay of IFR transports.

Learning Objective:

1. The participant will be able to understand the difference in response times for Ground, Helicopter VFR and Helicopter IFR transport.

2:30 PM**[318] INSTRUMENTED SUPINE MANIKIN FOR VIBRATION (ISMv)**

Khalid Barazanji¹, Jonathan DeShaw¹, Salam Rahmatalla², Rachel Kinsler³

¹ActiBioMotion LLC, Coralville, IA, USA; ²University of Iowa, Iowa City, IA, USA; ³U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL, USA

(Original Research)

INTRODUCTION: Patient transport systems such as litters, immobilization systems, litter support systems are often evaluated in vibration environments using deadweight manikins or sand bags. These tools are not suitable representatives of supine humans and may show erroneous patient transport system responses that lead to making wrong decisions in the development, evaluation, and procurement of patient transport systems. Human subjects use in patient system evaluation is costly, cumbersome, and limited to only safe environments. **OBJECTIVES:** (1) Develop, test, and validate an instrumented supine manikin for vibration (ISMv) that replicates the biomechanical response of a supine human. (2) Develop a user-friendly graphical user interface that can calculate vibration transmission and body segment motions due to transport environments. **METHODS:** The ActiBioMotion (ABM) research team modified the skeleton, stiffness and mass properties of an existing supine manikin to closely represent the supine human biodynamic response to repeated shock and vibration from human data that was collected at University of Iowa. The ABM team instrumented the manikin with motion sensors embedded at the head, chest, pelvis, arms, and legs. The sensors were rigidly attached to the manikin's skeleton to improve the repeatability of the vibration response. The ISMv was tested at University of Iowa using different vibrations including sinusoidal sweeps and field collected vibration signatures of ground and air military vehicles. The current ISMv weighs approximately 186 lbs and has a height of about 68.5 inches. **RESULTS:** The vibration transmissibility function of the manikin in the three-directional axes, including the auto and cross directional axes, were comparable with the human data. Sensitivity analyses show the motion response is reproducible with high fidelity. The ISMv showed no skin motion artifact, sensor placement issues, or data processing discrepancies. **DISCUSSION:** The ISMv allows standardized testing done between patient system manufacturers and procuring agencies or companies, and can replace human participants during system design, evaluation and comparison between different patient systems (e.g. immobilization systems). The ISMv can be used in extreme settings that could be unsafe for human testing. The ISMv performance will be tested by the U.S. Army Aeromedical Research Laboratory next year.

Learning Objectives:

1. The audience will learn the disadvantages of using deadweight and unvalidated passive supine manikins for patient systems testing and comparisons.
2. The audience will learn the biomechanical responses of the ISMv and human subjects.
3. The audience will learn the advantages of using the ISMv for designing, evaluating, and comparison of patient systems.

2:45 PM**[319] COMPUTATIONAL FLUID DYNAMICS PREDICTION OF INFECTIOUS PATIENT AND BIOLOGICAL WARFARE CONTAMINANT TRANSPORT IN AN AIRCRAFT CARGO BAY**Daniel Reilly711th Human Performance Wing, Wright-Patterson AFB, OH, USA*(Original Research)*

INTRODUCTION: Cargo aircraft such as the C-130 are often used to transport sick and infectious patients out of warzones and similar scenarios for proper medical treatment in an offsite location. Aeromedical evacuation often involves infectious patient and biological warfare contamination movement throughout the cabin and ventilation system in cargo aircraft that has the potential to become a major cause of disease spread, especially to the flight doctors and nurses working in close quarters with the patients. A set of computational fluid dynamics (CFD) simulations was created using C-130 ventilation and geometric parameters to predict air flow movement patterns and instigate possible operational and engine control system design changes to reduce disease spread risks. **METHODS:** Transient CFD simulations were used to predict flow patterns throughout the cargo bay of a C-130 designed for typical aeromedical evacuation. The cargo bay geometry was built in a virtual environment through computer-aided design modeling. The geometry was then imported to a CFD simulation domain, and flow patterns were predicted using ventilation parameters as physical boundary conditions. Similarly, human exhalations were simulated, and associated pathogens were tracked for locational deposition tendencies. **RESULTS:** Pathogen deposition occurrence was most prevalent on the horizontal surfaces in the cargo bay. Very little pathogen deposition occurred on the flight deck. Areas such as the cargo netting as well as the nearby patients were specific areas of interest and proved to be not as involved with the pathogen deposition as expected. Ventilation parameters forced instances of high-density deposition in the back, aft section of the cabin. Results show good correlation to experimental data. **DISCUSSION:** Simulations and validation are ongoing. Future simulation physics additions include moving flight doctors and nurses and other airframe models, specifically the C-17. Further, ventilation designs will be updated to reduce potential pathogen airtime and working area deposition.

Learning Objectives:

1. The audience will learn about the impact of using computational fluid dynamics as a tool for personnel exposure prediction.
2. The attendees will understand the computational fluid dynamics tool chain and how an exposure scenario can be built from scratch in a virtual environment.

3:00 PM**[320] BUILDING A DIGITAL BIOBANK TECHNOLOGY PLATFORM FOR MILITARY PRECISION MEDICINE**Jameson Voss¹, Albert Bonnema², Catrina Lasome³, Pavithra Shivakumar⁴, Ezekiel Maier⁴¹Air Force Medical Support Agency, Falls Church, VA, USA; ²Air Force Research Laboratory, Wright-Patterson AFB, OH, USA; ³iON Informatics, Eagle, ID, USA; ⁴Booz Allen Hamilton, McLean, VA, USA*(Education - Program / Process Review Proposal)*

BACKGROUND: New technologies have reduced the cost of genetic sequencing at an exponential pace (currently faster than Moore's law). Direct-to-consumer products have also grown, expanding the number of individuals with incidental genetic information that is challenging to manage. There is additional uncertainty about appropriate applications for precision operational health and performance practitioners because of policy constraints, persistent knowledge gaps, and other

technical challenges. **OVERVIEW:** Recognizing the importance of this gap, the Defense Health Agency Joint Program Committee-1 funded a Digital Biobank effort to develop a cloud-based platform to address security, compliance, storage, and data access challenges, enabling researchers and practitioners to securely utilize genetic data in a military context. The Digital Biobank program will provide the MHS the ability to leverage the utility of datasets for reuse and reapplication in further research while identifying the resources to support a military precision medicine program. Using the Digital Biobank platform, researchers and clinicians will be able to: 1) upload and store 'omics data; 2) automate bioinformatics workflows to process the 'omics data; 3) integrate clinical outcomes and military exposures with the 'omics data; and 4) run precision health and human performance analytics at scale. This presentation will introduce a prototype of the resulting platform with special consideration for how it could aid aerospace medical professionals in securely integrating genomic data into healthcare delivery and force health protection. **DISCUSSION:** The Digital Biobank platform is the first secure, cloud-based platform that will allow integration of genotypes with human performance and readiness outcomes in MHS. This platform is the next step for genetic-informed precision health and human performance by: 1) securely storing genetic data for secondary analysis; 2) enabling data sharing and collaboration between multiple users at multiple sites; and 3) providing best practice tools for bioinformatics and integrated analysis. **DISCLAIMER:** The views expressed in this abstract are those of the authors and do not necessarily reflect the official policy or position of the Air Force, the Joint Program Committee-1, the Defense Health Agency, the Department of Defense, or the U.S. Government.

Learning Objectives:

1. Upon completion of this presentation, aerospace medical professionals will be able to identify the policy, security, data management, and knowledge-based challenges associated with precision health and human performance in a military context.
2. Upon completion of this presentation, aerospace medical professionals will be able to identify the utility of a Digital Biobank for advancing precision health and human performance research for the military service members and their beneficiaries.
3. Upon completion of this presentation, aerospace medical professionals will be able to understand the use cases and implications of integrating genetic data with military-relevant phenotypes such as performance and readiness.

3:15 PM**[321] BACK TO THE FUTURE: PREPARING FOR AEROMEDICAL SUPPORT FOR JOINT CASUALTY MANAGEMENT IN THE 21st CENTURY**Paul Nelson, Jennifer Garrison, Roy Houchin, James Powell, Michael Engel, Greg Garrison

The Air University, Maxwell Air Force Base, AL, USA

(Original Research)

INTRODUCTION: Over the past 2 decades, the U.S. Air Force Medical Service has performed admirably as part of the Joint Trauma System. We have seen remarkable advances in medical support and un-paralleled outcomes in patient survival. However, in the multi-domain and/or full-spectrum (Chemical, Biological, Radiological and Nuclear) environment expected with a peer or near-peer competitor, our current capabilities would likely be insufficient to provide the same level of operational support or casualty management. To support the future of warfare, we must change. The language in the National Defense Authorization Act (NDAA17) provides a forcing function to help us change how future medical readiness and support are delivered in a more joint and seamless manner. Now we must act. **METHODS:** The Air University has embarked on a multi-year collaborative effort focused on faculty supported student-led research papers and task forces, operational medical scenario planning, analytic wargaming, and engagement with civilian academia to analyze and frame current and future operational medical capabilities and requirements. These lines of research align with the broader Air Force and Department of Defense focus on emerging strategic threats in support of the current National Defense Strategy. **RESULTS:** Current Air University research has focused on delineating service-specific from joint-medical requirements. Additional research has explored effective change management strategies to better

align the training platforms so that we “train as we fight” all the while retaining the unique capabilities of each of the uniformed services when appropriate. Finally, additional research is focused on framing and communicating the political narrative associated with providing medical support associated for future conflicts. Many of these findings are based upon lessons from past conflicts against determined and capable adversaries. **DISCUSSION:** The Air University provides an academic platform to frame, shape, and integrate the Air Force and Joint medical support capabilities required for future conflict. This multi-year research effort will continue to inform medical, line, and civilian leaders.

Learning Objective:

1. Understand the implications of current Air University research on the future of Air Force operational medical support.

Wednesday, 05/08/2019
Brasilia 6

2:00 PM

[S-64] PANEL: GRAND ROUNDS III

*Sponsored by The American Society of Aerospace
Medicine Specialists*

Chair: Edgar Rodriguez

Co-Chairs: Edgar Rodriguez, Richard Allnutt

PANEL OVERVIEW: This panel will consist of pairs of Aerospace Medicine residents presenting clinical cases of aeromedical interest or significance. During their residency practicum years, residents conduct evaluations of patients with diverse medical problems. Residents prepare and present a case report based on a patient encounter undertaken during their practicum experience. One resident from each pair presents the history of the presented problem. The other resident presents the physical findings and a discussion of the aeromedical policies associated with the condition. Learning Aerospace Medicine at the specialist level involves understanding the impact of medical conditions on aircrew health and mission accomplishment. The cases presented will not only be of academic interest but will also illustrate aeromedical decision making in the operational environment.

[S-64a] JAW PAIN IN A ROTARY WING PILOT

David B. Leary, Melissa E. Gear

USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Education - Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report describes a rotary wing pilot who sustained temporomandibular joint (TMJ) disc displacement after a flight using night vision goggles (NVGs). **BACKGROUND/ LITERATURE REVIEW:** TMJ derangement is a common injury affecting 20-30% of the general population. This group of disorders may produce pain and limit important daily activities such as eating and speaking. Of those with TMJ disorders, approximately 5% are classified as TMJ disc displacement without reduction, or closed lock. The most common symptoms of this type of derangement are pain and a decreased mouth opening (≤ 35 mm). While the normal course of closed lock is self-limiting and should resolve within 12 wk, persistent symptoms require further medical attention. **CASE PRESENTATION:** A 35-yr-old female rotary wing pilot with over 2000 flight hours complained of jaw pain and inability to fully open her mouth after a flight using NVGs. The initial episode resolved, but after a subsequent night flight 5 d later, she experienced a recurrence. Even though her pain and associated symptoms had not responded to conservative treatment, she continued to fly for the next 2 mo. After repeat assessment by both medical and dental staff, imaging revealed a left TMJ anterior disc displacement without reduction. In an attempt to correct the derangement, she underwent arthrocentesis, arthroscopy, arthroplasty, Botox injections, and rehabilitative massage and manipulation over the next 2 yr. While her maximal mouth opening distance did improve slightly, she continued to not tolerate wearing a helmet, was unable to perform impact activity, and had persistent difficulties with sleeping and eating. She currently awaits assessment for permanent military medical limitations and is unlikely to return to rotary flying. **OPERATIONAL/CLINICAL RELEVANCE:** Aeromedical concerns

regarding TMJ disorders include continued pain that may affect performance, the inability to wear helmets and helmet-mounted devices, difficulty with communication during flight, and the use of medications commonly prescribed for muscle relaxation and pain management. TMJ disorders are not specifically mentioned in the U.S. Air Force, U.S. Navy, or U.S. Army waiver guides, the Royal Canadian Air Force flight surgeon guidelines, or the Federal Aviation Administration Guide for Aviation Medical Examiners. All guidelines, however, recommend that any injury that is not fully healed and potentially associated with a functional deficit should be considered for disqualification of flight duties, as they could compromise the crew member's performance, health, and flight safety.

Learning Objective:

1. Understand the implications and safety concerns for temporomandibular joint injuries in pilot populations using helmet-mounted devices.

[S-64b] FULL BATTLE RATTLE

Frank C. Stafford, Jr., Roger Williams

U.S. Army School of Aviation Medicine, Ft. Rucker, AL

(Education - Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report describes an Army Aviator who reported sensing an annoying sound in his left ear when he made radio calls during flight. **BACKGROUND/LITERATURE REVIEW:** This case involved a thorough audiology evaluation and ENT evaluation. **CASE PRESENTATION:** A 30-year-old, active duty rotary wing pilot was referred to the aviation medicine clinic due to a 6-year history of a “rattling noise” in his left ear. The noise presents sporadically and is notable for only occurring during radio transmissions while flying the UH-60 helicopter and while listening to talk radio in his personal vehicle. He denied tinnitus, vertigo, hearing loss, tympanic membrane rupture, left ear trauma, or balance issues. The patient did not endorse having speech or radio communication issues accompanying this concern. The case presentation will include the workup description, aeromedical disposition and a discussion of related Tri-Service/FAA aeromedical regulations related to the case. **OPERATIONAL/CLINICAL RELEVANCE:** The described condition could have a negative impact on safety of flight for the following reasons: The potential for unrecognized, but significant degradation of the aviator's ability to communicate with crew and tower as well as the possibility of in-flight distraction.

Learning Objectives:

1. Understand how to diagnose and treat the described condition.
2. Determine how to properly assign an aeromedical disposition for the described condition.

[S-64c] TRAUMATIC ANGLE GLAUCOMA

Sangheum Bang, Maria Fuentes

5th Air Mobility Wing – Busan, Republic of Korea; 2^{3rd} Air Brigade – Puerto Montt, Chile

(Education: Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report describes an active duty military C-130 Loadmaster with a recent history of PRK OU now presents with asymmetric post traumatic cortical cataract and traumatic angle glaucoma greater than two decades after the traumatic event. **BACKGROUND / LITERATURE REVIEW:** Glaucoma is an optic-nerve disease characterized by a combination of two or more of the following: elevated intraocular pressures, visual field loss and/or progressive cupping of the optic nerve. It may be associated with increasing age, a family history of glaucoma, racial predilection, underlying eye conditions associated with elevated pressures, or trauma to the involved eye. Even if the initial traumatic event does not cause an elevated IOP, blunt eye injury can place the patient at long-term risk of developing other forms of glaucoma. Angle recession is present in up to 85 percent of patients with hyphema and further elevates the risk. Open or closed angle glaucoma may result. For this reason, all patients who have had a traumatic hyphema warrant regular measurement of intraocular pressure annually. Treatment may initially be managed with eyedrops but may eventually require surgical intervention. **CASE PRESENTATION:** The subject is a 41-year-old, active duty, USAF C-130 Loadmaster with nearly 4,000 hours of flying experience. The patient gave a history of remote baseball injury in high school that resulted in periorbital fractures and requiring no surgical intervention at that time. The member's intraocular pressures

were normal and symmetric throughout his AF career until a periodic flight physical discovered asymmetric IOPs with a delta of 10. Ophthalmologic evaluation and treatment eventually resulted in surgical intervention. The loadmaster was evaluated by the USAF Aeromedical Consultation Service who also diagnosed a post traumatic cataract and retinal hole in the affected eye. **OPERATIONAL / CLINICAL RELEVANCE:** Enlarged optic nerve cupping and OHT may be indicators of early glaucoma. Elevated IOP may result in difficulty with night vision secondary to the appearance of halos and flares around lights, and decreased contrast sensitivity. Left undiagnosed or inadequately treated, glaucoma can cause acquired changes in color vision, loss of central or peripheral visual fields, loss of visual acuity, and blindness. All of these visual disturbances have the potential to impair the aviator's visual performance and may present a significant safety hazard or adversely impact mission effectiveness. Glaucoma associated visual degradation occurs insidiously without subjective complaints which makes the screening program even more vital. Even initial applicants for aircrew positions can be considered for waiver potential with the diagnosis of ocular hypertension if the member is treated appropriately. However, if there are any changes to the optic disc the member is subject to careful evaluation and more frequent follow-up.

Learning Objectives:

1. Recognize that even a remote history of traumatic eye injury predisposes aircrew to increased risk of post-traumatic glaucoma.
2. Review the aeromedical policies of the US Department of Defense, Federal Aviation Authority, and international aviation standards for glaucoma.

[S-64d] SINGLE EPISODE OF MANIA WITH PSYCHOSIS IN AN ACTIVE DUTY MILITARY PILOT

Marshall Hayes, Hattie McAviney

USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Education - Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report describes an active duty military pilot who suffered a single episode of mania with psychosis due to Addison's disease. **BACKGROUND/LITERATURE REVIEW:** At some point in their lifetime, it is estimated that 1-3% will meet criteria for a bipolar disorder. The prevalence of primary adrenal insufficiency in Western countries is estimated in the range of 35 to 60 per million, although some estimates are up to four times higher. Diagnosis of primary adrenal insufficiency is often delayed due to generally nonspecific presenting signs and symptoms, commonly fatigue, weight loss, skin hyperpigmentation, postural hypotension, hyponatremia, and hyperkalemia. Psychiatric symptoms such as memory impairment, depression, mania, or psychosis can occur in patients with severe, chronically untreated adrenal insufficiency or early on in the disease process before any other symptoms are declared. **CASE PRESENTATION:** A 46-yr-old male active duty military pilot suffered a single episode of mania with psychotic features lasting less than 3 d. This was the first episode of mania in his lifetime; he had no personal or family history of mental illness. Workup included detailed history with multiple collateral informants, serial laboratory testing, and imaging. Initial discovery of hyponatremia along with findings on physical exam resulted in endocrine consultation. Recovery from manic symptoms was rapid with minimal intervention besides two doses of antipsychotic medication. After 18 mo, the pilot was denied medical waiver for his condition, and a medical evaluation board resulted in medical discharge. **OPERATIONAL/CLINICAL RELEVANCE:** Symptoms of mania present a number of aeromedical concerns, including flight of ideas, distractibility, impulsive behavior, limited insight, bizarre behavior, and diminished reality testing. Mania may also include psychotic features such as auditory or visual hallucinations and paranoid or grandiose delusions. Confusion and self-destructive behavior may further impact aeromedical functioning. The concern of unpredictable recurrence following the first episode of mania is significant, with potentially grave consequences. An episode of psychosis may be considered for waiver if an attributable cause is identified, such as toxic, metabolic, infectious, or marked stressors. Addison's disease, a metabolic cause of psychosis, is both disqualifying for retention and all flying classes, requiring a medical board evaluation and waiver authority disposition, although no specific waiver guidance exists for Addison's disease or adrenal insufficiency. No waiver potential for bipolar disorder exists for any aviator of any flying class.

Learning Objective:

1. Understand the implications and safety concerns for a single episode of mania with psychotic features due to a medical condition in the pilot population.

[S-64e] FLASHES AND FLOATERS AND SHADOWS, OH MY!

Moriah S. Thompson, Ann H. Tsung

University of Texas Medical Branch, Galveston, TX, USA

(Education - Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report describes a male crop-dusting pilot who sustained bilateral retinal detachments. **BACKGROUND/LITERATURE REVIEW:** Retinal detachment (RD) occurs when the retina separates from the underlying retinal pigment epithelium and choroid, resulting in ischemia and photoreceptor degeneration. Rhegmatogenous RD, the most common type, results from a retinal hole or tear and occurs in approximately one in 10,000 people per year. Non-rhegmatogenous RD can be due to exudation of fluid beneath the retina or via direct traction from the vitreous. RD risk factors include myopia, posterior vitreous detachment, lattice degeneration, cataract surgery complications, or family history. Symptoms include floaters, flashes, decreased vision, or visual field defect. Diagnosis is made via slit lamp exam. Ultrasound may assist diagnosis, particularly if vitreous hemorrhage prevents direct visualization. Treatment comprises cryoretinopexy, laser photocoagulation, pneumatic retinopexy, scleral buckling, or vitrectomy. **CASE PRESENTATION:** A 57-year-old male crop-dusting pilot sustained a nontraumatic rhegmatogenous RD in the right eye. He was found to have lattice degeneration and retinal holes of the right eye. The patient underwent repair with laser therapy, vitrectomy, and air-fluid exchange. Three months post-operatively, distance vision was correctable to 20/20, and the pilot was released by his surgeon. At his flight physical, the pilot's vision was not correctable to 20/20 in the right eye. He was in the process of seeking special issuance for RD in the right eye, when he sustained a subsequent RD in the left eye. **OPERATIONAL/CLINICAL RELEVANCE:** Aeromedical concerns following RD include loss of vision, visual field alterations, and abnormal stereopsis. RD may occur suddenly and without warning, impairing a pilot's ability to safely and effectively maintain control of the aircraft. History of RD increases the risk of RD in the contralateral eye, particularly in individuals with significant myopia. These patients require a higher frequency of re-operations and have lower success rates when compared to unilateral RD. RD with successful surgical correction may be found qualified for FAA medical certification with adequate specialty evaluation and documentation. However, the examiner may not issue a certificate for the initial application as this requires FAA decision.

Learning Objective:

1. Understand the implications and safety concerns for retinal detachment in the pilot population.

[S-64f] OCCIPITAL INFARCTION

Ranjan Sarkar

UTKROSH, Indian Naval Air Station – Port Blair, Andaman & Nicobar Islands, India

(Education: Case Study: Clinical/ Human Performance)

PROBLEM STATEMENT: This case report describes an experienced active duty military pilot with a history of occipital infarction with subsequent diagnosis of coronary atherosclerotic disease (CAD). **BACKGROUND / LITERATURE REVIEW:** Stroke (cerebrovascular disease) is the acute neurological injury that occurs as a result of brain ischemia or brain hemorrhage. Brain hemorrhage may be secondary to intracerebral hemorrhage (ICH) or subarachnoid hemorrhage (SAH). Brain ischemia may be secondary to atherosclerosis, cardioembolism, artery-to-artery embolism, small-vessel lipohyalinosis, arteritis, arterial dissection, vasospasm, or systemic hypoperfusion. Cerebrovascular accidents (CVA), transient ischemic attacks (TIA), and Coronary Heart Disease (CHD) all share common risk factors and pathological mechanisms from the standpoint of ischemia. **CASE PRESENTATION:** The subject is a 48-year-old male, active duty USAF pilot presenting for his second aeromedical consultation service (ACS) evaluation. At his first ACS evaluation for the CVA, he was found to have significant left main coronary artery disease

requiring revascularization. 4 years prior the service member awoke with a severe stabbing right sided headache associated with bilateral visual "greying out". He took two aspirin and activated emergency services. The cranial CT was negative so he was discharged from the emergency room with a diagnosis of complex migraine headache. The next day neurological evaluation was normal and the pilot was asymptomatic with no residual deficits. Approximately 30 hours after initial symptom onset and at his spouse's insistence, he was re-evaluated with cranial MRI which revealed a 16 mm left occipital lobe infarct. Visual field assessment revealed a small area of peripheral vision deficit bilaterally. No cause was found, and he was diagnosed with cryptogenic stroke and grounded for a three-year period. The pilot developed palpitations about one year into his observation period. Subsequent cardiac work-up revealed significant CAD which responded well to surgical intervention. **OPERATIONAL/CLINICAL RELEVANCE:** Regardless of the etiology, waivers for CVA will usually not be considered unless a correctable cause is identified and definitively treated. Examples of correctable etiologies might include iatrogenically-induced stroke such as from catheterization or trauma to the carotid artery without residual injury. In addition, the occurrence of a stroke/TIA leaves a potential seizure focus. Several years of observation are required to demonstrate an aeromedically acceptable risk profile. Regardless any manned-aircraft pilot waiver recommendations after stroke or TIA should be limited to multi-crew platforms with a fully trained pilot present during aircraft operation.

Learning Objectives:

1. Review the aeromedical policies of the US Department of Defense, Federal Aviation Authority, and international aviation standards for cerebrovascular events.
2. Recognize and appreciate the value of coronary history from family and flight surgeons who best know their patient population.

Wednesday, 05/08/2019
Brasilia 7

2:00 PM

[S-65] PANEL: THE BIOMEDICAL LEGACY OF APOLLO 11

Sponsored by AsMA Arcives and History Committee, Space Medicine Association

Chair: Mark Campbell

Co-Chair: John B. Charles

PANEL OVERVIEW: The legacy of Apollo 11 was not only important for space exploration, but also for biomedical research and operations which formed a basis for future space flight missions.

[323] BIOMEDICAL RESULTS OF APOLLO

John Charles

ACT4space, LLC, Houston, TX, USA

(Education - Program / Process Review Proposal)

BACKGROUND: NASA's Apollo program built on the successes of the Mercury program, which established that humans could survive and function effectively in spaceflight, and especially in weightlessness (0 G), and of the Gemini program, which qualified humans for missions as long and complex as Apollo missions were expected to be. Apollo provided a relatively large cohort—thirty men, three of whom flew twice—under qualitatively similar conditions, in an operationally challenging context, and divided conveniently into two subgroups: lunar landers (n=12) and non-landers (n=21), with three men present in both groups. Within these constraints, certain basic questions in the human response to spaceflight factors could be addressed through observational research. **OVERVIEW:** Apollo spaceflight missions documented the presence of head fullness sensations, space motion sickness, lower back soreness, insomnia and cardiac dysrhythmicity inflight, and decreased intraocular pressure, orthostatic intolerance and exercise capacity postflight. Extravehicular activity produced metabolic rates lower than were predicted preflight and crewmembers were able to move easily and confidently on the lunar surface despite altered neurosensory input in the fractional (1/6-G)

environment. Perhaps the most significant postflight medical finding of Apollo was the absence of any pathophysiology attributable to spaceflight exposure, and the quick—two to three days—reversal of observed physiological changes in most, if not all, cases. **DISCUSSION:** Apollo provided not only evidence that such challenging missions were within the physiological and psychological capabilities of well-trained and properly-equipped astronauts but also laid a solid foundation for the detailed biomedical research to be undertaken during the subsequent Skylab program. The specific effects of 1-3 days on the lunar surface at 1/6-G were not readily apparent in the context of 8-13-day exposures to weightlessness. Nonetheless, this work will be of broad interest to professionals who may be in a position to apply human performance research findings to operational problems in future human planetary surface activities, as well as to those who are interested in the effects of intermittent fractional gravity on normal physiological processes.

Learning Objectives:

1. The participant will learn some of the limitations inherent in field research in a novel environment in an operational program.
2. The participant will learn the differences in post-flight physiological responses to provocative testing associated with brief residence in a fractional-G environment compared to no exposure to such an environment.

[324] A REVIEW OF MEDICAL OPERATIONS DURING THE APOLLO MISSIONS

Richard Scheuring

NASA- Johnson Space Center, Houston, TX, USA

(Original Research)

As NASA transitioned from the Gemini to Apollo programs, crew medical operations adapted to support the new mission profiles. Apollo had dedicated flight surgeons for all mission phases, an approach similar to medical support for space shuttle and current International Space Station missions. Additionally, research teams conducted preflight medical testing at Cape Canaveral and postflight studies on a Navy aircraft carrier in the central pacific recovery area. Crew preflight quarantine procedures changed throughout the eleven Apollo missions. An additional flight surgeon was assigned the job of "Recovery Flight Surgeon" for landing support, assisting the underwater demolition team (UDT) swimmers in the water in case a returning astronaut required medical care or resuscitation. The recovery surgeon also did the post-flight testing on the aircraft carrier. The crew surgeon conducted postflight medical surveillance of the returning astronauts in the mobile quarantine facility (MQF) during Apollo 11-14. Inflight monitoring of crew health status was performed by the crew surgeon from the Mission Operations Control Room (MOCR), in Houston, TX. To aid in our current understanding of the Apollo medical operations support, a review of historical records and a face-to-face meeting and/or online interaction with surviving Apollo astronauts and flight surgeons was conducted at NASA in 2006. Overall, 18 of 22 surviving Apollo astronauts (81%) participated in the project resulting in 107 recommendations for improving human health and performance in the design of future vehicles, extravehicular activity (EVA) suits, lunar surface operations, medical kits, launch and recovery operations, exercise, and behavioral health support.

Learning Objectives:

1. The participant will have an understanding of how medical operations supporting launch, inflight and landing phases during the Apollo missions was conducted.
2. The participant will understand the role of the NASA flight surgeon in supporting astronauts during the Apollo missions.

[325] FOOD AND NUTRITION ON APOLLO 11

Paul Rambaut

University of Hawaii, Hilo, HI, USA

(Original Research)

INTRODUCTION: Experience with the food system during Apollo 11 allayed concerns for any adverse nutritional reactions in the cislunar and lunar environments. The author draws from scientific papers, NASA Technical Notes, NAS-NRC Reports and his own recollections to describe this experience and to show how it laid the foundation for a program in

Space Nutrition that has continued to the present time. **METHODS:** The Apollo Food System was the result of intense scientific and technological collaboration between NASA and the U.S. Air Force Manned Orbiting Laboratory Program, the U.S. Army Natick Laboratories, industry and universities. Within stringent weight, volume and other constraints, it provided 3,200 kcal/man/day and all essential nutrients at levels recommended by the National Academy of Sciences. Nutrient intake data were obtained from food consumption records and inventory controls. During the 2.5 hours spent in extravehicular activity on the lunar surface no nourishment was provided although some metabolic data were obtained from the spacesuits' portable life support systems. Changes in body composition were derived from pre- and postflight measurements. Following splashdown special foods were provided in the Mobile Quarantine Facility as it was returned to Pearl Harbor onboard the USS Hornet and as it was flown to Houston in a C-141. **RESULTS:** As had been amply demonstrated in preceding parabolic, orbital and circumlunar flights, eating was accomplished normally in 0 g and, starting with the first meal consumed on the moon, in 1/6 g as well. There was no difficulty swallowing and no foreign body pneumonia from the aspiration of food particles or droplets. Food intake was similarly low at 1/6 g and 0 g. There appeared to be no changes in caloric requirements and gastrointestinal function was normal. **DISCUSSION:** Some loss of weight resulted from reduced food intake when the pressure of mission duties and the exhilaration of the environment relegated eating to a low priority. Appetite was also reduced by occasional nausea, a feeling of fullness in the abdomen and a somewhat diminished organoleptic response to food. Most of the weight losses consisted of water although fat and muscle tissue were also lost. Research in Space Nutrition has accelerated after Apollo and has gone on to account for 6% of all publications in Space Biomedical Research. Some 15% of publications in Space Nutrition have focused on nutritional countermeasures.

Learning Objective:

1. The participant will understand how astronauts were nourished during the Apollo 11 mission both in space and on the surface of the moon.

[326] ULTIMATE QUARANTINE: THE APOLLO BACK-CONTAMINATION PROGRAM

Judith Hayes

NASA / Johnson Space Center, Houston, TX, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Eight years after President John F. Kennedy charged a nation to send a man to the moon, NASA met that challenge with Apollo XI in 1969. This historic mission was the first human exposure to another celestial body and there was great uncertainty associated with the unknown outcomes that might result from a lunar exposure.

OVERVIEW: In 1963, a subset of the National Academy of Sciences Space Science Board convened to address the possibility of Moon missions bringing back organisms to Earth that might be a threat to public health and the biosphere with the return of lunar samples, crews, and spacecraft. As such, NASA and an Interagency Committee on Back Contamination (ICBC) were charged with the responsibility for requirements development, philosophy and guidelines for an Apollo Quarantine Program (AQP). The core purpose of the AQP was to protect public health, agriculture, and other living resources while preserving the integrity of the lunar samples. Thus, *quarantine* included biological containment of the crew, lunar samples, and other lunar-exposed instruments, as well as, the assessment of the lunar materials prior to distribution to researchers globally. The 3 phases of the AQP consisted of: 1) in-flight crew procedures to eliminate exposures to the Command Module, 2) recovery provisions for isolation and transport of crew, spacecraft, and samples, and 3) quarantine operations at the Johnson Space Center (JSC). Crew quarantine employed Biologic Isolation Garments, the Mobile Quarantine Facility, and Lunar Receiving Laboratory (LRL) at JSC. The LRL primary biological barriers involved a Vacuum Complex for lunar sample container handling and Biological Cabinet gloveboxes for bio-characterization studies of lunar micro-organism viability. Secondary barriers relied on negative pressure laboratories with air filters, incinerators, liquid sterilization processes, and ultraviolet airlocks. **DISCUSSION:** The Apollo XI, XII and XIV crews experienced the ultimate quarantine with their samples and spacecraft. Quarantine, a minimum of 21-days, began the

moment the spacecraft left the Moon with a sequential flow of crew, spacecraft and samples transported to the LRL for medical, biological and geo-physical studies. Finally, the crews and various test species did not experience any health consequences as a result of their exposure to lunar material. Crews were subsequently released as planned and the crew quarantine program was terminated after Apollo XIV.

Learning Objectives:

1. To describe the Apollo Quarantine Program for the protection of public health from lunar astronaut and samples returning from the moon.
2. To understand the sequential flow of the lunar quarantine capabilities, including the Biological Isolation Garments, Mobile Quarantine Facility, and the Lunar Receiving Laboratory.

[327] APOLLO 11 RECOVERY AND QUARANTINE: FLIGHT SURGEON EXPERIENCE

William Carpentier

Scott and White Medical Center, Temple, TX, USA

(Education - Program / Process Review Proposal)

The Apollo 11 mission was a unique historical event in world history. This will be the summation of the personal experience of the Apollo 11 flight surgeon who was involved in the recovery operations onboard the USS Hornet and then followed the crew into immediate quarantine - first in the Mobile Quarantine Facility and then in the Lunar Receiving Laboratory. A biomedical database incorporating all of the Gemini, Apollo, Skylab, Shuttle and ISS data is still being actively constructed and so the legacy of Apollo continues.

Learning Objectives:

1. The audience will learn about the recovery operations for the Apollo 11 mission.
2. The audience will learn about the quarantine experience for the Apollo 11 mission.
3. The audience will learn about the ongoing efforts to consolidate the biomedical data for the Apollo missions.

Wednesday, 05/08/2019

2:00 PM

Miranda 5/7

[S-66] SLIDE: MENTAL HEALTH AND DECISION MAKING

Chair: David Reyes

Co-Chair: Steven Guyton

[328] Medical Confidentiality for Mental Health

Diederik De Rooy

Leiden University Medical Center, Leiden, Netherlands

(Education - Program / Process Review Proposal)

BACKGROUND: Should healthcare professionals report all airline pilots presenting with mental problems to the aeromedical authorities? In the aftermath of the Germanwings accident, mandatory reporting legislation has been suggested. However, besides several legal difficulties, it is unclear whether mandatory reporting is effective. It may deter pilots from seeking help without decreasing the risks caused by mental disorders. The author studied confidentiality and mandatory reporting for the Aerospace Mental Health Working Group of AsMA. This abstract reflects his personal opinions and cannot be attributed to the Working Group. **OVERVIEW:** A literature search to the importance of medical confidentiality and mandatory reporting in case of mental health problems was performed. As little research has been done in the airline pilot population specifically, also comparable professional groups were studied. Furthermore, studies on mandatory reporting in drivers were included. An anonymous survey of 3485 airline pilots shows that worries about confidentiality may deter pilots from seeking help. 10 studies on mental health problems in physicians, medical students and military showed that 9 up to 99.8% perceives issues of confidentiality as a barrier for seeking help. This is especially the case for those with more severe mental disorders. Some countries have legislation that mandates reporting of mental health problems in physicians and drivers. The few

studies performed to this legislation show extensive underreporting and indicate that reporting may negatively affect the patient-physician relationship. **DISCUSSION:** Of course, practitioners should have the opportunity to breach confidentiality and report pilots when they pose a significant threat to flight safety or others. However, mandatory reporting of all airline pilots with mental health problems seems not effective and will likely deter pilots from seeking help. By their very nature, mental disorders may make people more suspicious towards others. They may make it difficult for patients to trust other people, making confidentiality even more important. Especially in case pilots cooperate with treatment, mandatory reporting is undesirable. Providing a safe harbor to disclose mental problems, offering help and trying to facilitate a culture change in the perception of mental disorders may be better ways to go.

Learning Objectives:

1. The participant will learn that mandatory reporting of mental health problems has no proven effect and will likely deter pilots from seeking help.
2. The participant will understand the importance of medical confidentiality for mental health problems.

[329] TRAINING PEOPLE HOW TO ACT DELIBERATELY IN EACH MOMENT PROMOTES LONG - DURATION MISSION SUCCESS: BEHAVIOURAL SCIENCE TO INCREASE PERFORMANCE

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(Education - Tutorial Proposal)

BACKGROUND: Applied psychology in space exploration is becoming vital (Vakoch, 2011) as humans are preparing to take the next leap to explore space and establish colonies on other planets and moons. These endeavors will require significantly longer missions and so it is crucial for astronauts to perform outstandingly, whilst maintaining their psychological well-being and performance in situations that have not yet been fully examined. Empirically based applied psychology can help people to thrive, experience meaning, and succeed in long-duration manned missions; that is to maintain well-being, and increase the productivity and cohesion among crew members, the mission control, management, and the multidisciplinary science teams. **OVERVIEW:** Contextual behavioral science (CBS) shows that long-term success depends on people acting with their focus on the present moment so that they can better accomplish their goals. Human action can only occur in one moment in time: the present one. By repeatedly taking present-focused actions, people are better able to identify ways to anticipate and solve contextual problems. Such success also results from enhanced self-efficacy, and a greater ability to understand, engage with, and communicate amongst and between groups and its' members. During this active state of mind an essential quality emerges: a meaning. Meaning is crucial for many reasons; besides it is naturally reinforcing for the behavior, it allows people to a greater understanding in what they are doing; and a better ability to communicate honestly and effectively. Meaningful experience of the best-chosen action in that context leads to more proactive and supportive actions amongst a group of people who increasingly function as a focused and self-supportive team and is able to engage with difficulties in meaningfully serving higher-order goals, the mission. **DISCUSSION:** CBS underpinned by over two decades of empirical research, is well placed to improve the psychological and behavioral skills needed for demanding and long duration missions; research clearly shows that CBS based interventions can improve mental health, productivity, prosocial behavior and innovation by increasing people's psychological flexibility. CBS's practice and effectiveness are increasingly being seen in clinical, educational, financial, media, premiere sport and public sectors to enhance human benefits.

Learning Objectives:

1. The audience will learn about the use of contextual behavioural science in performance environments.
2. Understand the psychological mechanisms of successful coping and high performance in extreme and demanding environments.

[330] ANALYSES OF FATIGUE-RELATED USAF AVIATION MISHAPS

Alex Gaines, Megan Morris, Glenn Gunzelmann

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(Original Research)

INTRODUCTION: Fatigue is a critical safety issue to Air Force flight crew and maintainers. Air Mobility Command (AMC) is particularly concerned with mitigating fatigue as their crews frequently work long hours, fly at night, and cross several time zones. Nearly 15 years of mishap reports were analyzed to determine how fatigue affects Air Force operations with the goal of improving AMC's fatigue risk management policies and tools. **METHODS:** Summary data for 19,920 class D and above aviation mishap reports dating back to 2003 were collected from the Air Force Safety Automated System. Mishaps that indicated fatigue with a Human Factors Analysis and Classification System (HFACS) code or with a "yes" in the "fatigue a possible factor" column were considered to be fatigue-related in this study. Other metrics used were the event date, event class, event time (local), total fatalities, total event cost with injuries, and aircraft type. Contingency tables built from these metrics were used to assess fatigue related trends across the Air Force. Additionally, the in-depth narratives and findings of 63 fatigue-related mobility mishap reports were used to conduct qualitative analysis regarding fatigue's operational antecedents and consequences. **RESULTS:** While only 3.85% of all mishaps are fatigue-related, they are associated with \$2.1 billion of medical expenses and property damage. This is 17.9% of the \$11.7 billion total cost of the mishaps. For mobility mishaps alone, 3.49% are fatigue-related and are associated with \$454 million of damage, 25.2% of the \$1.8 billion total cost. The most common antecedents of fatigue in mobility mishaps were mission planning or scheduling issues, insufficient rest, and circadian rhythm disruptions. Incorrect vehicle operations, procedure deviations, and communication errors were frequently cited consequences. **DISCUSSION:** Fatigue is very costly to the Air Force despite the relatively low incidence rate of fatigue-related mishaps. This is because larger proportions of severe mishaps were found to be fatigue-related. This trend is consistent across all aircraft types. Fatigue is especially pervasive among AMC crews due to their unique operational requirements. We must understand fatigue's operational causes and effects to inform policies able to mitigate its impacts. The qualitative analysis suggests changes to flight scheduling protocols and improvements to fatigue risk management tools are still possible to further mitigate fatigue risk.

Learning Objectives:

1. The audience will learn statistics about the fatigue-related aviation mishaps that have occurred in the last 15 years.
2. The audience will understand the antecedents and consequences of fatigue in fatigue.
3. The audience will learn about Air Mobility Command's unique operational requirements and fatigue risk management processes.

[331] IT STARTED WITH FATIGUE ... AIRLINE PILOTS MENTAL HEALTH AND WELLBEING UNDER PRESSURE

Marion Venus

University of Bern, Inst. for Clinical Psychology & Venus Aviation Research and Training, Zurich, Switzerland, Zurich, Switzerland

(Original Research)

INTRODUCTION: After the Germanwings crash in 2015, EASA and aviation industry became aware that mental disorders and emotional stress in pilots can have disastrous consequences. Before that, fatal crashes like LAM 470, Egypt Air 990, Silk Air 185 were also caused by mental health issues and acute stress. Accident investigators proved that pilot fatigue can have fatal consequences, like ColganAir 3407, Korean Air 801 and China Airlines 006. Research on pilot fatigue yielded in depth knowledge about its effects on pilot performance and aviation safety, while little is known about medium- and long-term correlates of fatigue in airline pilots' mental health. This research focuses on the correlates of flight and duty times, fatigue, stress in pilots' mental health, i.e. common mental disorders, depression and anxiety and quality of sleep. **METHODS:** This cross-sectional study analyses demographic data, working conditions of mostly Europe-based pilots (N=196). The sample consists of 8% female pilots, the average age is 40.7 years (SD=10.64) with 50% captains, 50% first officers. 65% of the airline pilots work for legacy carriers, 25% for low cost carriers, 11.4% fly air cargo, 8.6% charter services, 60% fly short-haul, 40% long-haul. 86.4% have an employment contract directly with the airline, the rest is employed by a manning agency or "self-employed". **RESULTS:** Average

number of duty-hours in the last month was 117.2 (SD=42.4) with M=67.3 (SD=21.9) flight hours. The self-assessed WHO5 score was M=56.5 (SD=20), PHQ8 M=6.00 (SD=5.05), GAD7 M=4.02 (SD=3.9), common mental disorders (SRQ20) M=4.07 (SD=3.98), PHQ-Stress M=3.89 (SD=4.02), Jenkins Sleep Scale M=1.95 (SD=1.24). Fatigue Severity of active airline pilots was M=4.54 (SD=1.05), while the healthy reference group (Valko et al., 2008) was 3 (SD=1.08). Regression analysis (R=.826, F(df=18)= 13,367, p<.001) showed that psychosocial stress (Beta=.67), age (Beta=.29) and fatigue (Beta=.12) appeared to be the most relevant predictors for CMDs. **DISCUSSION:** During the last years many studies focused on airline pilots' fatigue. While former research mainly focused on effects of fatigue on pilot performance and aviation safety, this research spots on the correlates of duty times and fatigue on airline pilots' mental health. Cross sectional online surveys have their operational limits. Psychophysiological measurement with psych. questionnaires over several days can provide deeper insight into fatigue and recovery.

Learning Objectives:

1. The audience will learn about correlates of flight-, duty times and fatigue and potential correlates in commercial pilots' mental health (i.e. common mental disorders, depression, anxiety), and the role of sleep problems, age, psychosocial stress, number of early starts and night flights in the last months.
2. The audience will learn about the relevance of fatigue for the mental fitness assessment of pilots, and how apparent depression or anxiety symptoms can in fact be the long term consequences of chronic and acute fatigue.
3. The audience will learn about airline pilots' attitude towards the present flight time limitations, degree of protection by these FTL by their operator or CAA, how many fatigue reports they filed in the last year, why pilots did not file a fatigue report despite they were thoroughly fatigued, etc.

[332] AN INTERDISCIPLINARY PROCESS FOR INTEGRATING CURRENT CLINICAL PRACTICE WITH AEROMEDICAL DECISION MAKING - AN ONCOLOGY MODEL

Courtney Scott

Federal Aviation Administration, Hartsel, CO, USA

(Education - Program / Process Review Proposal)

We have been accused in aerospace medicine of not being current with clinical practice in other areas of medicine. One clinical area that is changing at an exponential rate is that of oncology. We sought to have a dialogue with top level experts in this field to ensure that our aeromedical decision making considered and incorporated the latest advances in clinical oncology. As oncology is a very broad field, we narrowed our specific malignancies to those that are either very common or very problematic in our population of (primarily) US airmen. As such we limited our discussion to malignancies involving lung, colorectal, leukemias, thyroid, melanoma, and breast. We were able to garner participation in each of these areas with clinicians from diverse major university medical centers who are actively involved in writing the National Comprehensive Cancer Network (NCCN) guidelines for cancer care in the USA. These are perhaps the best evidence-based standards of care available in the field at this time. Two other special areas of consideration that were considered extremely germane to the discussions were a) neurocognitive concerns with malignancy, both related and unrelated to chemotherapy and b) the fact that new medications in this field are being fielded at a rate which is difficult to grasp. To assist in these areas, we were able to include a National Cancer Institute who publishes on the cognitive aspect and a PharmD who oversees a specialty fellowship in oncology drugs at a major University Medical Center. Malignancy cases are often difficult aeromedical decisions. The FAA has dispositioned 7,240 cases of malignancy from Jan 2013 to July 2018. These dispositions seek to balance the safety of the National Air Space (NAS) with the airman's life and livelihood. We also recognize many of these airmen are older and also contribute to the safety of the NAS by virtue of their skill and experience. The discussions spanned 2 1/2 days. The first day was spent framing the problem; first from the perspective of aerospace medicine, then from the perspective of current clinical oncology. We then reviewed evidence-based risk assessment. The remainder of the time

was spent reviewing case histories and recommended dispositions. This material was carefully recorded, then synthesized into policy requirements to help us make the best evidence-based decisions. Long term plans call for regular review of clinical advances in this field.

Learning Objectives:

1. If one reaches out to advanced practice clinicians for assistance, they will tend to respond positively.
2. Decisions that require integration from multiple clinical specialties require that the different specialties educate each other as to their core thinking, their different obstacles, and their current advances.
3. Aerospace medicine practitioners should ALWAYS practice good, current medicine, consistent with the best evidence and practice of the time. To achieve that we are wise to seek assistance from those who know and practice the very best clinical medicine. It is a win-win.

[333] A 10-YEAR RETROSPECTIVE REVIEW OF UROLITHIASIS IN THE ROCAF PILOTS

Kwo-Tsao Chiang¹, Ruo-Chiang Chao¹, Ching-Hsien Lu¹, Chia-Ting Lai²

¹Air Force Command Headquarters, MND, ROC(TAIWAN), Taipei, Taiwan; ²The 2nd Tactical Fighter Wing, ROCAF, Hsin-Chu, Taiwan

(Original Research)

INTRODUCTION: Urinary tract calculi are a common affliction in R.O.C. (Taiwan). In-flight incapacitation secondary to the pain of renal colic is the most important aeromedical concern. According to the Armed Forces Manual of Aviation Medicine, Ministry of National Defense, R.O.C. (Taiwan), pilot must be stone free to be qualified in flight status. The primary objectives of this study were to determine the nature of urolithiasis in ROCAF pilots, include the incidence, symptom and management, then investigate the effect to the pilots, include related DNIF day and waiver apply. **METHODS:** We retrospectively studied all the waiver applications for urolithiasis from 2008 to 2017 in the records of the Medical Affairs Section, Air Force Command Headquarters to determine the nature and effect of urolithiasis to ROCAF pilots. **RESULTS:** From 2008 to 2017, there were 11 waiver applications for urolithiasis in the 10-year period. The 10-year incidence rate was less than 0.1%. They are all male with average age 38 Y/O, range from 28-54, 5 of them were between 30-40 Y/O, 2 were under 30 Y/O. Only 1 of them was a recurrent case in the followed 7th year. Five of them were found due to renal colic attacked, 6 are asymptomatic (incidental finding in annual health examination), all incidental finding cases were diagnosed as renal stone. Management include 1 spontaneous passage, 6 with Extracorporeal Shock Wave Lithotripsy (ESWL), 4 with Ureteroscopic Lithotripsy or other combined treatment. The average DNIF day was 165 days, range from 26 to 403 days, in renal colic group was 65.6 days, and asymptomatic group 247.7 days. In treated with ESWL group the average DNIF day was 198.2 days. They all got waiver for 1 year and be followed every year. **DISCUSSION:** Pilots were thought to be at high risk of urolithiasis due to the flight environment. The low incidence rate in this study could be due to other than flight time, pilots all live in air-conditioned environment with drinking water easily available. Besides, some comorbidity of urolithiasis was excluded because they were all fit the flight physique standards. The average DNIF day in renal colic group was shorter than asymptomatic group with statistics significant. In the treated with ESWL group, 2 of them DNIF combined with some other clinical condition. If we exclude these 2 cases, the left 4 cases in this group average DNIF day shall be 101 days, prolonged DNIF days were resulted from residual stones after ESWL management.

Learning Objectives:

1. Pilots were thought to be at high risk of urolithiasis due to the flight environment. The low incidence rate in this study could be due to other than flight time, pilots all live in air-conditioned environment with drinking water easily available.
2. The average DNIF day in renal colic group was shorter than asymptomatic group with statistics significant in this study.

Wednesday, 05/08/2019
Exhibit Hall

2:00 PM

[S-67] POSTER: SPACE

Chair: Sanjay Gogate

Co-Chair: Rowena Christiansen

[334] STONES OF SISYPHUS: FIRST STEPS TOWARD GENETICALLY-INFORMED PREVENTION OF KIDNEY STONES

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(Original Research)

INTRODUCTION: Astronauts would benefit from more accurate kidney stone risk profiling and personalized preventive therapies. Recent evidence suggests that single mutations could be responsible for a larger proportion of kidney stones than previously thought. Theoretically, specific allelic defects would contribute to the risk of stone formation in microgravity. Diagnosis of a monogenic stone disorder can enable the use of individualized prophylaxis. To ensure cost-effective use of gene panel sequencing, candidates can be identified via metabolic testing. We hypothesized that some patients in a general stone clinic would possess metabolic phenotypes corresponding to known monogenic causes, a first step in demonstrating the feasibility of triggered genetic testing. **METHODS:** 375 patients at our urology clinic billed for stones between 2010-2016 were reviewed retrospectively. IRB approval was obtained. 89 patients were excluded due to absent lab data or known disease affecting stone formation. Lab values needed to identify metabolic phenotypes were extracted, being excluded in acute illness or if discordant with other time points.

RESULTS: 16% (42/286) of patients had lab values potentially consistent with a monogenic cause, while 9% (26/286) did using more strict criteria. The prevalence of the signature of distal RTA, metabolic acidosis with inappropriately alkaline urine, was 7% (19/263). Among those with stone analysis available, 3% (3/91) had a calcium phosphate stone along with the signature of dRTA. Among patients with phosphate measured, 14% (14/99) had hypophosphatemia (evidence of *SLC34A3* or *SLC34A1* mutation). Among patients with 24h urine oxalate measured, 13% (1/8) had urine oxalate >70 mg (evidence of primary hyperoxaluria). Among those with PTH measured, 21% (4/19) had hypocalcemia with normal PTH (evidence of *CASR* activating mutation), and, 5% (1/19) had hypercalcemia with normal-to-high PTH (evidence of *CASR* inactivating mutation). **DISCUSSION:** Triggered genetic testing has the potential to yield results for several genes, enabling personalized medicine for stone formers. As access to space expands, preexisting stone disease may be less concerning if diagnosed and treated at the genetic level. Stone risk profiling in astronauts could be expanded to utilize gene panel sequencing when appropriate. To evade legal and practical barriers, initial research could be done in astronauts who have already flown and developed stones.

Learning Objective:

1. Learn how metabolic testing and gene sequencing could enable more personalized diagnosis and treatment of renal stone disease.

[335] EFFECTS OF CHRONIC HYPERGRAVITY EXPOSURE ON ALLERGIC ANIMAL MODELS

Young Hyo Kim, Ah-Yeoun Jung, Kyu-Sung Kim, Hyun-Ji Kim
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(Original Research)

INTRODUCTION: We investigated the effects of chronic high gravity on animal models with allergic diseases. **METHODS:** Forty BALB/c mice were equally divided into 4 groups as follows. Group A (control group) was intraperitoneally and intranasally injected with physiological saline. Group B (allergic disease group) received intraperitoneal and nasal ovalbumin for the induction of systemic allergy. Mice belonging

to group C (normal gravity control) were exposed to mild rotational stimulation while inducing allergic disease through ovalbumin administration. As a result, they were exposed to rotational stimulus stress, but gravity itself was exposed to 1G, like earth gravity. Finally, group D (hypergravity exposure group) was exposed to 5 G of hypergravity through rotation stimulation throughout the period of allergic disease induction (4 weeks). To determine the effects of hypergravity on allergic diseases, we measured total IgE and OVA-specific IgE in serum and the number of inflammatory cells in the broncho-alveolar lavage. We also performed real-time PCR to detect the genetic expression of Th2 cytokines such as IL-4, IL-5, and IL-13 using lung homogenate tissue. **RESULTS:** We found a statistically significant decrease in serum total IgE in Group D compared to Group B and Group C ($p < 0.05$). Group D also showed significant decrease in eosinophil count in broncho-alveolar lavage after hypergravity exposure. Real-time PCR showed that all Th2 cytokine gene expression was significantly inhibited in Group D. **DISCUSSION:** We could first prove that proper size of hypergravity in individuals with allergic diseases could have health promotion effect. Further studies are needed to confirm the mechanism of these effects.

Learning Objective:

1. Understand the beneficial effect of moderate hypergravity on the immune system.

[336] SPACE ASTHENIA: AN EVOLUTIONARY CONCEPT ANALYSIS

Aubrey Florom-Smith

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(Original Research)

INTRODUCTION: Space asthenia is a serious threat to human health and performance during long-duration spaceflight. Although an acknowledged psychopathology, space asthenia lacks a uniform definition in the literature and ICD-10, and is not included in the DSM-V. Without a clear conceptual definition, which is intended to evolve as new knowledge emerges, space asthenia cannot be detected, diagnosed, measured, or treated. **METHODS:** A concept analysis via literature review was conducted using Rodger's evolutionary method. CINAHL, NASA Technical Reports Server, PubMed, PsychInfo, ICD-10, DSM-V, and a medical dictionary and space psychology/psychology textbook were searched. Key words were "space asthenia", "neurasthenia", "psychasthenia" and "spaceflight". Inclusion criteria were specific to humans and published in English between 1961 and 2018 ($n = 170$ initial sample). The final sample was 32 articles, abstracts, technical reports, and definitions. Thematic analysis consisted of iterative data review and organization of antecedents ($n = 8$), attributes ($n = 17$), consequences ($n = 5$), and contextual factors ($n = 4$). **RESULTS:** Space asthenia appears between one and six months of long-duration spaceflight and after exposure to isolation, confinement, and microgravity; cognitive/physical demands; or experienced mood/behavior changes. Prevalent symptoms are physical discomfort; weakness; mood/behavior lability; sleep problems; cognitive issues; fatigue; irritability; poor concentration; and work/performance decrement. Consequences are diminished performance; mood/behavior/personality changes; and mission failure. Cultural factors may be influential, and antecedents, attributes, and consequences overlap. **DISCUSSION:** This concept analysis revealed that 2 of the 3 most prevalent symptoms identified differed from those previously reported, and many factors overlapped. As such, space asthenia may be highly individual and progress atypically. Similar to other conditions experienced in harsh environments, space asthenia may be the result of multiple, intertwined, and mutually exacerbating factors. To optimize outcomes, individually tailored diagnostic and treatment approaches that consider these factors and cultural influences may be required. This definition of concept analysis can be used to drive future research, additional concept refinement, and model development needed to inform space asthenia-specific diagnostic tools, treatment, and countermeasures.

Learning Objective:

1. Understand the evolutionary concept analysis of space asthenia.

[337] DEVELOPMENT OF A WEB-BASED RATING PLATFORM FOR MEASUREMENT OF CREW BEHAVIORAL SKILLS DURING SIMULATED MEDICAL EMERGENCIES IN SPACE

Roger Dias¹, Thomas Doyle², Jamie Robertson¹, Joelle Thorgrimson³, Avni Gupta¹, Benjamin Mormann¹, Charles Pozner¹, Douglas Smink¹, Stuart Lipsitz¹, David Musson³, Steven Yule¹
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(Original Research)

INTRODUCTION: Long-duration exploration missions (LDEMs) impose unique physical and psychological demands on crew members, affecting their performance during routine activities in space. A relevant gap for the NASA Human Research Roadmap is the lack of knowledge on how space crew should be trained for medical decision making and medical skills to enable extended mission or autonomous operations. The aim of this study is to develop a web-based assessment platform, enabling raters to observe crew members managing simulated medical events in a spacecraft simulator and measure their non-technical skills using a behavioral marker system. **METHODS:** An astronaut crew behavioral skills taxonomy called Space Flight Resource Management for Medical Event Management (SFRM-MED) was developed to capture the specific non-technical skills entailed during medical event management in space. A series of four emergency simulation scenarios (tension pneumothorax, cardiac arrhythmia, eye injury, toxic inhalation) were filmed in a spacecraft simulator, generating a total of sixteen 2-minute video clips. A HTML-based application was developed, allowing collection of rater demographics and randomly displaying the videos for observation and measurement. A total of 10 raters provided their assessment regarding specific SFRM-MED behaviors observed in the videos, using a visual analogue rating scale (0 to 100). Raw data was exported in csv format for statistical analysis. **RESULTS:** Raters were from diverse backgrounds, such as emergency medicine, surgery, anesthesiology, dentistry, human factors, medical simulation, psychology and computer engineering. Six distinct behavioral skills were observed and rated across the 16 video clips. The inter-rater comparison showed that the mean score for each behavior ranged from 52.8 to 88.2, with a mean of 67.2 (variance = 117.1) across all raters. Reliability analysis demonstrated a Cronbach's Alpha of 0.833 and an intraclass correlation coefficient of 0.798 (95% CI 0.684 - 0.882; $p < 0.001$). **DISCUSSION:** The web-based platform developed in this study enables raters to remotely assess crew behavioral skills during simulated medical emergencies in space. The SFRM-MED tool presented a high reliability and internal consistency. This online platform may be used for training raters in crew behavioral skills assessment and for future research involving simulation-based countermeasure development to mitigate team vulnerabilities on LDSM.

Learning Objective:

1. The audience will learn how a behavioral skills rating system can be integrated into a web-based platform for observation and assessment of crew non-technical skills during simulated medical event management in space.

[338] TIME COURSE OF CHANGES IN CEREBRAL OXYGEN SATURATION BY NIRS AND CEREBRAL BLOOD FLOW VELOCITY BY TCD UNDER MILD +Gz HYPERGRAVITY

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 Nihon University School of Medicine, Tokyo, Japan

(Original Research)

INTRODUCTION: Intermittent exposure to mild +Gz hypergravity has been proposed as a countermeasure against space flight-induced physiological deconditioning. We previously reported that cerebral blood flow (CBF) velocity as measured by transcranial Doppler (TCD) was reduced by even mild +Gz hypergravity, suggesting the necessity of obtaining basic physiological information related to cerebral circulation under hypergravity. Cerebral oxygenation as measured by near-infrared spectroscopy (NIRS) has been used clinically to monitor cerebral ischemia. For example, decreases in cerebral oxygenation indices reflect reduced CBF or arterial oxygen saturation (SaO₂). Thus, it is hypothesized

that cerebral oxygenation would decrease in association with reduced CBF during hypergravity. To test this hypothesis, we measured CBF velocity and regional cerebral oxygen saturation (C-rSO₂) by TCD and NIRS, respectively, during mild +Gz hypergravity. **METHODS:** Fifteen male volunteers were exposed to +1.5 Gz generated by short-arm human centrifuge for 21 min. C-rSO₂ and mean CBF velocity in the middle cerebral artery (MCBFV_{MCA}) during centrifugation were averaged every 5 min and compared with pre-hypergravity data (+1.0 Gz, 5 min). One-way repeated-measures ANOVA was performed with Holm's post hoc test. This study was approved by our institutional review board (29-2-0). **RESULTS:** No significant changes were seen in C-rSO₂ throughout centrifugation, but MCBFV_{MCA} gradually decreased from the beginning (-1.2% at 0-5 min), and significantly decreased at 5-10 min (-4.8%), 10-15 min (-6.7%), and 15-20 min (-7.4%). **DISCUSSION:** Contrary to our hypothesis, no significant change in C-rSO₂ was detected throughout centrifugation; however, CBF velocity decreased significantly. To monitor cerebral ischemia by cerebral oxygenation, some assumptions, such as unaltered brain activity and arteriovenous volume ratio, are necessary. Therefore, the most likely mechanism for explaining the unchanged C-rSO₂ despite the reduced CBF velocity is a gravitational force-induced decrease in venous volume. The assumption of an unchanged arteriovenous volume ratio would not be applicable during mild hypergravity. However, other possible mechanisms, such as increases in SaO₂ or brain activity, cannot be ruled out. These results suggest that cerebral oxygenation as measured by NIRS does not simply reflect decreases in CBF as monitored by TCD under mild +Gz hypergravity. (USPS KAKENHI JP15H05939)

Learning Objective:

1. Understand the different time courses of changes in cerebral oxygenation as measured by near-infrared spectroscopy and cerebral blood flow as measured by transcranial Doppler ultrasonography under mild +Gz hypergravity.

[339] EXTRACTION AND ANALYSIS OF PRIVATE MEDICAL CONFERENCE AUDIO TRANSCRIPTS

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(Original Research)

INTRODUCTION: Private Medical Conferences (PMCs) are discussions between an astronaut and a flight surgeon about circumstances related to astronaut health during space flight. While PMCs are audio recorded, the official documentation of the medical encounter is entered into the Electronic Medical Record (EMR) or the PMC Tool. A subset of PMCs was transcribed but not entered into either location due to changes in the data entry process. These transcripts provide important data on astronaut health, requiring consolidation and comparison to the existing medical records. **METHODS:** 125 PMC transcripts were read and relevant medical data was abstracted into a spreadsheet based on the format of the original PMC tool. The prevalence of the transcripts' five most common chief complaints was calculated for the entire group. Another set of 48 PMCs entered into the PMC Tool as verbatim transcripts were similarly abstracted and then compared to the first set. Fisher's exact test was used to measure any significant difference in the prevalence of the five most common complaints in these two groups. Additionally, the five most common chief complaints were mapped to the NASA HRP Risks to see if they were adequately addressed. **RESULTS:** The top five chief complaints from the subset included musculoskeletal pain (n=20), headache (n=12), sleep disturbance (n=12), congestion (n=9), and rash (n=8), each of which maps to at least one current HRP Risk. There was no statistically significant difference in the prevalence of the five most common chief complaints between the 125 new transcripts and the existing 48 transcripts in the PMC Tool. **DISCUSSION:** Completeness is a vital trait in a medical record. Inclusion of the omitted PMC transcripts provides more data points in the understanding of aerospace medicine. The lack of any significant difference between the two groups indicates that the PMCs not in the PMC tool were left out at random, rather than for any specific reason. Comparing the data in the two sets also demonstrated that the transcripts contained additional occurrences of complaints that are known hazards of spaceflight present in the HRP Risks. This further demonstrates the need to properly document and address these medical issues for future missions.

Learning Objective:

1. The audience will learn about the use of Private Medical Conferences in space flight and their input into medical records.

[340] INCREASED INTRAOCULAR PRESSURE DURING EXTENDED-DURATION SHUTTLE MISSIONS IN GLAUCOMA AS WELL AS OCULAR NORMOTENSIVE AND HYPERTENSIVE CREWMEMBERS

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(Original Research)

INTRODUCTION: Microgravity alters physiology, causing cardiovascular dysfunction, impaired immunity, and musculoskeletal atrophy. Vision changes also occur, implicated by cranial fluid shifts causing increased ocular pressure (IOP). Glaucoma and ocular hypertension (OHT) are prevalent diseases with baseline IOP elevations. Research on subjects with glaucoma/OHT is limited. Future astronauts and especially commercial spaceflight participants may have these conditions. This study probes preflight, inflight, and postflight IOP aboard two short duration shuttle missions in control crewmembers and flightcrew with glaucoma and OHT. **METHODS:** Six subjects (4 controls, 1 glaucoma, 1 OHT) underwent the study aboard 2-week missions. Baseline IOP (triplicate; handheld tonometry) was recorded during training 1-2 months preflight, inflight (F+2 days), and post-flight (R+0-5 days). Subjective symptoms were recorded via questionnaires. Data was analyzed using spreadsheet with paired t-tests ($p < 0.05$). **RESULTS:** Overall, IOP increased for all values in-flight compared to pre-flight. IOP eventually returned to baseline post-flight (R+0-5 days), except for the astronaut with OHT (R+9). Normal controls had +26% increase in IOP inflight, compared to baseline ($p < 0.05$). The OHT patient had +24% increase in IOP inflight, compared to baseline ($p < 0.05$). Meanwhile, the glaucoma patient +31% increase in IOP inflight, compared to baseline ($p < 0.05$) despite daily application of his habitual pressure lowering topical drop. Subjectively reported symptoms included vision changes (ex. blurred vision, decreased visual acuity) and headaches. **DISCUSSION:** IOP increased during spaceflight and normalized upon return. It is unclear how this relates to space-associated neuro-ocular syndrome (SANS) seen in long-duration spaceflight. 1.9% of Americans over 40 have glaucoma and 9.4% have OHT. Many are undiagnosed. Commercial spaceflight travel necessitates addressing glaucoma and OHT before, during, and after spaceflight to prevent vision-related sequelae. Furthermore, OHT is asymptomatic increased IOP, known as glaucoma suspects in ophthalmology. Spaceflight may predispose OHT patients to glaucoma, an understudied hypothesis. Prophylactic treatment may be needed. As such, IOP screening of astronaut candidates and civilian spaceflight participants may be needed. Finally, space eye care (ex. drops) poses major challenges. Other treatment strategies are needed for acute and chronic ocular pathology.

Learning Objectives:

1. The participant will be able to understand the proposed theories of increased intraocular pressure during spaceflight.
2. The participant will be able to understand the underlying pathophysiology of ocular hypertension and glaucoma and why these conditions are relevant to study in spaceflight.
3. The participant will be able to understand the challenges facing treatment/management of ocular pathology in space.

[341] MEDICAL KIT DESIGN FOR AN EXPLORATION ATMOSPHERE PREBREATHE PROTOCOL VALIDATION TEST

Jennifer Ma¹, Joseph Dervay², Johnny Conkin²

¹Albert Einstein College of Medicine, Bronx, NY, USA; ²NASA - Johnson Space Center, Houston, TX, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Existing oxygen (O₂) prebreathe protocols for extravehicular activities (EVAs) from the International Space Station (ISS) require significant crew time and consumables. This is acceptable for current ISS operations with infrequent EVAs and resupply of consumables

from Earth. NASA's upcoming missions for human exploration of Mars and the Moon will require periods of high frequency EVAs with significantly increased constraints on crew time and consumables. **OVERVIEW:** In order to address this gap, NASA is conducting an exploration atmosphere prebreathe protocol validation test of 8.2 pounds per square inch absolute (psia)/34% O₂/66% N₂ to significantly reduce prebreathe durations. Effects of chronic hypoxia and frequent EVAs will be examined in six volunteers and two medical technicians over 11 days. Pressure will decrease to 4.3 psia for 6-hour intervals with a 15-minute decompression to simulate planetary EVA every other day. The development of a medical kit will be essential for the successful execution of this project and must anticipate issues of living and working in the proposed environment. The process and its development will be presented with special reference given on how the medical kit differs from typical kits at normal atmospheric pressure. **DISCUSSION:** A comprehensive medical kit is essential to the successful completion of the experiment by preventing removal of study participants for medical issues that can be addressed from within the chamber. The medical kit accounts for the exploration atmosphere of the facility, including repeated pressure changes and minimizing flammability risk, and comprises 187 items for anticipated common medical issues including pressure-related side effects affecting the eyes, sinuses, and ears (14 items), insomnia (3), and gastrointestinal upset (7). A broad spectrum of consumables (128 items) and medications are also included for infection (13), trauma, allergic reactions (11), or other conditions (11) which may affect study eligibility. Due to the unique environmental properties, all ampules will be vented prior to chamber insertion and volatile medications have been removed. One kit will be maintained within the chamber, with additional medications provided through a Med Lock as needed. This work is of broad interest to professionals conducting similar experiments at various exploration atmospheres for further investigation of operational problems associated with Mars and Moon exploration.

Learning Objectives:

1. Become familiar with anticipated common medical conditions associated with chronic exposure to a hypobaric environment.
2. Understand the effects of a hypobaric exploration atmosphere on medication storage and administration.
3. Understand countermeasures for addressing pressure and flammability concerns regarding medication storage in a hypobaric exploration atmosphere.

[342] OPTIC NERVE TORTUOSITY IN TERRESTRIAL POPULATIONS

Rachel Scott¹, Emmanuel Urquieta¹, Tyson Brunstetter², William Tarver³

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(Original Research)

INTRODUCTION: Spaceflight Associated Neuro-ocular Syndrome (SANS) results from long-duration spaceflight and presents with a constellation of signs (e.g., optic disc edema, choroidal folds, globe flattening, refractive error shifts, etc.). While many findings resolve post-flight, some persist, and it is unclear whether increasing severity and/or duration (e.g., a Mars mission) will result in permanent and/or mission-compromising findings. Optic nerve tortuosity (ONT), including kinking, has been detected in approximately 47% of astronauts after long-duration spaceflight, but has not yet been fully analyzed. This review examines terrestrial ONT in order to better understand how the condition is caused and measured. **METHODS:** References were identified by PubMed and ScienceDirect searches covering 1955 to October 2018 using the terms "optic nerve tortuosity," "optic nerve kinking," "optic disc torsion," "optic kinking," and "ocular torsion." Additional references were identified by searching relevant articles. **RESULTS:** ONT measurements have evolved and become more objective. One measure consists of meeting two criteria: 1) lack of optic nerve (ON) congruity in >1 coronal section and 2) subarachnoid space dilation. Another uses a tortuosity index, which represents the ratio between a straight line along the ON and the tortuous length calculated by summing the short segments between adjacent coronal MRI slices. There are numerous terrestrial ONT causes, including intracranial tumors, intracranial hypertension, hydrocephalus, Chiari malformation, neurofibromatosis, sigmoid sinus dehiscence/diverticulum, glaucoma, and progeria, among others.

DISCUSSION: To accurately measure ONT, it is crucial to adhere to objective, standardized techniques. The "criteria measure" is objective, sensitive, and specific for determining whether or not tortuosity is present. However, a "tortuosity index" offers additional benefits; since ONT is dynamic and responds to pressure changes, there are advantages to measuring the degree of ONT and tracking changes over time. Among the varied conditions associated with ONT, one commonality is pressure change. Pressure changes can occur directly (e.g., a mass impinging on the ON) or indirectly (e.g., via changes in intracranial or intraocular pressure), but either can result in ONT. The impact of intracranial pressure on the vascular system and vice versa is of particular interest, as it may offer insight to what is occurring in space.

Learning Objective:

1. Understand the potential causes of optic nerve tortuosity within the terrestrial population, how it is currently measured, and how this information might apply to Spaceflight Associated Neuro-ocular Syndrome (SANS).

[343] DISORIENTATION TRAINING FOR A SPACEFLIGHT ANALOG TASK: TRAINING, RETENTION, AND INDIVIDUAL DIFFERENCES

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(Original Research)

INTRODUCTION: Astronauts and military pilots experience spatial disorientation when gravitational cues are degraded. Previously, we secured subjects into a Multi-Axis Rotation System (MARS) device programmed with inverted pendulum dynamics. They used a joystick to stabilize the MARS. We created a spaceflight analog condition (SAC) by having subjects balance in the Horizontal Roll Plane where they could not use gravitational cues to determine their angular position. Subjects in the SAC showed poor performance and learning. Our objectives are to determine: 1. if a training program can enhance performance and learning in the SAC, 2. if visual-only training is effective, 3. if the acquired skill is retained over 4 months and 4. if machine learning can predict who will perform better. **METHODS:** We created a training program based on our previous finding that balance control consists of 2 dissociable processes: aligning with the vertical using gravitational cues and dynamically stabilizing using motion cues. Because subjects in the SAC can only rely on motion cues, our training program focused on developing the ability to dynamically stabilize independent of aligning with the vertical. We accomplished this by programming the MARS to have balance points different than the gravitational vertical in the Vertical Roll Plane. Subjects were instructed to seek and then stabilize around the balance point. To test for retention, they balanced in the SAC 4 months later. To test the effectiveness of visual-only training, another group sat outside of the MARS while controlling it. We used machine learning to create predictive classifiers that used early performance to predict final performance. **RESULTS:** The training group showed significant learning when tested in the SAC and retention when tested 4 months later. The control group showed minimal learning. Subjects who received visual-only training did not acquire any enhancement in performance. We successfully predicted individual differences in final performance based on early performance using machine learning. **DISCUSSION:** Using our prior idea that balance control consists of 2 dissociable processes, we developed an effective training program that enhances performance, learning and retention in the SAC. We show the feasibility of machine learning to predict individual differences. Our results highlight the importance of self-motion cues during training because the visual-only group did not transfer learning to the SAC.

Learning Objectives:

1. Understand how to develop a training program that exploits the 2 dissociable components of balance control, to allow enhanced learning, performance and retention of dynamic stabilization skill in a disorienting spaceflight analog task.
2. Understand what types of skills relevant to dynamic stabilization in a disorienting spaceflight analog task cannot be trained through only visual simulations.
3. Understand how to use machine learning to create classifiers that can predict the individual differences in performance in a spaceflight analog task.

[344] SHORT-DURATION SIMULATED MICROGRAVITY ALTERS HUMAN SKELETAL MUSCLE NUCLEI MORPHOLOGY

Christopher Pardini¹, Kaylie Zapanta¹, Kent Lorenz¹, Andrew Galpin², Joshua Cotter³, James Bagley¹
¹San Francisco State University, San Francisco, CA, USA; ²California State University, Fullerton, Fullerton, CA, USA; ³California State University, Long Beach, Long Beach, CA, USA;

(Original Research)

INTRODUCTION: Understanding the cellular mechanisms responsible for muscle deconditioning in microgravity is imperative to develop successful countermeasures. Just 10 days of simulated microgravity (unilateral lower limb suspension; ULLS) causes a 9.5% decrease in lower-leg strength, as reported by Cotter et al., 2015. Muscle nuclei (myonuclei) regulate cell size/function and have been under-investigated in microgravity research. Identifying changes in myonuclear domain size (MND; area each myonuclei controls) or morphology (shape and size) may elucidate mechanisms responsible for unloading decrements. The current investigation adds additional analyses of lower-leg muscle (*soleus*) from Cotter et al. Our aim was to determine if short-duration simulated microgravity (10-d ULLS) affects muscle cell size, MND, or myonuclear morphology. **METHODS:** Seven healthy volunteers (4 men, 3 women) underwent 10-d ULLS (Pre- and Post-*soleus* biopsies). Individual muscle cells (~1 mm) were isolated from samples and each fiber was 1) fluorescently labeled (myonuclei and actin filaments), 2) 3D imaged via laser scanning confocal microscopy, and 3) analyzed for cell size, MND, and myonuclear size and shape (radius ratio, RR). ANOVAs determined potential differences in variables Pre- vs. Post-ULLS ($\alpha=0.05$). **RESULTS:** Sixty-five muscle cells and 7,333 nuclei underwent analysis. Muscle cell size was not affected by 10-d ULLS, but there was a trend for decreased MND after ULLS ($P=0.06$). Simulated microgravity significantly altered myonuclei morphology ($P<0.05$), increasing nuclei RR (20%) and decreasing nuclei size (-12%). There were no differences between men and women in any variable. **DISCUSSION:** These findings suggest that, while 10-d ULLS caused a decline in muscle strength (as shown in Cotter et al.), it may not be long enough to significantly affect *soleus* muscle fiber size or MND size. However, the elongation of nuclear shape (\uparrow RR) shows that structural changes occurred along the cell membrane (where nuclei reside). Alterations in cell membrane proteins may affect force transfer, partially explaining losses in whole muscle strength. With upcoming plans to send astronauts back to the Moon (~10-d round trip), more short-duration unloading investigations are needed. Determining the time-course of muscle cell structure/function alterations with unloading will help develop appropriate exercise, nutrition, and/or pharmacological countermeasures to maintain Astronaut health.

Learning Objectives:

1. The audience will learn about skeletal muscle function decrements associated with short-duration microgravity exposure.
2. The audience will learn about ground-based models to simulate short-duration microgravity exposure (i.e., unilateral lower limb suspension, ULLS).
3. The audience will learn about muscle cell structural changes associated with short-duration simulated microgravity.

[345] MANAGEMENT OF THE EXERCISE FIELD IN SUMMER SEASON FROM THE EXPERIENCE OF JAXA EARLY RETURN PROGRAM IN ISS PROGRAM

Shinji Wada, Atsuhiko Mitsumaru
Japan Aerospace Exploration Agency, Tsukuba-shi, Japan

(Education - Program / Process Review Proposal)

BACKGROUND: Japan is the one of the International partner of International Space Station (ISS) program since 1988. In recent years, JAXA started the early return (ER) program (R+21 – R+27) from JSC to Japan on 47S landing step by step, to prepare the direct return from Kazakhstan to Japan. We report the preparation and management of the exercise field in Tsukuba Space Center (TKSC) of the ER program (R+9 – R+21) on 53S. **OVERVIEW:** On 3rd Jun 2018, the 53S Japanese astronaut landed at Kazakhstan by the Soyuz capsule. We, JAXA coordinated with NASA member and so on to prepare the ER program. We planed the reconditioning training in TKSC in the ER program. For the reconditioning

training, we had the weight training room. But for the functional training, it was small to use. So, we prepared the exercise space with a lot of mattresses and 6 big fans around it in the huge room of the Weightless Environment Test Simulator (WETS) building for the functioning training. In June- July, it is very hot and humid in Japan. Therefore, we use the temperature and humidity recorder (Sigma II 7210-00TM, SATO KEIRYOKI MFG.CO., LTD) and Heatstroke heat index meter (SK-150GTTM, SATO KEIRYOKI MFG.CO., LTD) twice a day to measure the temperature, the humidity and the Wet-Bulb Globe Temperature (WBGT) index and to minimize the risk of the heat stroke. We decided the exercise strength and the exercise method according to the WBGT index (Red ≥ 25 degrees C, Yellow 25-21 degree C, Green < 21 degrees C). We recorded the WBGT index for 34 days, from 1st June to 4th July. Fortunately, we could do the reconditioning training in WETS, because the WBGT did not exceed 25 degrees C. But the WBGT index become near 25 degrees C, the astronaut felt the difficulties to squeeze the ball because of the sweat of his hands, and the mattresses came up to the surface due to the heat expansion. **DISCUSSION:** The pool of WETS was heavily damaged due to the Great East Japan Earthquake occurred on 11th Mar 2011 and was disassembled and removed. The huge space was remained and had no air conditioner. Therefore, we could not manage the temperature in it. The WETS is not a suitable place in summer, so we must prepare another gym in TKSC. The WBGT index, we used, is the promising index to be measured by small tool. In future, the smaller a measurement tools are, the wider WBGT index is applied in the air plane, space ship, the suit for EVA to keep the astronaut safety.

Learning Objective:

1. WBGT index is a promising index to keep the astronaut safety.

[346] NASA HUMAN FACTORS PROGRAM

Nick Kiriokos

NASA, Tehachapi, CA, USA

(Education - Program / Process Review Proposal)

The information will highlight the history from conception to implementation with the agency. The Human Factors Program supports all NASA mission and strategic efforts within the Agency. This includes NASA Headquarters, NASA Centers, and Mission Directorates, Institutions, support functions, component facilities, NASA crewmembers or vehicles, operations, and training. The Program will:

- Include members from a variety of professionals from across the Agency.
- Have familiarity of Human Factors theories and tools, including the Human Factors Analysis and Classification System (HFACS).
- Develop, update and maintain an Agency specific HFACS taxonomy (NASAHFACS) geared to all aspects of NASA endeavors; space, aviation, research
- Use the NASAHFACS tool for analysis, trending and benchmarking of HF within the Agency.
- Seek inter-Agency collaborations with NASA Safety Center, Mishap Investigation experts, Program Managers, etc.
- Cultivate technical informational exchanges with Academia, other Government agencies and industrial organizations.

Learning Objective:

1. Learn the history of inception of HFACS into the NASA toolkit for safety, outreach to academia, inter-agency organizations and external government agencies.

[347] IMPACT OF PILOT-MODEL TIME DELAY ON AN ACHIEVABILITY LIMIT DISPLAY FOR A FUEL-CONSTRAINED, PILOTED, PLANETARY VEHICLE

Carlos Pinedo, Jordan Dixon, Edward Zuzula, Elliott Davis, Meer Baker, Torin Clark

University of Colorado Boulder, Boulder, CO, USA

(Original Research)

INTRODUCTION: Providing achievability limit information to astronaut crewmembers has been previously proposed as a means to reduce pilot workload, improve situation awareness, and increase safety during planetary landings. The six Apollo landings all encountered

potentially mission ending hazards while managing diminishing fuel reserves. A generalized achievability limit algorithm was developed that includes both a behavioral model of the pilot and physical models of the vehicle and environmental dynamics to predict the fuel remaining at any potential landing site. This study focuses on improvements to the behavioral model, specifically pilot time delay, in an effort to improve the accuracy of achievability predictions. **METHODS:** A 10 subject study to evaluate the impact of pilot-model time delay on the achievability algorithm was conducted on a ground-based simulator. Subjects completed 24 simulated lunar landing trials, where they were asked to maintain manual control of the vehicle's pitch and roll through joystick inputs. Guidance commands were provided to the subject thru landing. The trials consisting of three starting positions along a predefined initial trajectory, four redesignated landing directions, and four values for pilot-model time delay (between 0.2-1.0 sec). In each trial the subject flew to a point on the boundary of the achievability limit. Subject flying performance and fuel remaining were recorded. **RESULTS:** To date, the predicted achievable landing point and fuel remaining has been consistent with pilot subject data. Including a time delay of 0.5 seconds in the behavioral model resulted in subjects landing with fuel remaining error approximately 2% of the initial fuel mass. An assessment of subject pilot strategy indicated a series of common tracking errors including: control reversals, low gain control inputs, and cross-axis coupling effects. **DISCUSSION:** The algorithm was reasonably accurate across a range of conditions. Particularly, landings on the edge of achievability limit with a 0.5 second time delay resulted in near zero fuel remaining. The factors that define landing site achievability often behave and interact in a non-intuitive manner such that even experienced pilots may struggle to accurately estimate the achievable limits. Although the vehicle and environmental dynamics in this study are currently specified for a lunar landing, the algorithm is generalized such that it could be applied to any future planetary vehicle.

Learning Objectives:

1. Understand the impact of pilot-model time delay during a planetary landing task.
2. The audience will learn about the complexities of calculating the achievability limit during planetary landings.

[348] PRELIMINARY RESULTS: REGIONAL NERVE BLOCK FEASIBILITY STUDY FOR LONG-DURATION MARS MISSIONS AT THE MARS DESERT RESEARCH STATION

John Sczepaniak¹, Sultana Peffley², Joseph Maroge¹, Preetham Suresh³, Ching-Rong Cheng³

¹Sczepaniak Health & Med. Enterprises, San Diego, CA, USA;

²University of AZ, Tuscon, AZ, USA; ³University of California,

San Diego, San Diego, CA, USA

(Original Research)

INTRODUCTION: Long duration space missions will require light weight and simple methods for analgesia. Crews travelling to Mars will experience a communication delay and must perform operations with minimal guidance. **METHODS:** 11 participants from three crews joined this regional anesthesia study. The members were all picked for the 2017-2018 Mars Desert Research Station (MDRS) session by the Mars Society (MS). Participants received ~30 minutes of training prior to starting their mission. During the mission participants received an emergency scenario in which a crew member required a left popliteal nerve block. Participants had to identify anatomic structures on the ultrasound of the crew member followed by placement of a nerve block into a gel model of the popliteal fossa. Sessions were video recorded from two perspectives, the operator's actions and the ultrasound display. Videos were synchronized via Adobe Premier Pro and reviewed by two medical doctors to calculate total activity time, anesthesia time, number of assists, and quality of needle insertion. Participants filled out surveys before and after the activity. Performance was based on relevant criteria previously published using the delphi method. Images saved from the ultrasound were analyzed for needle tip distance to the model's nerve. **RESULTS:** One member received training but was excluded from this study by the MS for logistic reasons, resulting in 10 participants. Average time from probe placement to nerve visualization was 2.9 +/- 0.6min. Average time from needle insertion to proper positions was 1.3 +/- 0.2min. Subjective confidence in nerve visualization and needle

placement was 81 +/-5 and 70+/-6 out of 100. Correlations to survey data are provided in table 1. Proper nerve identification and appropriate needle alignment was adequately performed by 70% of participants. Except for the journalist, participants had <12 instances of partner assistance. There was one instance of a participant passing through a vessel. There was one instance of passing through the nerve inferiorly. The journalist failed to place the needle tip within 33mm of the nerve superiorly and inferiorly. Two other participants failed superiorly.

CONCLUSION: Regional anesthesia to the popliteal nerve can be performed by a majority of the crew members for MDRS. Further study is required to analyze retention rates over time and methods to avoid complications and ensure procedures are performed with a higher degree of accuracy.

Learning Objectives:

1. The audience will learn about regional anesthesia to the lower extremity via ultrasound guidance.
2. The audience will learn about current conditions for human research at the Mars Desert Research Station, UT.
3. The audience will learn about gel models for anesthesia training and simulations.

[349] USING DEEP LEARNING-ENABLED COMPUTER VISION TO MEASURE TEAM DYNAMICS DURING SIMULATED MEDICAL EMERGENCIES IN SPACE: A FEASIBILITY STUDY

Benjamin Mormann¹, Roger D. Dias², Steven Yule³
¹Harvard Medical School, Boston, MA, Boston, MA, USA; ²Brigham and Women's Hospital, STRATUS Center for Medical Simulation, Department of Emergency Medicine, Boston, MA, USA; ³Brigham and Women's Hospital, STRATUS Center for Medical Simulation, Department of Surgery, Boston, MA, USA

(Original Research)

INTRODUCTION: Long-duration spaceflight crews will rely on teamwork and behavioral skills to successfully operate in extreme environments. The development of automated metrics of team dynamics may play an important role on the assessment of team performance in a reliable and unobtrusive manner. In this study, we explored the feasibility of using a computer vision system to capture motion data of multiple crew members during simulated medical events in a spacecraft simulator and generate multiple metrics of team dynamics. **METHODS:** OpenPose v1.3.0 is open-source, deep-learning enabled computer vision software capable of detecting multiple humans and labeling key body points using 2D video input from conventional cameras. We used this software on six videos captured in our spacecraft simulator at 30 FPS by a GoPro Hero 5 camera, and exported (x,y) coordinates of the neck body point from each team member for each frame. The videos captured different lighting and visibility conditions and included emergency medical events important in spaceflight: cardiac arrhythmia, tension pneumothorax, toxic inhalation and eye injury. Team proximity was measured by averaging the distances between each dyad of participants. To measure motion, distances from a stationary reference point (0,0) were used to calculate frame-to-frame change in distance, which was used to calculate root mean square (RMS) for each participant over time. **RESULTS:** Six video clips of approximately 60 seconds each were analyzed. The software was able to capture teams of 2, 3 and 4 members of different skin colors in different light and visibility conditions (smoke and darkness). Metrics of team proximity, total amount of movement and motion variability during team performance were plotted in a visual analytics dashboard, allowing the visualization of team dynamicity overtime. In addition, team member positions were displayed as a heat map, allowing the analysis of different team roles and their relationships with specific spatial locations. **DISCUSSION:** In this pilot study, we demonstrated the feasibility of using computer vision software to measure position and motion of multiple crew members over time in a spacecraft simulator. These data can provide objective measures of team dynamicity and allow automated analysis of teamwork and behavioral skills. Our future work will investigate the relationship between position/ motion data and measurements of behavioral skills assessed by human raters.

Learning Objective:

1. The audience will learn about the feasibility of using computer vision software to detect motion of crew participating in simulated medical events on a spacecraft simulator.

[350] USING A COMMERCIAL WEARABLE TO OBJECTIVELY CLASSIFY WORKLOAD DURING THE MULTI-ATTRIBUTE TASK BATTERY (MATB)

Grace Wusk, Hampton Gabler
 Virginia Tech, Blacksburg, VA, USA

(Original Research)

INTRODUCTION: As next-generation space exploration missions necessitate increasingly autonomous systems, there is a critical need to better detect and anticipate astronaut interactions with these systems. Real-time, objective metrics of crew state will be especially important to assess operational performance and behavioral health during flight. As a real-time solution, we propose a psychophysiological monitoring approach to classify an operator's cognitive state. To focus on mental workload during a flight-like task, we use the Multi-Attribute Task Battery (MATB). The MATB is a well-validated tool complete with system monitoring, tracking, resource management, and communication tasks that can be adjusted in frequency and difficulty to simulate high and low workload flight events. The objective of this study is to use a commercial, wearable device with electroencephalography (EEG) and electrocardiography (ECG) sensing capabilities, specifically the Muse, to discriminate between high and low workload MATB events. **METHODS:** The protocol has been approved by the Institutional Review Board. Participants complete 6-minute high and low workload MATB events, following a 3-minute training, while wearing the Muse headset. The Muse consists of four dry electrodes for EEG and one auxiliary electrode for ECG. After each event, participants complete the NASA Task Load Index for subjective workload ratings to compare to the MATB workload setting and psychophysiology results. **RESULTS:** Psychophysiological features extracted from the raw EEG and ECG signals include power spectral densities for the delta, theta, alpha, beta, and gamma frequency bands, heart rate, and heart rate variability. Binary classification is performed using logistic regression and classification trees. Performance metrics from MATB, including reaction times from the system monitoring task and error from the tracking task, are also analyzed. Preliminary results show higher subjective workload ratings for the high workload events compared to the low workload events. **DISCUSSION:** This study evaluates the Muse as a low-cost, portable tool for psychophysiological monitoring with MATB. Future work will focus on implementing real-time classification of workload and adapting the approach to a higher fidelity, space-relevant simulation. A multimodal system including an electrodermal activity sensor could improve classification accuracy and will be tested in future work.

Learning Objective:

1. The audience will learn about psychophysiological monitoring using the Muse device during the Multi-Attribute Task Battery (MATB).

Wednesday, 05/08/2019

4:00 PM

Amazon G

[S-68] PANEL: THE 11TH ANNUAL RAM BOWL

*Sponsored by American Society of Aerospace
 Medicine Specialists*

Chair: Al Parmet

Co-Chairs: Jan Stepanek, Rebecca Blue

PANEL OVERVIEW: The American Society of Aerospace Medicine Specialists presents the 11th Annual RAM Bowl contest for the Louis H. Bauer Trophy.

[351] THE 11TH ANNUAL RAM BOWL

Allen Parmet¹, Jan Stepanek², Rebecca Blue³, Robert Johnson⁴, Rahul Suresh⁵

¹Missouri Disaster Medical Assistance Team, Kansas City, MO;

²Altitude & Austere Medicine Clinic, Mayo Clinic, Scottsdale, AZ,

USA; ³Cornell, Ithaca, NY, USA; ⁴FAA, Oklahoma City, OK, USA;

⁵Mayo Clinic, Scottsdale, AZ, USA

(Education - Program / Process Review Proposal)

The 11th Annual RAM Bowl features teams from the Air Force, Navy/Army, Mayo Clinic, Wright State and University of Texas competing for the Louis H. Bauer Trophy. International residents will be able to participate. 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. Teams complete in a college bowl format that tests aerospace medicine competencies, recall speed, teamwork and individual knowledge. Topics include the specialty 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 regulations, passenger transport, restraint and escape, cockpit resource management and AeroMedical transportation. Questions are divided into toss-up questions and bonus questions. Multiple rounds of competition will lead to the selection of this year's victor and awarding of the Louis H. Bauer Trophy, sponsored by the American Society of Aerospace Medicine Specialists.

Learning Objectives:

1. The contest will enable participants to prepare for ABPM examinations in Aerospace Medicine.
2. Attendees will receive an intense review of Aerospace and Preventive Medicine.

THURSDAY, MAY 9, 2019

Thursday, 05/09/2019

Amazon G

8:15 AM

**54TH ANNUAL HARRY G. ARMSTRONG
LECTURER**

Adriaan Heerbaart

“Navigating the European Skies: Money Makes the World Fly Safer!”

Thursday, 05/09/2019

Brasilia 1

10:00 AM

**[S-69] PANEL: CONTINGENCY COMPREHENSIVE
MEDICAL READINESS PROGRAM FOR FLIGHT
SURGEONS**

Chair: Douglas Files

Co-Chairs: Amy Hicks, Ann Hoyniak-Becker

PANEL OVERVIEW: Aerospace medicine professionals need to be prepared for a wide range of contingencies. Whatever situation arises that day, such as a physiologic event response, a bus mishap with mass casualties, or an aeromedical evacuation, flight medicine professionals need to think correctly even when moving fast. This panel will engage participants with a hands-on interactive experience addressing a mishap sequence that begins with an aircrew member experiencing a physiologic event. Following that they will discuss a scenario involving mass casualties from a bus accident. After scene safety is addressed, some casualties may require medical clearance for aeromedical evacuation. Finally, a briefing will be simulated addressing the human factors related to an aircraft accident. The session format will include updated didactic material addressing each step in the sequence, and attendees will engage directly in the mishap by splitting into groups and working through each of the four sections with a facilitator. At the conclusion, attendees will have enhanced preparedness for a wide variety of medical and aviation contingencies.

[352] CONTINGENCY AEROMEDICAL EVACUATION

Douglas Files, Charles Clinton

USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Aeromedical professionals sometimes certify if a patient is medically cleared for transport through the aeromedical evacuation system. An interactive scenario will engage professionals with simulated evacuation clearance cases to help maintain comprehensive medical readiness skills. **OVERVIEW:** Following any mass-casualty event, some patients will require medical evacuation while others will have conditions that pose relative contraindications for air transport, such as trapped intracranial or intraocular air. Others may have medical equipment that needs modification prior to aeromedical movement. In this session attendees will make medically complex clearance decisions, using a casualty tracking system such as the U.S. Transportation Command Regulating and Command & Control Evaluation System, in a deployed environment. Emphasis will be placed on air transport of military patients with orthopedic injuries. **DISCUSSION:** Medical clearance is an important function in garrison and in deployed environments. U.S. Air Force flight surgeons and allied professionals need regular training to rehearse the skills required to achieve comprehensive medical readiness. This training is applicable to all aeromedical evacuation including the joint interface with an intertheater military casualty evacuation system.

Learning Objective:

1. The participant will be able to safely prepare patients for transport by air.

[353] CONTINGENCY MASS CASUALTY RESPONSE

Russell Turner, Douglas Files

USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Mishap response is a key competency for aerospace medicine professionals who may be called upon to respond to various mass casualty scenarios. One common possibility involves an aircraft mishap, but many other disaster situations could arise. The current session will propose a simulated mass casualty event revolving around a bus crash with 25 patients. **OVERVIEW:** Medical first responders require a range of skills including advanced trauma life support, triage, and procedural skills. Aerospace medicine professionals often manage mass casualty situations at a higher level, requiring knowledge of their local mishap response plan and how they fit within a national incident management system. To make matters more complicated, in this case the bus has crashed into a fire hydrant, adding copious amounts of water to the scene. **DISCUSSION:** Aerospace medicine professionals rarely encounter real emergency situations and may lose currency in how to manage them. The National Incident Management System is only required in the USA, but attendees from all countries can benefit from considering integration of the disaster response capabilities in a bus crash scenario.

Learning Objective:

1. Participants will be able to plan for and deal with a complex mass casualty situation.

[354] CONTINGENCY IN-FLIGHT PHYSIOLOGIC EMERGENCY RESPONSE

Dai Tran, Douglas Files

USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Education - Case Study: Clinical / Human Performance)

BACKGROUND: Acute physiologic emergencies such as hypoxia, decompression sickness, and spatial disorientation can have life-threatening consequences when occurring in an aircraft. These causes of aircraft mishaps are often preventable, so preparation is crucial. **OVERVIEW:** Physiologic events require medical evaluation to determine the contributing causes, such as environmental conditions, flight equipment, or underlying predisposition, how it could be prevented, and the aeromedical disposition. Some physiologic events require a medical work-up for diagnosis of an underlying condition or to rule out serious