(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 ***8:15 AM***
Amazon G

54TH ANNUAL HARRY G. ARMSTRONG LECTURER

Adriaan Heerbaart

"Navigating the European Skies: Money Makes the World Fly Safer!"

Thursday, 05/09/2019 ***10:00 AM***
Brasilia 1

[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

sequelae. Students will focus on how to care for aircrew who have injured themselves in flight. **DISCUSSION:** Physiologic injuries are not common in flight, so some aerospace medicine professionals get out of practice. Thus, in this lab students will perform a case-based rehearsal. Those attending this session will consider the mishap sequence of an injury case to demonstrate the potentially serious consequences of these events. Following the training, aeromedical professionals will have enhanced comprehensive medical readiness skills.

Learning Objective:

1. Participants will be able to respond to an in-flight physiologic event, specifically an injury which occurred in flight.

[355] CONTINGENCY HUMAN FACTORS BRIEFINGS

Douglas Files, Ann Hoyniak-Becker
[1]*USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA*

(Education - Program / Process Review Proposal)

BACKGROUND: Human factors briefings allow aerospace medicine professionals to educate the aviation community about the potential impact of human factors on flight safety. **OVERVIEW:** Human factors briefings serve a role in circumstances varying from a regularly scheduled unit flying safety briefing, a formal course utilizing special equipment, or analyzing data recorders following an aircraft mishap. In this case, participants will consider the circumstances of the mishap, then identify how to brief the relevant human factors. They will particularly consider the role of risk communication under these circumstances. **DISCUSSION:** Aerospace medicine professionals communicate human factors in a manner that can be understood by aircrew and identify the causal human factors involved in a mishap. By practicing briefing techniques, participants will gain confidence in their ability to communicate the impact of human factors on flight safety.

Learning Objective:

1. Participants will be able to present a scenario to laypeople using risk communication skills.

Thursday, 05/09/2019 ***10:00 AM***
Brasilia 2

[S-70] PANEL: ADJUSTMENT DISORDERS IN AIR AND SPACE OPERATIONS

Endorsed by: Aerospace Nursing & Allied Health Professionals Society

Chair: Kevin Heacock

PANEL OVERVIEW: This panel presents an educational tutorial regarding an adjustment disorder diagnosis in humans in aircraft and spacecraft environments. The U.S. Air Force School of Aerospace Medicine Aeromedical Consultation Service's Neuropsychiatry Branch regularly reviews and evaluates aviators with a diagnosis of adjustment disorder and has reviewed the data regarding the accuracy and outcomes. The first presentation describes the criteria, diagnostic features, and prevalence of adjustment disorders in aviators as compared to the general population. The second presentation discusses the functional consequences of adjustment disorders in the military aviation environment and the possible implications for fitness for flight and operational duties. The third presentation discusses the consequences of adjustment disorders in the NASA flight controllers with obvious potential consequences. The fourth presentation discusses the differential diagnosis of adjustment disorders and takes a look at how often the diagnosis is an accurate diagnosis, with suggestions that it may be used inappropriately in attempts to limit the actual severity of the aviator's condition. The last presentation discusses the treatments for adjustment disorder along with the waiverability following treatment and stabilization of the aviator.

[356] ADJUSTMENT DISORDER CRITERIA IN AVIATORS

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

(Education - Tutorial Proposal)

INTRODUCTION: An understanding of what constitutes an adjustment disorder is important for all flight medicine providers to maintain a safe flying environment for the aviators under their care. **TOPIC:** Prior to 2014, adjustment disorders were their own category in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition Text Revision, but with the new fifth edition, adjustment disorders are now part of trauma- and stressor-related disorders, which include acute stress disorder and post-traumatic stress disorder. While the category of adjustment disorders has changed, the symptoms needed to meet criteria have not changed significantly. Emotional or behavioral symptoms in response to an identifiable stressor must form within 3 mo of the stressor. These symptoms must be clinically significant as noted by distress out of proportion to the stressor and/or significant impairment in social, occupational, or other important areas of functioning. This is important when differentiating between adjustment disorder and expected reactions to significant life events. Also, the symptoms cannot meet criteria for another mental disorder, such as major depressive disorder, generalized anxiety disorder, or post-traumatic stress disorder. Generally, once the stressor has resolved, the symptoms do not persist more than 6 mo. **APPLICATIONS:** Being able to recognize an adjustment disorder versus a normative stress reaction to a stressor is important for all flight medicine providers, as adjustment disorders are associated with an increased risk of suicide attempts and completed suicide in addition to the occupational impacts it can have on their flight duties. **RESOURCES:** American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders,* 5th ed. Washington (DC): American Psychiatric Association; 2013.

Learning Objectives:

1. The audience will learn about the criteria for an Adjustment Disorder diagnosis in aviators.
2. The audience will learn about the difference between Adjustment Disorder and expected reactions to significant life events.
3. The participant will be able to recognize an Adjustment Disorder versus a normative stress reaction.

[357] FUNCTIONAL IMPAIRMENT OF ADJUSTMENT DISORDERS IN AVIATORS

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

(Education - Tutorial Proposal)

INTRODUCTION: To fully appreciate how adjustment disorders manifest in aviators, it is necessary to recognize how flyers and special operations personnel manifest impairment in social, occupational, or other important life functioning. **TOPIC:** An essential component of making an accurate adjustment disorder diagnosis is a thorough understanding of how an individual's excessive reaction to an identifiable life stressor is more severe than would normally be expected. These emotional or behavioral reactions often result in significant impairment in social, occupational, or other important areas of functioning. Appreciating how impairment is distinctively manifest in aviators is essential to accurate case conceptualization and diagnosis. Psychometric data of aviators evaluated and diagnosed with adjustment disorder at the U.S. Air Force Aeromedical Consultation Service from 2008 through 2018 will be presented, highlighting capability, emotional stability, and personality profiles. METHODS of accurately assessing impairment will be discussed, including the utilization of psychological testing instruments to improve accuracy. Case examples of aviators will be utilized to elucidate how impairment is manifest as well as how to accurately assess. **APPLICATION:** Flight surgeons frequently evaluate aviators experiencing excessive reactions to life stressors. Understanding how severe reactions can manifest in significant impairment in important areas of functioning will increase diagnostic accuracy. **RESOURCES:** American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders,* 5th ed. Washington (DC): American Psychiatric Association; 2013.

Learning Objectives:

1. The audience will learn about how adjustment disorders manifest in aviators.
2. Learn how to more effectively diagnose adjustment disorders.

[358] ADJUSTMENT DISORDER A CASE STUDY

Ronald Moomaw[1], Gary Beven MD[2]
[1]*University of Texas Medical Branch, Galveston, Houston, TX, USA;* [2]*NASA, Houston, TX, USA*

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: Assessment of NASA flight controllers who may have a disqualifying psychiatric disorder includes an accurate history that supports the diagnosis, the course of the disorder over time, and current presenting symptoms. NASA flight controllers presenting with a history of depression or anxiety, and a prescription for use of a serotonergic reuptake inhibitor (SSRI) such as sertraline, often appear to manifest a diagnosis of adjustment disorder once precise psychiatric assessment occurs. **TOPIC:** The process for NASA flight controller medical certification includes a referral to an aerospace psychiatrist at the NASA Johnson Space Center for evaluation of any potentially disqualifying psychiatric disorder. Such cases are presented to the NASA Aerospace Medical Board (AMB), using FAA standards, for waiver consideration. In this composite case study, the salient issue is not initial misdiagnosis by the patient's primary care provider, but the ability to analyze the patient's chronological history with precision in order to formulate an accurate diagnosis of adjustment disorder. This case study, a composite of similar psychiatric assessments performed over the past decade at the NASA Johnson Space Center, is representative of individuals psychiatrically evaluated for waiver of a disqualifying psychiatric condition and where retrospective analysis was valuable and necessary. **APPLICATION:** In order to provide accurate diagnostic information and waiver recommendations to the NASA Aerospace Medical Board in cases that include a history of treatment for depression and/or anxiety with psychiatric medication, several important assessment elements are required. These include taking the necessary time to obtain a detailed and accurate historical account of symptom development; an extensive psychosocial history; review of all pertinent ancillary information that includes medical records; and the comprehensive understanding of what differentiates adjustment disorder from other psychiatric diagnoses including major depressive disorder and generalized anxiety disorder. **RESOURCES:** American Psychiatric Association. (2013). Diagnostic and Statistical Manual of Mental Disorders (5th ed.). Washington, DC: FAA code of Federal Regulations, title 14, Aeronautics and Space Part 67.

Learning Objectives:

1. The importance of historical information in formulating a diagnosis.
2. the use of human performance over time as a factor in changing a formal diagnosis.
3. The consequences of diagnosing a major mental disorder verses an adjustment disorder.

[359] DIAGNOSTIC CLARITY WITH ADJUSTMENT DISORDER

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

(Education - Tutorial Proposal)

INTRODUCTION: Adjustment disorder is the most commonly diagnosed condition (20%) among aviators referred to consultation at the U.S. Air Force Aeromedical Consultation Service (ACS). It is a diagnosis with some controversy, and despite its relatively high occurrence in the general population (5-20% of patients in general mental health clinics), it may have issues with diagnostic reliability.[1] **TOPIC:** The diagnosis of adjustment disorder is made when symptoms develop after an identifiable stressor or stressors. Great care must be used in making clinical judgment, as it is crucial that "normal" biopsychosocial reactions are not pathologized and that significant pathology is not minimized. Certain economic incentives and disincentives exist to influence providers in making a diagnosis, and cultural biases exist. These factors combined with perceptions about reliability and precision (a so-called "garbage can" diagnosis) require attention. Also, concerns have been raised about the long-term stability of the diagnosis, raising questions about risk calculation and mitigation.[2] Two examples from the ACS will be used to highlight and explain the phenomenon of diagnosis inflation and minimization; themes of military providers minimizing the diagnosis to save an aviator's career and civilian providers upgrading the diagnosis for purposes of reimbursement feature prominently. Strategies to refine the diagnosis will be discussed as will ideas for future research. **APPLICATION:** Adjustment disorder is the most common mental disorder in aviators seen at the ACS. Most often the diagnosis is appropriate, but several factors combine to influence the diagnosis of a relatively controversial disorder. Understanding of this topic is useful for the military flight surgeon, as U.S. Air Force experiences will guide the discussion, but the information is also generalizable to commercial and general aeromedical practitioners. **RESOURCES:** 1. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders,* 5th ed. Washington (DC): American Psychiatric Association; 2013. 2. Jäger M, Burger D, Becker T, Frasch K. Diagnosis of adjustment disorder: reliability of its clinical use and long-term stability. Psychopathology. 2012; 45(5):305-309.

Learning Objective:

1. Participants will learn about the cultural phenomenon of "down-diagnosing" conditions as adjustment disorder.

[360] ADJUSTMENT DISORDERS IN U.S. AIR FORCE AVIATORS – HOW BEST TO MANAGE THEM

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

(Education - Tutorial Proposal)

INTRODUCTION: The U.S. Air Force School of Aerospace Medicine Aeromedical Consultation Service's Neuropsychiatry Branch regularly reviews and evaluates aviators with a diagnosis of adjustment disorder, which is one of our most prevalent diagnoses. Such conditions typically impair the ability of the aviator to fly and can damage mission effectiveness. **TOPIC:** Extended "down" times are common in aviators with adjustment disorders. It is very typical for aviators with adjustment disorders to be prescribed a long-term antidepressant, receive no psychotherapy, and even not to be evaluated and treated by mental health. This presentation discusses optimal treatment for adjustment disorders along with the waiverability potential following treatment and stabilization of the aviator. When managed well, many adjustment disorders never require "down" periods, and even when they do, their length can be minimized. **APPLICATION:** Excellent evaluation and management (including potentially healthy lifestyle interventions, psychotherapy, and medication) can not only minimize and even avoid "down" periods, but can enhance resilience to avoid recurrence of similar future episodes.

Learning Objective:

1. The participant will learn optimal treatment for adjustment disorders to minimize the risk of impairment in the ability of the aviator to fly.

Thursday, 05/09/2019 ***10:00 AM***
Brasilia 3

[S-71] SLIDE: THE OVER/UNDER ON SPACE MEDICINE

Chair: John B. Charles

Co-Chair: Kseniya Masterova

10:00 AM

[361] NOVEL TOOLS TO DIAGNOSE AND UNDERSTAND THE SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME

Emmanuel Urquieta
Baylor College of Medicine, Houston, TX, USA

(Original Research)

Some astronauts exposed to microgravity develop hyperopic refractive error shifts and varying levels of papilledema. The etiology of SANS has not been elucidated. The Translational Research Institute for Space Health (TRISH) is testing the hypothesis that impaired lymphatic flow in the cervical region in microgravity may contribute to anatomical ophthalmological pathologies seen. In addition, close monitoring of fundoscopic images is required to track this syndrome as it progresses in spaceflight. Hence, miniaturized, simple to use, wide-angle retinal

self-imaging capabilities are being developed by TRISH as well. TRISH has funded physiology research aiming to develop imaging techniques that will provide new information and tools to characterize the effect of microgravity on deep cervical lymphatic function and its relationship to SANS. Dr. Dawn Kernagis from the Institute of Human and Machine Cognition and Dr. Lihong Wang from CALTECH are developing a spaceflight compatible label-free photoacoustic system to measure multiple key parameters of the lymphatic flows, including the lymphatic vessel diameter, flow direction, flow velocity, and volumetric flow rate. Machine learning algorithms will be applied to develop a software program that automatically quantifies lymphatic function in conjunction with the measuring device. Lastly, this project will evaluate targeted molecular biomarkers associated with impaired lymphatic clearance in response to simulated microgravity in humans. From a clinical perspective, TRISH has funded the development of technology to self-image the retina and other visual measurements related to SANS. Mr. Bob Main from Web Vision Technologies is developing the Advanced Retinal Imager (ARI), a compact, goggle-based (slightly larger than an augmented reality headset) device that will enable astronauts to take retinal images by themselves and without pupil dilation. This device will save significant astronaut time and will allow a better tracking of retinal changes. Additionally, this system will expand diagnostic capabilities to include: Kinetic papillary detection, Panoramic visual field, Contrast sensitivity test, Ishihara color test. TRISH's SANS research portfolio will provide mission feasible tools to diagnose and monitor the progression of SANS during spaceflight. From a physiological point of view, testing of a novel hypothesis about SANS will be enabled in an effort to better understand this syndrome.

Learning Objectives:

1. To consider new hypotheses that might lead to a new or better understanding of SANS.
2. To consider new mission feasible technologies (low mass, power, volume, standalone) being developed to monitor and prevent progression of SANS during deep space exploration missions.

10:15 AM
[362] PROCESS FOR DEVELOPMENT OF SPACEFLIGHT BIOMEDICAL AND HEALTH HARDWARE ACCORDING TO THE NEEDS OF USERS IN MEDICAL DEVICE AND DIAGNOSTIC INDUSTRY

Kimia Seyedmadani[1], Lilian Gavalas[2], Keith Tucker[2]
[1]University Space Research Association, University of Colorado, Boulder, Boulder, CO, USA; [2]NASA Johnson Space Center, Houston, TX, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Biomedical device manufacturers (MDDI), following the guidelines of the Food and Drug Administration (FDA), develop products with a specific user need in mind. Due to the changes represented by the intended end use and the environment in space, additional development and/or modification is often required on off the shelf equipment (COTS). This process affected equipment, and it follows a specific set of methods designed by engineers in the National Aeronautics and Space Administration (NASA). As exploration expands beyond Earth orbit, it is essential to close gaps such as complexity and lack of information on existing procedures; and increase the understanding of aerospace medical, and Bioastronautics professionals regarding this process, for enabling the development of safer and robust systems to carry out the mission. This presentation will overview FDA and NASA design processes by providing examples from the International Space Station Medical Project group, as well as recommendations on possible solutions to existing gaps. **OVERVIEW:** The Human Research Program had identified health care needs for the future mission and develop detailed annual reports. The investigator's partner with NASA use this information to plan their research; however, in order to identify the right tools for the investigation, they rely on existing medical capabilities and advancement in the biomedical field. Space affects the nature of the operation of onboard equipment's, resulted in the use of in-depth feasibility trade studies of existing COTS for use on board. Scientific meetings and workshops were held to introduce these investigations; in parallel MDDI industry, publishes several reports on new technology development. **DISCUSSION:** The ongoing extended investigation of human adaption and exploration builds on findings to date as well as past protocols; and, the safety and reliability of the diagnostic and analysis systems used in such investigations. Lessons learned since the Skylab missions, and consideration of the momentum in the biomedical field, have resulted in a recommendation for the design process of such systems. This presentation is a tool to close the gap between MMDI and Space industry with the aim of increasing collaboration, and an understanding of the resulting science, via standardization of design, development, and quality control processes.

Learning Objectives:

1. The participant will be able to understand the current state of the art design process in MDDI.The participant will be able to understand the current state of the art design process in space hardware design.
2. The participant will be able to understand the gaps between the two fields.
3. The participant will be able to close the gap and invest in safer and more efficient deep space exploration investigation and healthcare.

10:30 AM
[363] MAJOR INCIDENT PLANNING: LESSONS LEARNT FROM A MARS ANALOG MISSION

Justin Koh[1], Rochelle Velho[2,3], Bonnie Posselt[3], Andreas Zoller[3,4], Nils Kaufmann[3,5], Lucas Rehnberg[3,6]
[1]University Hospitals of Derby & Burton NHS Trust, Burton-upon-Trent, United Kingdom; [2]Heart of England NHS Trust and University of Warwick, Warwick, United Kingdom; [3]Austrian Space Forum, Innsbruck, Austria; [4]Medical Faculty, University Ulm, Ulm, Germany; [5]Southmead Hospital, North Bristol NHS Trust, Bristol, United Kingdom; [6]University Hospital Southampton, Southampton, United Kingdom

(Education - Program / Process Review Proposal)

BACKGROUND: A major incident plan (MIP) is a vital aspect of any operation, equipping organizations with a framework of timely, coordinated emergency responses to a health and safety incident. However, despite extensive major incident policies on Earth, little has been done for extraterrestrial operations. This gap demands significant attention to optimize the success of future missions. Thus, we analyze MIPs for analog extraterrestrial missions and learn from the experiences from a Mars analog mission. **OVERVIEW:** The AMADEE18 Mars analog mission was a high-fidelity simulation to prepare for future missions on Mars, conducted in an isolated desert in the Sultanate of Oman. Analog astronauts (AA) wore spacesuits to simulate Extravehicular Activities (EVA) and performed a range of scientific experiments. An on-site Medical Officer (MEDO) provided and prepared for general medical care, occupation-specific space medicine simulation care, and out-of-simulation care. Communication between the simulated crew and simulation terrestrial Mission Support Center (MSC) incorporated a 20-minute delay to increase fidelity. Protocols were also in place for major incidents. During this mission, two major incidents were sustained necessitating urgent pre-hospital care. The first was a structural failure of the main dome tent requiring test site evacuation. The second was a quad bike accident involving a crew member requiring ATLS and immobilization procedures. These two events reflect two foci of an MIP – single-casualty trauma and multiple-casualty incidents. Reports from these two major incidents were analyzed, and the MIPs were updated to cover evacuation/retrieval, and trauma. **DISCUSSION:** From these two incidents, recommendations are made for the future Mars analog missions. These include emergency protocols for pre-hospital care facilities and personnel, on-site table-top exercises, and confidential, reliable communication channels. Further, we emphasize identifying optimal training methods to prepare crew members for catastrophes. We are currently conducting a systematic review to answer this question. This work aims to generalize to extraterrestrial as well as terrestrial and analog operations.

Learning Objectives:

1. Understand the framework and challenges of a high-fidelity extraterrestrial analog mission.
2. Understand the major incident plans designed for a high-fidelity extraterrestrial analog mission.

10:45 AM

[364] THE IMPACT OF A HEMODYNAMIC PUSH-PULL EFFECT ON GZ TOLERANCE DURING SIMULATED SUB-ORBITAL SPACEFLIGHT

Ries Simons[1], Arjan Meskers[1], Eric Groen[1], Mark Houben[1], Eric Frijters[2]
[1]TNO Human Factors, Soesterberg, Netherlands; [2]Center for Man and Aviation RNLAF, Soesterberg, Netherlands

(Original Research)

INTRODUCTION: In fighter pilots rapid transitions from negative to positive Gz-load are known to lower the pilot's G-tolerance and to increase the risk of G-induced Loss of Consciousness (G-LOC). This so-called push-pull effect is caused by a headward fluid shift under negative Gz-loads and subsequent footward fluid shift under positive Gz-loads. The aim of our studies was to assess whether a 'push-pull' mechanism might affect Gz tolerance in pilots of commercial suborbital flights sitting in upright position while experiencing 4-5 minutes of microgravity directly followed by +4-6 Gz during 20-30s in the pull out phase of the flight. **METHODS:** we studied 13 healthy male volunteers in two conditions using a within-subjects balanced design: 1) '0-3Gz' ('push-pull'): 3 degrees head-down tilt (HDT) position during 3 minutes directly followed by acceleration (0.5Gz/s) up to 15 s of +3Gz; and 2) '1-3Gz' condition: acceleration to +3Gz (15 s) in an upright seated position. We used the centrifuge-based simulator DESDEMONA. Measurements included ratings of peripheral light loss (PLL), heart rate, cerebral blood flow using Near Infra-Red Spectroscopy (NIRS), and electromyography. **RESULTS:** We found no statistically significant differences between the 2 conditions concerning PLL, heart rate, cerebral blood flow, and muscle activity. PLL and grey-out were experienced in 50% of the runs, without significant differences between the two conditions. **DISCUSSION:** Because we considered that the 3 degrees HDT might not have adequately simulated microgravity and some subjects may have used anti-G straining in an uncontrolled way, we did a supplemental study with 22 healthy male subjects. Simulated microgravity consisted of 5-minute 6 degrees HDT in sitting position ('0 G') directly followed by centrifugation towards +3 Gz load in upright sitting position. The reference measurements were made in a condition where subjects are sitting upright (i.e. +1 Gz) for 5 minutes, after which the simulator applies a +3 Gz loading. PLL was objectified using a newly developed method and anti-G straining was not allowed. The data of the supplemental study are presently analyzed and compared with the previous results. The outcome of both studies will be presented in the present panel session.

Learning Objective:

1. Participants learn to understand the hemodynamic effects of microgravity and positive Gz accelerations and the consequences for pilots engaged in commercial sub-orbital flights.

11:00 AM

[365] HUMAN PERCEPTION OF VERTICALITY IN REDUCED GRAVITY CONDITIONS

Eric Groen[1], Gilles Clement[2]
[1]TNO, Soesterberg, Netherlands; [2]Lyon Neuroscience Research Center, Lyon, France

(Education - Program / Process Review Proposal)

BACKGROUND: On Earth, humans need an accurate sense of upright, or "subjective vertical", for their spatial orientation as well as for the control of postural equilibrium. An important question for interplanetary travel is how the subjective vertical is affected under reduced gravity conditions, such as on the Moon (0.16g) or Mars (0.38g). This presentation provides an overview of recent studies in partial gravity and will put the results in a theoretical context. **OVERVIEW:** Mathematically, the subjective vertical can be represented as a weighted summation of three vectors: 1) a vestibular vector based on inputs from the otolith organs in the inner ear; 2) a visual vector based on orientation information in the retinal image, and 3) an idiotropic vector defining an ego-centric bias towards the longitudinal body axis based on non-vestibular, somatosensory inputs. This vector model is based on laboratory experiments with various visual stimuli and body orientations, but all under normal gravity (1g). Some research has been done in microgravity (0g) conditions in low Earth orbit and immediately after landing. However, little is known about the subjective vertical in partial gravity conditions, i.e., between 0g and 1g. Recent parabolic flight experiments filled this gap by investigating human spatial orientation under partial gravity. The results show that gravity must exceed a certain threshold before it is recognized as reference for upright. This threshold value is between Lunar and Martian gravity. **DISCUSSION:** The operational significance of the results of these experiments is that for most astronauts spatial orientation and postural balance will be challenged on the Moon, and for some also on Mars, because gravity levels are too small to produce meaningful otolith cues on the direction of the vertical. This finding is supported by NASA mission reports. For example, Apollo 14 crew did not feel the tilt of the Lunar Module when they landed on a 7-degree slope, and reported this to be "very disconcerting during the sleep period". The astronauts resorted to hanging a piece of string to determine the module's tilt angle. Together with this anecdotal evidence, the research on the subjective vertical indicates that a reduced sense of upright should be taken into account when preparing future space missions. The results also provide guidelines for designing artificial gravity measures against the physiological effects of prolonged exposure to microgravity.

Learning Objectives:

1. The audience will learn about a commonly used neurophysiological model to describe the human perception of verticality, which forms the basis for human postural balance and spatial orientation.
2. The audience will learn about the latest insights about human orientation in reduced gravity levels, representative of conditions on the Moon and Mars.

Thursday, 05/09/2019 ***10:00 AM***
Brasilia 4

[S-72] PANEL: RESIDENT RESEARCH AND QI/PI PRESENTATIONS

Chair: Edgar Rodriguez

Co-Chair: Mark Coakwell, Richard Allnutt

PANEL OVERVIEW: This panel will consist of Aerospace Medicine residents presenting the findings from their scholarly activity. During their residency practicum years, residents develop and execute either a research project or a quality improvement/process improvement (QI/PI) project on a topic of aeromedical importance and prepare a presentation to report their results. Residents will here present the findings from their projects. Engaging in scholarly activity advances resident learning and produces information that contributes positively to the body of knowledge relevant to Aerospace and Operational Medicine.

[366] IMPROVING SEVERAL OPERATIONAL MEDICINE PROCESSES USING THE AIR FORCE SMART OPERATIONS IN THE 21ST CENTURY RAPID IMPROVEMENT EVENT MODEL

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

(Education - Program / Process Review Proposal)

BACKGROUND: A U.S. Air Force Flight Medicine clinic suspected its operations relating to the medical and administrative support of aircrew members were inefficient enough to benefit from a process review and improvement. Further, several operational support activities had not been exercised or used recently, leading to the opportunity to consider these under the same process review construct. Relatively rapid improvements were sought, weeks rather than months preferred, and a visiting resident volunteered to spearhead the process review effort. **OVERVIEW:** Air Force Smart Operations in the 21st Century (AFSO21) was introduced over 10 yr ago to streamline processes in the U.S. Air Force by reducing unnecessary steps, shortening timelines, improving safety, and cutting costs. Within the AFSO21 paradigm, a "High Value Initiative" is a long-term (multiple months) effort to improve complex processes, while a "Just Do It" review usually is informal and can quickly be implemented

(matter of days). In-between is a "Rapid Improvement Event" with a focused process review scope and timeline (a week or two) that involves a small team. Incorporating now-familiar techniques such as Six Sigma, Lean, and Business Process Reengineering, AFSO21 is a modification of the OODA loop (observe, orient, decide, act) broken up into eight steps. Observations are (1) key to validating that a problem exists and allows the team to (2) identify problems/gaps in processes. Orientation involves (3) setting improvement goals and (4) determining root causes of the problems/gaps. Decisions are then made regarding (5) countermeasures and a plan for their use. Actions subsequently involve (6) implementing countermeasures, (7) confirming the results, and (8) standardizing the process improvements that prove successful. **DISCUSSION:** Improving any process can positively impact the use of resources (manpower, funds), job satisfaction of participants, and effectiveness of the overall mission. Various process review methods have been successfully developed and deployed, and the U.S. Air Force has adopted a Rapid Improvement Event paradigm for short-term, limited-scope projects. Regardless of specific method used, all aerospace medicine professionals and enterprises can and should continue to improve their clinical and operational processes.

Learning Objectives:

1. Understand the importance of process review and improvement in clinical and operational aerospace medicine context.
2. Understand the OODA loop methodology of process improvement through the example of a Rapid Improvement Event.

[367] EXTERNAL INFLUENCES OF REPORTED PHYSIOLOGIC EVENTS IN MILITARY TRAINING AIRCRAFT

Scott Dillard[1], Matthew Doubrava[2]
[1]U.S. Air Force, Columbus, OH, USA; [2]U.S. Navy, Dayton, OH, USA

(Original Research)

INTRODUCTION: Increased awareness of physiologic events (PEs) in U.S. fighter and training aircraft has driven research efforts to focus on possible causes and corrections of these episodes. Multiple agencies are examining the problem for different possible etiologies. Most of these efforts focus on internal experiences of the aircrew or possible malfunctions of the aircraft. This study examined external conditions that might predispose aircrew to reporting a possible PE. Using retrospective epidemiology methods, this study looked at possible relationships between weather conditions, flight conditions, and training efforts in U.S. Navy T-45 training aircraft. The purpose was to determine if an external factor is associated with an increased likelihood of aircrew reporting a PE. **METHODS:** The study looked at 117 sorties flown by T-45 aircraft between 2012 and 2017. The bureau number of the aircraft and the type of sortie flown according to the T-45 training syllabus were confirmed using the Naval Flight Record. Data provided by the Navy Safety Center determined when the PE occurred and where in the training syllabus of a Student Naval Aviator or Student Naval Flight Officer. Statistical analysis of meteorological conditions, geographic origin of flight, type of training syllabus, and progression were compared to ascertain if any aspect was a significant predictor of PE reporting. **RESULTS:** Of the 117 reported PEs in the T-45, solo flights were 24% of events reported. These reports were evenly split between instructors and students. In the remaining flights, both seats were occupied. Both occupants reported symptoms in 22% of the events. If only one occupant reported symptoms, it was twice as likely to be reported by a student (61 vs. 26). Severity, weather, temperature, date, time of day, location, warning lights, and cockpit altitude were also evaluated. **CONCLUSION:** In addition to the efforts of others investigating hardware performance and the physiology of the aircrew, we considered external environmental factors as a possible contributor to the multifactorial causes of the reporting of PEs. External stressors of the flight environment may have enough impact on the performance of aircrew to the point of them feeling symptomology. Furthermore, the data we acquired had many gaps. With more complete event and control data, some of the other aspects evaluated may have been significant.

Learning Objective:

1. Recognize the risk factors, clinical presentation, and potential contagion effect of physiologic events.

[368] AEROSPACE MEDICAL ASSOCIATION AIR TRAVEL MEDICAL GUIDELINES: DECOMPRESSION SICKNESS UPDATE

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

(Education - Program / Process Review Proposal)

BACKGROUND: Encounters with recreational, commercial, and medically related hyperbaric environments are becoming more frequent with greater access to diving sites and increased use of hyperbaric oxygen therapy for a variety of medical conditions. Combine this with a steady increase in air travel, and the need to understand the stresses of flight and how they can cause or affect decompression sickness (DCS) becomes fundamentally important. Complicating the situation is the fact that the guidance related to flying after diving has fluctuated over the years, with limited research available to help support the recommendations. **OVERVIEW:** The flight environment has the potential to exacerbate or cause DCS based on the principles of Henry's law and Boyle's law. When the ambient pressure decreases, Henry's law explains why bubbles form in the body's tissues and Boyle's law explains why the bubbles enlarge. This presentation will expand on these principles by revieweing the mechanisms involved with DCS, the effects of the flight environment on DCS, and the clinical manifestations of DCS. The associated risk factors for DCS will be discussed, and current guidance on flying after diving to help prevent DCS will be provided. **DISCUSSION:** Although the incidence of DCS is small, its effects can be quite debilitating if not recognized and treated appropriately. Equally important is the fact that DCS is preventable. By understanding bubble mechanics, medical providers will be able to advise military or civilian air travelers on the best ways to mitigate the risks of developing DCS.

Learning Objectives:

1. Understand the mechanism of decompression sickness and how the stresses of flight can adversely affect decompression sickness.
2. Gain knowledge on how to minimize the risk of decompression sickness when flying after diving.

[369] INCIDENCE AND BURDEN OF NECK, BACK, AND SHOULDER INJURY IN USA AIR FORCE BOOM OPERATORS

Paul Vu, Charles Shurlow, Bryant Webber, Sonal Pathak
USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Original Research)

INTRODUCTION: Aerial refueling is a critical component of operational reach and air superiority. Although musculoskeletal epidemiology in pilots and other aviator occupations has been well documented, little is known about in-flight refuelers. The incidence and healthcare burden of neck, back, and shoulder injuries among U.S. Air Force in-flight refueling technicians, also known as *boom operators*, are presented here. **METHODS:** This retrospective cohort study included all U.S. Air Force enlisted aircrew stationed at selected military installations between January 2010 and December 2016. Exposure was defined as being a KC-135 boom operator during the surveillance period. Incidence rates and overall healthcare burden of neck, back, and shoulder injuries in KC-135 boom operators were compared to two unexposed groups: (1) KC-10 boom operators and (2) all other enlisted aircrew. All neck, back, and shoulder injury diagnoses received by the exposed and unexposed cohorts in the TRICARE system (i.e., during inpatient visits and outpatient encounters at military treatment facilities or in reimbursed civilian facilities) were obtained from the Military Health System Mart. Incidence rates and incidence rate ratios (IRRs) with 95% confidence intervals (CIs), stratified by anatomic site, were calculated. **RESULTS:** KC-135 boom operators (n=658) experienced a 97% higher rate of back injury (IRR: 1.97; 95% CI: 1.08, 3.59) and had 4.36 times as many clinical visits for back injury (IRR: 4.36; 95% CI: 3.14, 6.06) as compared to their peers in KC-10 aircraft (n=63; rates of neck (IRR: 0.89; 95% CI: 0.36, 2.84) and shoulder (IRR: 0.93; 95% CI: 0.52, 1.67) injuries were statistically equivalent between the two groups. There was no statistical difference between KC-135 boom operators and other enlisted aircrew (n=8514) for neck, back, or shoulder injuries. **DISCUSSION:** The increased rate and healthcare burden of back injury among KC-135 boom operators, as compared to KC-10 boom operators, may be related to the different ergonomic configurations between the two airframes. This warrants an investigation of potential causative factors and mitigating strategies.

Learning Objectives:
1. Recognize that the ergonomic configurations between KC-10 and KC-135 boom operator work stations are different.
2. Recognize that KC-135 boom operators are at increased risk for back injury when compared to KC-10 boom operators.

[370] DESCRIPTIVE EPIDEMIOLOGY OF USA AIR FORCE AVIATORS REFERRED FOR EVALUATION OF OBSTRUCTIVE SLEEP APNEA

Melissa Gear[1], Lt Col Dara Regn[2], Jared T. Haynes[2], Rosa Linda Alvarado[2]
[1]Canadian Armed Forces, Wright-Patterson AFB, OH, USA; [2]711th Human Performance Wing/USAF School of Aerospace Medicine, Aeromedical Consultation Service, Wright-Patterson AFB, OH, USA

(Original Research)

INTRODUCTION: It is well understood that obstructive sleep apnea (OSA) negatively affects sleep quality and consequently contributes to fatigue and performance decrement. In an effort to mitigate risk of acute incapacitation in aviation, screening for this sleep disorder in aircrew has received much attention. As the diagnosis of OSA is disqualifying in all three U.S. military services and the Federal Aviation Administration, any pilot or rated aircrew diagnosed with OSA must be evaluated for a waiver or special issuance. To date, there is a lack of aircrew-specific data in this area of the literature. This study aims to add a description of the epidemiology of U.S. Air Force (USAF) aviators referred for OSA evaluation. **METHODS:** This retrospective chart review examined the clinical records and polysomnogram data of USAF flying class II/III aviators and Ground Based Control referred to the Aeromedical Consultation Service at Wright-Patterson Air Force Base for evaluation of OSA from 2009-2018. The research protocol was reviewed and approved by the AFRL Institutional Review Board. **RESULTS:** One hundred and two records of male aviators were used in this analysis and were composed mainly of Caucasians (88.2%), pilots (61.8%), and active duty personnel (70.6%). The majority of referred pilots fly non-high-performance aircraft (60.3%) with pilots of fighters and remotely piloted aircraft respectively contributing 15.5% and 17.2% to pilot referrals. The mean age was 42 ± 6.8 yr, with 54% of the cases falling between 40 and 49 yr of age. The mean body mass index was 29.2 ± 3.8 kg/m^2, with 46.1% of the sample having a body mass index greater than or equal to 30 kg/m^2. OSA was diagnosed as severe in 37.3% of cases, with mild and moderate severity each accounting for 31.4% of the diagnoses. The mean respiratory disturbance index was 29.1 ± 24.9 per hour, and the oxygen nadir was 87.7% ± 4.4%. Forty percent of cases had subjective symptoms of at least one other sleep disorder, including parasomnias, restless leg syndrome, or insomnia. **DISCUSSION:** This is the first review of the epidemiology of USAF aviators referred to the Aeromedical Consultation Service for evaluation and waiver of OSA. Further analysis of these data will increase understanding of the risk factors for diagnosis and severity of OSA in this population and may add evidence to guide screening practices.

Learning Objective:
1. The audience will be able to understand the epidemiology of U.S. Air Force aviators being referred for evaluation and waiver of obstructive sleep apnea.

Thursday, 05/09/2019 ***10:00 AM***
Brasilia 5

[S-73] SLIDE: MIND BLOWN: ALTERNOBARIA

Chair: William Buck Dodson

Co-Chair: Bob Cheung

10:00 AM

[371] PULMONARY B LINES RESULTING FROM SCUBA DIVING EXPOSURES AT THE NASA NEUTRAL BUOYANCY LABORATORY

Kristi Ray[1], Sandra Williams[2], Robert Sanders[3]
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(Original Research)

INTRODUCTION: Pulmonary fluid shifts may occur while scuba diving. Such shifts, generally thought to be rare, can be life threatening, and result in Immersion Pulmonary Edema (IPE). This study aims to better classify the normal physiology of diving using ultrasound (US) to determine if fluid shifts occur routinely during commercial diving work at the NASA Neutral Buoyancy Laboratory (NBL). **METHODS:** Chest US was performed pre and post dive to evaluate the presence of B lines in a total of 12 intercostal points on the anterior, posterior, and lateral chest wall in this prospective study. All US studies were performed by a board certified emergency physician with ultrasound fellowship training and then later reviewed by a second physician with the same training. Pre-dive US was conducted in the morning prior to entering the pool and post-dive US was conducted by the same investigator within 30 minutes of dive completion. The number of B lines at each anatomic site was recorded in real time and any increase in the number of B lines was considered a positive study. **RESULTS:** There were a total of 71 exposures; four were eliminated due to missing images for secondary review, leaving 67 exposures for comparison. Of the 67 exposures, 38 (56%) had an increase of 1 or more B lines post dive (Fisher exact: OR 7.79 (2.54-29.1; p<0.001). Three exposures resulted in an increase of 3-5 B lines during the dive (6%). 64% of the female exposures (nine) and 54% of the male exposures (29) were positive for B-lines post dive, suggesting no difference across genders (Fisher's exact: OR 1.48 (0.38-6.42; p = 0.5613). Post dive, all divers were asked if they had any symptoms such as chest pain, difficulty breathing, or hemoptysis and all were asymptomatic. **DISCUSSION:** From our results, fluid shifts, as confirmed by the emergence of US B lines, can be viewed as a normal, transient, physiologic process in commercial divers. This correlation can be compared to the formation of low grade VGE from decompression that do not result in decompression sickness. This also supports the hypothesis that pulmonary fluid shifts are a physiologic result of immersion, not just a pathologic process. Further study of US B lines in symptomatic divers may yield the usefulness of field US in the diagnosis and treatment of IPE.

Learning Objectives:
1. Understand the signs and symptoms of immersion pulmonary edema (IPE) in relation to SCUBA diving exposures.
2. Review the physiology of immersion including the formation of pulmonary extravascular fluid (B lines) and how chest US detects these changes.

10:15 AM

[372] IS THERE A SAFE ALTITUDE TO COMPRESS VENOUS GAS EMBOLI AFTER SIMULATED HIGH-ALTITUDE FLYING?

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(Original Research)

INTRODUCTION: Improved aircraft performance and new tactical demands will expose fighter pilots to repeated periods of low cabin pressure. Previous results showed prevalence of venous gas emboli (VGE) during prolonged exposure to 24000 ft. Excursions to 900 ft, but not to 20000 ft reduced the VGE score. The aim was to investigate whether excursions to 15000 ft – corresponding to a low re-fueling altitude – would reduce VGE. **METHODS:** Eight men were investigated during three normoxic exposures: A) 90 min continuously at 24000 ft, B) 3 x 30-min at 24000 ft, interspersed by two 30-min intervals at 15000 ft, C) 90 min continuously at 15000 ft. VGE score was assessed by cardiac ultrasound, using a 5-graded scale. Nitrogen exchange was measured continuously using a modified closed-circuit electronic rebreather. **RESULTS:** The A and B conditions induced persistent VGE, with no difference in peak VGE either at rest (A:1.5 (0-3; B: 1.9 (0-3)) or after knee-bends: (A: 2.8 (1-4), B: 2.9 (0-4)), whereas the score was considerably less in the C condition (rest: 0.3 (0-1), knee bends: 0.3 (0-2)). During the first 30 min, the nitrogen wash-out rate was similar in A (10.8±5.4 mL/min) and B (11.4±4.2 mL/min) and lower (p<0.05) in C (7.1±3.3 mL/min). **DISCUSSION:** Thirty-minute periods of altitude reduction from 24000 to 15000 ft were not long or deep enough to remove VGE. VGE did not form during 90 min at 15000 ft, but the pressure increase when descending to this altitude was not sufficient to rapidly compress formed bubbles.

Learning Objectives:
1. Understand the mechanisms underlying occurrence of Venous Gas Emboli (VGE) during long-duration sustained vs repeated exposures to high altitude.
2. Understand why the nitrogen wash-out rate may not always be a valid marker of DCS risk.

10:30 AM
[373] RISK-BASED REVIEW AND UPDATING OF NASA'S PREBREATHE PROTOCOLS FOR AMBULATORY GROUND-BASED VACUUM CHAMBER TESTING

Andrew Abercromby[1], Raul Blanco[1], Mary Cerimele[1], Johnny Conkin[2], Christopher Counts[1], Stacie Cox[1], Joseph Dervay[1], Michael Gernhardt[1], Shannan Moynihan[1], Scott Ross[1], Robert Sanders[2]
[1]NASA Johnson Space Center, Houston, TX, USA; [2]KBRwyle, Houston, TX, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Suited vacuum chamber testing is critical to extravehicular activity (EVA) flight crew training, sustaining engineering, and development engineering. Since 1986, NASA has required a 4-hour resting prebreathe (PB) with 100% oxygen for hypobaric chamber exposures of 4.2 psia lasting > 30 minutes to reduce the risk of decompression sickness (DCS). There have been no reports of Type II DCS at NASA while using this protocol. Approximately 5% of chamber runs have been terminated due to performance-limiting Type I DCS symptoms; however, detailed records of DCS symptoms during these runs are not available. A "Tiger Team" initiated in 2018 was directed to assess the adequacy of the 4 hour PB protocol, as well as the processes by which NASA's PB protocols and policies are established. **OVERVIEW:** The 12-person team, which included engineering, test operations, medical, physiological, International Space Station (ISS) EVA, and safety representatives, took an approach similar to that used in the development of non-ambulatory spaceflight PB protocols for ISS during the Prebreathe Reduction Program. The foundation of the approach was the prospective definition of programmatic success and acceptable risk, based on the consideration and quantification of operational, engineering, cost, medical, and ethical drivers. Acceptable risk was defined as: 1. Zero predicted incidents of Type II DCS at 0.95 probability across all planned suited vacuum chamber exposures from 2018-2028. 2. Less than 0.1% predicted risk of Type II DCS for any single exposure. 3. Less than 20% risk of Type I DCS for any single exposure. Three probabilistic models of Type I and Type II DCS risk were selected and used to evaluate a range of PB options against the acceptable risk criteria. A literature review found zero Type II cases in 2,188 comparable exposures. Further DCS risk reduction through additional PB was then weighed against the increased fatigue, discomfort, and other impacts of increasing overall test duration. **DISCUSSION:** The team's primary recommendations, which provide for acceptable DCS risk mitigation while enabling essential crew training and engineering testing, were to 1) Maintain the existing 4-hour PB protocol for runs ≤ 2 hours in duration (68% of all expected runs) and to add 30 minutes PB for runs > 2 hours, and 2) Implement a process for the systematic diagnosis, tracking, and analysis of DCS outcomes during suited vacuum chamber testing.

Learning Objectives:
1. The audience will learn about the process used by NASA to evaluate the adequacy of existing prebreathe protocols for mitigation of decompression sickness risk during suited vacuum chamber exposures.

10:45 AM
[374] NEUROPATHOLOGICAL FINDINGS IN PORCINE BRAINS FOLLOWING HYPOBARIC EXPOSURE

John Sladky[1], Melissa Cook[2], Paul Sherman[1]
[1]711th Human Performance Wing/USAF School of Aerospace Medicine/59MDW, San Antonio, TX, USA; [2]959th MDW, San Antonio, TX, USA

(Original Research)

INTRODUCTION: Repeated human exposure to extreme hypobaria (low atmospheric pressure) is associated with increased white matter hyperintensities (WMH) in humans as observed on T2-weighted imaging and decline of axonal integrity as measured by fractional anisotropy (FA) in both humans and swine (*sus scrofa*) animal models. While WMH's were not observed in the swine model, we hypothesize that neuropathological analysis of the porcine brains coupled with MRI analysis will shed light on the underlying pathophysiological process in both humans and animals exposed to hypobaric environments. **METHODS:** Brains from 4 adolescent age porcine (*sus scrofa*) animals exposed to 30k feet chamber flights on 100% FiO2, each lasting eight hours, occurring every three days for total of 6 flights were examined and contrasted to 4 porcine "control" brains who were exposed to 6 sham flights without hypobaric exposure. Samples were sent to the Center of Neuroregenerative Medicine, and pathology specimens were reviewed by a blinded neuropathologist skilled in animal neuropathology. **RESULTS:** Preliminary results demonstrate immunoreactivity to AT8 (hyper-phosphorylated tau protein) TAU-pathology, TAU-tangles to pre-tangles in cortical layer 3 of the temporal cortex and hippocampus in 2 of 4 of exposed and control animals. Staining for amyloid precursor protein (APP), glial fibrillary astrocytic protein (GFAP: a marker for inflammation), and myelin basic protein (MBP: marker for demyelination) were negative. **DISCUSSION:** The incidence of TAU-pathology in the form of both tangles, pre-tangles and hyper-phosphorylated tau has not been reported in swine models before. The presence of TAU-pathology in both exposed and control adolescent groups is unclear in the absence of demyelination or inflammatory changes, although the "n" is small (8). Further sampling and analysis (already underway) is required. However, such findings are instrumental to elucidate the underlying pathophysiology of hypobaric effects on the brain leading to optimal mitigation strategies.

Learning Objective:
1. Participants will learn neuropathological changes in an animal model to repeated exposure to hypobaric environment.

11:00 AM
[375] WHITE MATTER HEALTH AND MRI SCREENING REQUIREMENT FOR FUTURE ALTITUDE RESEARCH

Desmond Connolly
QinetiQ plc, Farnborough, United Kingdom

(Original Research)

INTRODUCTION: A total of 33 individuals have undergone high resolution, 3-D volumetric brain magnetic resonance imaging (MRI) screening in UK to assess white matter status. These encompass a retrospective survey of 20 participants in altitude chamber research and training, and prospective screening of 13 volunteers for recent altitude chamber oxygen system assessments. These data are reviewed to inform the ethical requirement for future MRI screening for altitude chamber research. **METHODS:** Participant exposure limits that do not warrant post-exposure MRI screening have been derived based on the decompression profiles completed by participants in the retrospective and prospective studies. However, there remains a requirement to screen out future volunteers with pre-existing white matter changes. In the retrospective survey an association was identified between past concussive head injury, consistent with a diagnosis of mild traumatic brain injury (MTBI), and excess white matter hyperintensities (WMH) on MRI. This analysis has been extended to include the entry MRI data from the prospective study, to further inform the relationship between past MTBI and WMH status. **RESULTS:** Of 33 individuals screened to date using 3-D volumetric MRI, nine have a past history of likely MTBI, of which four have 'excess' (>15) WMH. The 24 individuals without significant past head injury all have normal background numbers of WMH. From a 2 x 2 contingency table, Fisher's Exact Test statistic = 0.0031, indicating a statistically significant association between past MTBI and excess WMH in this sample. In this sample, a screening question for past MTBI would exclude those with excess WMH with 100% sensitivity (zero false negatives) and 100% negative predictive value (no MTBI = no excess WMH). **DISCUSSION:** For future altitude programs less extensive than the prospective study, comprising relatively brief and infrequent exposures, it is proposed that exit MRI screening is unnecessary, while entry screening based on history of MTBI alone will exclude volunteers with excess pre-existing WMH. Future studies imposing greater decompression stress (higher altitudes, longer durations, more frequent decompression, exertion at altitude,

limited denitrogenation) will still require entry and exit MRI screening. Current screening criteria will be detailed.

Learning Objectives:

1. The audience will understand the considerations being given to ensure that future human altitude chamber research in the UK is conducted ethically and safely.
2. The audience will be informed about safe (sub-threshold) levels of decompression stress that do not appear to be associated with white matter injury in humans.
3. The audience will be advised of the potential effectiveness of using a screening question about mild traumatic brain injury to exclude volunteer participants for altitude research who may have pre-existing white matter changes, in addition to other exclusion criteria.

11:15 AM

[376] AIRCREW TRAINING HYPOXIC HYPOBARIC INDUCED ELEVATED CEREBRAL BLOOD FLOW - WHEN DOES IT RETURN TO NORMAL?

Paul Sherman[1], John Sladky[1], Bianca Cerqueira[2]
[1]USAF School of Aerospace Medicine, Joint Base San Antonio-Lackland, TX, USA; [2]KBRwyle Labs and USAF School of Aerospace Medicine, Joint Base San Antonio-Lackland, TX, USA

(Original Research)

INTRODUCTION: Subcortical white matter (WM) injury and global decreased fractional anisotropy are associated with repetitive exposure to non-hypoxic hypobaric conditions. A single hypobaric hypoxic occupational exposure to 7620 m (5.45 psi) induces magnetic resonance imaging (MRI) changes that may reflect transient brain injury, including elevated cerebral blood flow (CBF) that persists at 72 h after exposure. **METHODS:** Fourteen U.S. Air Force aircrew trainees (AFC2) completing occupational altitude chamber training underwent 3T MRI brain examinations 24 h pre-exposure and 24 h, 72 h, 120 h, and 168 h post-exposure. Previously, 96 aircrew trainees (AFC1) and 65 age-matched control (NOR) subjects not exposed to hypobaria were evaluated with brain MRI 24 h pre-exposure and 48 and 72 h post-exposure, demonstrating significant increased WM CBF at 24 h that persisted at 72 h. MRI protocol included fluid-attenuated inversion recovery images, diffusion-weighted imaging, and pseudo-continuous arterial spin labeling perfusion imaging. There were insufficient female subjects in the control group to permit robust analysis, so statistical analysis was confined to male subjects only (AFC1=64; NOR=60). Statistical analyses were performed with analysis of covariance to account for age and group (AFC vs. NOR), two-tailed t-tests, and a generalized linear mixed effects model. **RESULTS:** No significant change in CBF was observed in the control subjects. Analysis of covariance demonstrated an elevation in WM CBF at 24 h ($p=0.22$) that remained elevated at 72 h ($p=0.597$). There were no significant changes in gray matter CBF or structural measurements (fluid-attenuated inversion recovery WM hyperintensities, fractional anisotropy). In the 14 AFC2 subjects, WM CBF appeared to return to normal at 120 h post-exposure ($p=0.576$), but was not significant given the small sample size. **DISCUSSION:** A single exposure to hypoxic hypobaria in routine altitude chamber training demonstrates an upregulation of WM CBF 24 h post-exposure that persists at 72 h. This reflects an increased metabolic demand and may represent a transient cerebral injury has occurred. CBF trends to normal at 120 h post-exposure, but a larger sample size is needed to confirm this finding.

Learning Objective:

1. Understand the acute effects of hypoxic hypobaria upon the brain.

Thursday, 05/09/2019 ***10:00 AM***
Brasilia 7

[S-74] PANEL: THE IMPACT OF TRANSLATION SCIENCE ON BUILDING NEW MULTIDISCIPLINARY FIELDS IN RESEARCH – PANEL I

Chair: Ilaria Cinelli

Co-Chairs: Marian B. Sides, Smith L. Johnston

PANEL OVERVIEW: The Bellagio II Summit sought to identify the major advances in aerospace medicine that can be translated and applied to the field of terrestrial medicine. The preservation of the human health in outer space could be seen as detached from terrestrial medicine as it focuses on the needs of the astronaut population only, a small population with high physical and mental performance. However, the findings of aerospace medicine are applicable to terrestrial populations through translation. Transitional science is the discipline allowing exchange of knowledge and technology between scientific fields. This transfer can be the base of a further understanding and improvement of current clinical care, where scientists try to answer opened questions by looking at the same phenomenon in a different domain. From this multidisciplinary interaction, new research fields result as the most appropriate way to filling in gaps of on-going research. Looking at aerospace and terrestrial medicine, this panel will present four examples of new research fields born within space medicine with high potential of having remarkable terrestrial applications. These fields are identified in alignment with the objectives of the Bellagio II Summit. First, cardiovascular responses in lower-limb amputees during microgravity simulation is an example for understanding clinical situations on Earth, and physiological adaptation of astronauts during and after space missions. Second, residents of New Zealand are the population with highest rate of skin cancer worldwide, where the high melanoma incidence is due to UV radiation and reduced overlying atmosphere. A translation study is carried for improving skin cancer detection comparing skin examination procedure and available technology to residents of New Zealand and to astronauts. Third, the progress in informatics is supporting the development of digital health and personalized medicine. The Texas Tech University is leading innovation in current and incoming applications to translational health science where human performance, cognitive and situation awareness can be enhanced by improving emerging technology tools. In the end, in this regard, artificial intelligence (AI) seems the promising technology that can revolutionized the current medicine. Here, a context-specific application of AI is presented for anticipating and treating of medical events as a comprehensive behavioral countermeasure, built on multidisciplinary translation.

[377] WHAT CAN BE LEARNED THROUGH A COMPREHENSIVE APPROACH OF CARDIOVASCULAR RESPONSES TO MICROGRAVITY SIMULATION IN LOWER-LIMB AMPUTEES?

Thais Russomano[1], Marcelo Balestro Pereira[2], Marcelo Haertel Miglioranza[2]
[1]King's College London, London, United Kingdom; [2]Cardiovascular Imaging Research and Innovation Core Lab Institute of Cardiology/ University Foundation of Cardiology, Porto Alegre, Brazil

(Education - Program / Process Review Proposal)

BACKGROUND: A progressive shift of blood from the lower to the upper body occurs in the absence of Earth's gravitational force in the first 7-10 days of a space mission. Initially, this headward shift increases the central fluid volume, cardiac size (around 20%) and cardiac output, and is accompanied by a decrease in lower limbs volume (puffy-face and bird-legs syndrome). These cardiovascular responses to microgravity exposure cause a negative fluid balance and a reduction of 12-20% of plasma volume, which in turn decreases resting stroke volume by 10-20% and reduces cardiac output by an average of 1.5L.min-1 lower than pre-flight values, reflecting the reduction in circulating blood volume. The situation is reversed when an astronaut is once more subject to the gravitational force of the Earth, which distributes blood back to the lower body, contributing to decreased orthostatic tolerance and aerobic capacity post-flight. The in-flight cardiovascular changes are known to influence the anatomy and physiology of other body systems, such as the pulmonary and nervous systems. **OVERVIEW:** Physiological responses of lower-limb amputees to head-down (HDT), including the evaluation of data obtained from echocardiogram, heart rate and rhythm, vascular pressures measurements and neurovascular autoregulation through transcranial Doppler, might shed some new light on the real impact of blood redistribution in microgravity and its consequences on the cardiopulmonary and neuro-vascular-ophthalmic systems, as there is a substantial reduction in the blood component coming from the lower

to upper body. A comprehensive approach related to physiological responses of lower-limb amputees and the possible implications for space and terrestrial cardiovascular physiology and anatomy is presented. **DISCUSSION:** Cardiovascular changes to microgravity simulation in lower-limb amputees have been poorly studied and could contribute to a better understanding of how blood and fluid shift affects astronauts in space missions. This novel and complex evaluation of space physiology requires the integration of different areas of expertise, such as medicine, biomechanics, physiotherapy, and sport sciences, creating a clear case of translational science. The knowledge obtained by this protocol design can serve as the basis for a greater understanding of clinical situations related to lower-limb amputees on Earth and to the physiological adaptation of astronauts during and after space missions.

Learning Objectives:

1. Understanding neuro-cardiovascular responses to microgravity simulation in lower-limb amputees.
2. Understanding the role of translation science in clinical cardiology and neurology on Earth.
3. Understanding cardiovascular physiology in space.

[378] LINKING TRANSLATIONAL MEDICINE – MELANOMA DETECTION IN TWO HIGH RISK POPULATIONS – ASTRONAUT CORPS AND NEW ZEALAND RESIDENTS

Lisa Brown, Richard Harman, Richard Martin
Department of Surgery, North Shore Hospital, Auckland, New Zealand

(Education - Program / Process Review Proposal)

INTRODUCTION: Astronauts are exposed to ionizing radiation up to 2000mSv during long duration missions with an increased risk of carcinogenesis after radiation exposure of 50mSv. A known significant risk to Astronaut future health is the development of melanomatous and non-melanomatous skin cancer, with the Astronaut corp. reported to have up to a 59% higher rate of melanoma than the general population within the USA. As part of the longitudinal Astronaut health study, Astronauts are screened for signs of skin cancer at an annual physical exam. Residents of New Zealand have the highest rate of skin cancer worldwide with a melanoma incidence of 40/100,000 population, largely influenced by UV radiation exposure secondary to the reduced overlying atmosphere. **METHODS:** The aim of this study was to evaluate and compare the screening of NASA Astronauts for Melanoma against the methods of detection and monitoring currently employed within the New Zealand population. Current technology available including mole map screening, dermoscopy, digital photography and applications on personal technology devices were reviewed. **RESULTS:** NASA have employed a screening program through annual surveillance skin examination to detect skin cancer in the Astronaut population. New Zealand does not have a dedicated screening program, however has enlisted the use of multiple new and emerging technologies including smart phone applications utilised by both patients and physicians to detect early changes in skin lesions. These new technologies could be utilised also on long duration inter-planetary missions due to their portable nature and suitability of tele-dermatology. **DISCUSSION:** The technology used within the New Zealand health system in monitoring for skin cancer in this high-risk population could be translated for use in the screening program currently in place at NASA. The annual surveillance program used by NASA for skin cancer could be evaluated as part of information gathering for a skin cancer screening service within the New Zealand health system. The link and translation between the two programs can improve the detection and early treatment of Melanoma.

Learning Objective:

1. To understand the implications of melanoma screening for Astronauts and the translation of this to other high-risk populations.

[379] BIOINFORMATICS EDUCATIONAL PROCESSES: ESSENTIAL ELEMENTS IN THE TRANSLATIONAL SCIENCE TOOLKIT

Annette Sobel
Texas Tech Health Sciences Center, Lubbock, TX, USA

(Education - Program / Process Review Proposal)

BACKGROUND: The field of bioinformatics is emerging rapidly as an essential element to translational medical research. Massive data sets, self-learning algorithms, and pattern recognition algorithms form the basis of complex decision-making and analytics. Bioinformatics is central to disparate inter-professional activities such as effective utilization of electronic health records data, application of health data to personalized medicine as well as pre-hospital care stabilization and early identification and forecasting of diagnostic challenges. **OVERVIEW:** This presentation will describe doctoral-level educational initiatives at Texas Tech University Health Sciences Center, emphasizing case centered discussions, current and future applications to translational health science research and practical applications to team case management. **DISCUSSION:** Ultimately, the field will enhance human performance and optimize human population resiliency and sustainability in extreme environments such as space. The speaker will emphasize current gaps and shortfalls of the technologies, with an eye toward demonstrable human performance and cognitive and situation awareness enhancement. These technologies impart new opportunities for advancement of translational science in multidisciplinary research and education.

Learning Objectives:

1. The audience will gain an improved understanding of the applications of bioinformatics in translational research.
2. The individual participant will understand the relationship between human performance optimization and bioinformatics.

[380] ARTIFICIAL INTELLIGENCE: A COMPREHENSIVE BEHAVIORAL COUNTERMEASURE FOR LONG-TERM SPACE MISSIONS

Illaria Cinelli
Tufts University, Medford, MA, USA

(Education - Program / Process Review Proposal)

BACKGROUND: A new era is coming for medical care where artificial intelligence (AI) will be used in prevention, diagnosis and treatment. AI medical systems are currently developed utilizing big data of patient medical history, environmental conditions, probabilistic models as learning algorithms and more. Although AI-based technology is currently purpose oriented only, the reliability of autonomous system is going to be scaled up for integrating systems of different domain covering a wider field of tasks and opportunity for action. This will allow AI to be context specific, not just purpose oriented. AI is applicable to behavioral and mental health care too. Neuro-cognitive performance are expected to be altered during long periods of isolation, as those of crewed missions to the Moon, Mars or of remote Terrestrial environment. So, how to counteract mental health hazards in commercial astronauts and astronauts? **OVERVIEW:** Autonomous systems are built on large datasets that include Terrestrial medical conditions only. Probabilistic models based on data taken from analogue missions, extreme expeditions and people living in remote conditions could be the base for establishing learning algorithms to be used in outer space. A design approach of AI-based mental care systems is presented, from the training to the autonomy of the same. Autonomous treatment capacities are integrated as AI-guided noninvasive transcranial brain stimulations only, where the brain electrical activity is the bridge between prevention and treatment. **DISCUSSION:** A new multidisciplinary field is born from the needs of remote monitoring and the challenges to face in space exploration. In such context, AI reliability builds on translation science. Autonomous prevention and monitoring of mental health care shall be considered in mission operations, safety management, ergonomics and are also applicable to transportation, emergency procedures, prisoners, nursing homes and more.

Learning Objectives:

1. Understanding the importance of artificial intelligence in medical care and in aerospace medicine.
2. Understanding the role of translation science at the base of autonomous systems.
3. Understanding that systems developed on big (medical) data refer to terrestrial medicine only.

Thursday, 05/09/2019 ***10:00 AM***
Miranda 5/7

[S-75] SLIDE: GASES & ULTRASOUND

Chair: Ashot Sargsyan

Co-Chair: Jason Norcross

10:00 AM
[381] REAL-TIME ULTRASOUND GUIDED LUMBAR PUNCTURE TECHNIQUE WITH REMOTE GUIDANCE BY PROCEDURAL NAÏVE POPULATION FOR POTENTIAL IN-FLIGHT EVALUATION OF VIIP

David Lerner, Ranjit Chima, Kirang Patel
University of Missouri - Kansas City School of Medicine, Kansas City, MO, USA

(Original Research)

INTRODUCTION: Although theories have been suggested for Visual Impairment and Intracranial Pressure Syndrome/Spaceflight-Associated Neuro-ocular Syndrome (VIIP/SANS), the mechanism is unknown. Knowing true pathophysiology is important as longer missions are planned. Only indirect measurements of intracranial pressure (ICP) have been performed in spaceflight. Direct inflight measure could help understand VIIP. The "gold standard" is lumbar puncture. This would allow correlation of opening pressures and contributing factors. The only imaging modality on ISS is ultrasound. With appropriate methodology, remotely guided real-time ultrasound guided lumbar puncture (USGLP) may allow the safe performance of LP inflight. Therefore, we sought to develop and prove a novel ultrasound guided approach for the definitive placement of an LP needle, and to validate this can be achieved with remote guidance by those without specific training. **METHODS:** Cross-discipline literature review was performed and discussion with fellowship-trained practitioners in Diagnostic, Interventional, and Neurointerventional Radiology, and other fields. Volunteers were scanned with US for purposes of optimizing technique, resolution, windowing, and planned needle approach in different anatomic positions. A cadaver was then used to perform lumbar puncture using real-time ultrasound guidance by a radiologist. This technique was then taught to 4 volunteers not experienced in performing image guided procedures. The procedure was repeated multiple times by these people with simulated remote guidance. **RESULTS:** Optimal anatomic visualization was in fetal and seated lordotic positions. Technical success was achieved by the radiologist in all attempts on first try as demonstrated by the return of spinal fluid as well as direct visualization of the needle throughout the procedure with final position in the thecal sac. 2 of 12 attempts required one needle redirection. Three different needle sizes (18, 20, 22 Gauge) were used. Technical success was achieved in nine of eleven attempts by the trainees. **DISCUSSION:** Given current experience with ultrasound for independent scanning and real time guided procedures at NASA, as well as the ability described to educate non-image guided trained people in the paramedian longitudinal oblique remote guided technique, these could make remotely guided USGLP technically feasible. This could aid in making direct inflight measurements to further research VIIP.

Learning Objectives:

1. The audience will learn about real time ultrasound guided lumbar puncture technique.
2. The audience will learn about applications and feasibility of remote guidance of procedures for use in microgravity for potential direct evaluation of VIIP/SANS.

10:15 AM
[382] DEVELOPMENT AND EVALUATION OF A SOFTWARE GUIDANCE TOOL FOR AUTONOMOUS MUSCULOSKELETAL ULTRASOUND EXAMS IN SPACEFLIGHT

Ethan Monhollon[1], Douglas Ebert[2], Richard Cole[3], Vicky Byrne[2], Kathleen Garcia[2], Ashot Sargsyan[2], Scott Dulchavsky[4]
[1]University of Nebraska Medical Center, Omaha, NE, USA; [2]KBRwyle, Houston, TX, USA; [3]University of Texas Medical Branch, Galveston, TX, USA; [4]Henry Ford Hospital, Detroit, MI, USA

(Original Research)

INTRODUCTION: Ultrasound (US) has proven to be a reliable and effective modality for management of health conditions in resource-limited environments such as spaceflight. While remote guidance has demonstrated utility in spaceflight, communication latency of missions beyond low Earth orbit may prevent execution of real-time remote guidance. To expand the capability of crews and enable autonomous collection of diagnostic quality US imagery, a software guidance tool was designed and evaluated. **METHODS:** Twenty-three subjects with varied medical experience used the software tool to perform autonomous musculoskeletal US image collection on forearm phantoms and a living human shoulder. Image results were blinded and scored by subject matter experts for quality and adequacy for intended target. RESULTS were analyzed by frequency, proportion, chi square analysis, and mixed regression modeling. Usability questionnaires for software and equipment were administered and evaluated to identify software improvement opportunities. **RESULTS:** Among all subjects, image quality levels were 53% diagnostic, 20% marginal, and 27% unusable. A chi-square test for independence examining the relation between medical training and image quality showed significance, $X^2(4, N = 161) = 9.53$, $p = 0.0491$. Mixed regression modeling showed similar results. The system usability scale scores for the software tool and US equipment were 70% and 75% respectively. Usability issues were compiled and recommendations implemented in subsequent software products. **DISCUSSION:** Despite not having any software training, subjects generated images of some clinical value in 73% of attempts, with over half of the images being of diagnostic quality indistinguishable from trained sonographers. Subjects with previous medical training obtained higher quality images, which may be related to knowledge of visualized anatomy during the US exam. While impractical to provide years of medical training to astronauts, improvement of the acquired images could be attained through software improvements, training, and remote guidance. We recommend US training, plus detailed anatomical guidance provided by a just-in-time tool, be incorporated for crew medical officers to maximize obtained image quality. Further development of autonomous tools could significantly reduce the need for remote guidance on ISS and enable autonomous image collection for missions beyond low Earth orbit or other resource-constrained terrestrial situations.

Learning Objectives:

1. The audience will learn about the current challenges of medical imaging on the International Space Station and how these challenges will change with human exploration further away from Earth.
2. The audience will learn about current medical imaging capabilities and techniques to improve image quality during spaceflight.

10:30 AM
[383] REMOTELY GUIDED ULTRASOUND EXAMINATION AMONG NON-MEDICAL PERSONNEL: EVALUATING IMAGE QUALITY AND UTILITY

Quinn Dufurrena[1], Kazi Ullah[2], Sahar Ahmad[1]
[1]Stony Brook University Hospital, Stony Brook, NY, USA; [2]Stony Brook University School of Medicine, Stony Brook, NY, USA

(Original Research)

INTRODUCTION: Ultrasound (U/S) is an increasingly utilized diagnostic modality in austere environments, including space flight. U/S exams carried out by non-medical personnel under remote expert guidance have been shown to be a viable tool in emergency situations, however, have yet to be objectively compared to U/S exams carried out by trained medical practitioners. This study aims to determine if U/S can be reliably used by non-medical personnel guided remotely. **METHODS:** Non-medical volunteers (N=6) conducted cardiopulmonary U/S exams under remote video/audio guidance by a physician ultrasound expert. Exams assessing for pneumothorax, pulmonary edema, pleural effusion, pericardial effusion and left ventricular (LV) dysfunction were carried out on healthy standardized patients. Senior internal medicine residents and pulmonary/critical care fellows with formal U/S training (N=5) carried out similar exams as a comparison. Imaging was blindly scored,on

both objective and subjective criteria, by an independent physician U/S expert. Wilcoxon Rank Sum and Fisher's exact test were used in statistical analysis. Stony Brook University Hospital IRB approval was obtained. **RESULTS:** Volunteers' exams were scored as acceptable or ideal by the expert reviewer (Likert scale) at the following percentage for the following exams; 83%-pericardial effusions, 83%-pneumothorax, 83%-pulmonary edema, 33%-LV dysfunction, 0% for diaphragm dysfunction and pleural effusion. No significant differences were seen in clinically useful exams between volunteers and residents/fellows for pericardial effusion, pneumothorax, or pulmonary edema exams (p=1, 1, 0.481, respectively). Time to complete the U/S exams was longer in volunteers compared to residents/fellows (median 10m39s vs 4m16s, p=0.0081). **DISCUSSION:** Volunteers were able to carry out clinically useful exams with high frequency for ruling out pericardial effusion, pneumothorax and pulmonary edema, however not for exams assessing for LV dysfunction, diaphragm dysfunction and pleural effusion. They were able to carry out these U/S exams in a reasonable time, though required longer time than residents/fellows, unsurprisingly. These data show that non-medical personnel are able to carry out adequate U/S exams for some pathology, but perhaps not so for other, more difficult exams.

Learning Objectives:

1. To learn how remotely guided ultrasound exams carried out by non-medical experts compare to formally trained physicians (residents and fellows).
2. To learn which ultrasound exams carried out by non-medical personnel, under remote guidance by experts, may be clinically useful, as well as those that may not be.
3. To learn that while ultrasound exams carried out by non-experts under remote guidance may take longer than their physician counterparts, they are able to achieve thorough examinations within a reasonable timeframe.

10:45 AM
[384] PULMONARY OXYGEN TOXICITY IN ASTRONAUTS PERFORMING SIMULATED EXTRAVEHICULAR ACTIVITY AT THE NASA NEUTRAL BUOYANCY LABORATORY

Yousef Ahmed[1], Robert Sanders[2], Shane Walker[3]
[1]Naval Special Warfare Group One, Coronado, CA, USA; [2]Neutral Buoyancy Lab at NASA Johnson Space Center, Houston, TX, USA; [3]UCSF, San Francisco, CA, USA

(Original Research)

INTRODUCTION: Within hyperbaric environments, pulmonary oxygen toxicity can cause harm with prolonged exposures to partial pressures of oxygen greater than 0.5 ATA. Previous medical evidence has demonstrated that a decrease in lung vital capacity and diffusing capacity may result from prolonged exposure. A recently published paper using data from NASA's Neutral Buoyancy Laboratory (NBL) described central nervous system oxygen toxicity in the astronaut cohort (Walker, et al. 2018). The undersea and aerospace medical communities requested that pulmonary oxygen toxicity also be studied in the same cohort. Unlike existing studies, this particular study focuses on long-term, intermittent oxygen exposures rather than acute, high-dose exposures. The work will determine if hyperbaric oxygen exposure in chronic, intermittent doses when near or beyond established exposure limits causes any pulmonary function change. **METHODS:** All exposures in this data represent astronauts, training underwater wearing "space suits." Suited subjects breathe a mixture of 46% oxygen and 54% nitrogen (nitrox), resulting in a maximum partial pressure of oxygen of 1.15 ATA at a depth of 40 feet. Cumulative Pulmonary Toxicity Dose (CPTD) was calculated for each of the 1772 exposures, as well as mean and maximum dose for each of the 85 astronauts. **RESULTS:** Spanning the past 20 years, more than 10,000 simulated EVA runs have been performed at the NBL. In this sample of 85 astronauts and 1,772 exposures, only one run exceeded the NOAA/NASA CPTD limit of 694 units. The NASA CPTD limit of 694 units was derived from a target of 2% decrement of vital lung capacity in 50% of the subjects. By protocol, CPTD calculations were performed using the maximum partial pressure possible at the NBL pool. **DISCUSSION:** Because CPTD calculations are performed using the maximum partial pressure during a dive, our results may represent a conservative assessment. This study validates the safe nature of NBL training, documenting the low risk for pulmonary oxygen toxicity. Forward work will compare these individual exposures to pulmonary functions over time with respect to the published limits.

Learning Objectives:

1. The audience will learn about the strong safety record of simulated space walks at the Neutral Buoyancy Lab; specifically, they will understand the low-risk for pulmonary oxygen toxicity.
2. The audience will understand how pulmonary oxygen toxicity can be calculated using time at depth.
3. The audience will understand how chronic, intermittent, high-dose oxygen exposures lead to a decreased risk for pulmonary oxygen toxicity when compared to acute, high-dose oxygen exposures.

11:00 AM
[386] IMPAIRMENT OF GAS EXCHANGE IN THE LUNG DURING SUSTAINED +GX ACCELERATION RELEVANT TO SUBORBITAL SPACEFLIGHT PROFILES

Alec Stevenson[1], Ross Pollock[2], Henry Tank[1], Snapper Magor-Elliott[3], John Couper[3], Graham Richmond[3], Nadia Abid[2], Peter Hodkinson[4], Grant Ritchie[3], Peter Robbins[3], Thomas Smith[2]
[1]QinetiQ, Farnborough, United Kingdom; [2]King's College London, London, United Kingdom; [3]University of Oxford, Oxford, United Kingdom; [4]Royal Air Force Centre of Aviation Medicine, RAF Henlow, United Kingdom

(Original Research)

INTRODUCTION: Members of the public will soon be flying on commercial suborbital spaceflights with acceleration loads expected to peak at up to +6 Gx. The physiological and clinical implications of this environment for the general population have yet to be fully established. Centrifuge studies have suggested that suborbital acceleration profiles could impair gas exchange in the lung and cause a degree of in-flight hypoxemia, and this could be compounded by the use of airline-style cabin pressurization. This centrifuge study used two-minute Gx exposures to characterize the underlying pulmonary response more fully. We hypothesized that increasing Gx would progressively impair gas exchange and reduce arterial oxygenation, and that hypoxemia would be more pronounced at a simulated cabin pressure altitude of 8,000 ft. **METHODS:** This study was approved by the QinetiQ and King's College London Research Ethics Committees. Eleven healthy participants (8 men and 3 women) were each studied twice at 2, 4 and 6 Gx: once breathing air and once breathing a 15% oxygen mixture to simulate an altitude of 8,000 ft. Respiratory gases were measured breath-by-breath using a novel laser-based molecular flow sensor. Ventilation and arterial oxygen saturation (SpO_2) were measured continuously. In a sub-set of participants, arterial blood gases including the arterial partial pressure of oxygen (PaO_2) were measured towards the end of each Gx exposure, allowing calculation of the alveolar-arterial (A-a) gradient. **RESULTS:** There was a progressive fall in SpO_2 at each Gx load which was magnified when breathing 15% oxygen ($P < 0.05$). At 4 Gx, the minimum SpO_2 was 84 ± 2% when breathing 15% oxygen compared with 92 ± 1% when breathing air ($P < 0.05$). Corresponding SpO_2 values at 6 Gx were 78 ± 1% vs 86 ± 1% ($P < 0.05$). The A-a gradient widened substantially with increasing acceleration. The lowest recorded value for PaO_2 was 41 mmHg (5.5 kPa). **DISCUSSION:** When sustained, Gx loads associated with suborbital spaceflight cause marked hypoxemia that is exacerbated by simulated airline-style cabin conditions. Gx loads during actual suborbital flights will be relatively brief. The extent to which they evoke these underlying physiological responses and become clinically meaningful is likely to depend on interaction with individual factors such as age, smoking history, baseline fitness and pre-existing disease.

Learning Objective:

1. The audience will learn about the effects of high +Gx acceleration relevant to commercial suborbital human spaceflight on pulmonary physiology.

11:15 AM

[385] VENTILATION, RESPIRATORY DRIVE AND BREATHING MECHANICS DURING SUSTAINED +GX ACCELERATION RELEVANT TO SUBORBITAL SPACEFLIGHT PROFILES

Ross Pollock[1], Alec Stevenson[2], Caroline Jolley[1], Gerrard Rafferty[1], Luis Estrada[1], Mitchell Segal[1], Henry Tank[2], Tobias Menden[3], Steffen Leonhardt[3], Thomas Smith[1]
[1]King's College London, London, United Kingdom; [2]QinetiQ, Farnborough, United Kingdom; [3]RWTH Aachen University, Aachen, Germany

(Original Research)

INTRODUCTION: The lung has little actual tissue mass and deforms under its own weight, and postural effects of gravity on respiratory function can be important in clinical medicine. Members of the public will soon be flying on commercial suborbital spaceflights with short periods of hypergravity expected to peak at up to +6 Gx. We used two-minute centrifuge exposures to explore how the lungs are affected by G loads over this range. We hypothesized that increasing Gx would progressively change the distribution of pulmonary ventilation and impair breathing mechanics, leading to increased work of breathing, increased neural respiratory drive (NRD) and breathlessness. **METHODS:** This study was approved by the QinetiQ and King's College London Research Ethics Committees. Healthy participants (8 men and 3 women) were studied at 2, 4 and 6 Gx. 16-electrode electrical impedance tomography was used to determine regional distribution of ventilation. In nine participants, the crural diaphragm electromyogram (EMGdi) was recorded continuously using an esophageal multipair electrode catheter, and quantified as a proportion of maximum volitional EMGdi (EMGdi%max) to provide an index of NRD. Transdiaphragmatic pressure was measured simultaneously using a dual pressure transducer tipped catheter, with the proximal transducer in the mid esophagus and the distal transducer in the stomach. Breathlessness was assessed using the modified Borg scale (mBorg). Data were analyzed using repeated-measures ANOVA. **RESULTS:** With increasing Gx there was a reversal of distribution of ventilation from dorsal to ventral lung regions ($P < 0.05$). There was a progressive increase in the diaphragm pressure-time-product (PTPdi) and EMGdi%max from baseline to 6Gx. Mean (SD) PTPdi at 1Gx, 2Gx, 4Gx and 6Gx was 243.0 (67.6), 394.0 (126.1), 476.0 (173.4) and 604.5 (258.0) $cmH_2O.s.min^{-1}$ respectively ($P = 0.0013$). EMGdi%max at 1Gx, 2Gx, 4Gx and 6Gx was 11.6 (5.0), 17.4 (9.7), 33.4 (18.1) and 45.0 (21.3) %max respectively ($P < 0.0001$). Breathlessness was severe at 6Gx (median mBorg 5 (IQR 3.5 – 7)). **DISCUSSION:** Sustained Gx profoundly alters the mechanical behavior of the lung and chest wall and the regional distribution of pulmonary ventilation. This is associated with a substantial increase in NRD and breathlessness**.** Suborbital flights will transiently trigger these responses, which may have clinical implications for some individuals such as those with pre-existing respiratory disease.

Learning Objective:

1. The audience will learn about how the acceleration loads associated with suborbital spaceflights may affect respiratory physiology, including the regional distribution of ventilation, breathing mechanics and the neural drive to breathe.

Thursday, 05/09/2019 ***9:30 AM***
Exhibit Hall

[S-76] POSTER: CLINICAL AEROSPACE MEDICINE

Chair: Richard Bachmann

Co-Chair: Ross Pollock

[387] BRANCH RETINAL VEIN OCCLUSION IN A C-17 LOADMASTER: A CASE REPORT

Paul Vu[1], Michael Parsons[2], Jonathan Ellis[2]
[1]USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA; [2]Ophthalmology Aeromedical Consultation Service, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This case report describes a USAF C-17 loadmaster who experienced visual impairment from an occluded branch retinal vein. **BACKGROUND:** The USAF C-17 loadmaster is responsible for the proper and safe on- and off-loading of cargo. They perform visual and operational inspections on loading systems and ensure the safety and comfort of passengers. During flight, they conduct inflight systems inspections, often in low-light conditions. Additionally, aerial cargo drops at night require excellent vision for effective mission execution. Degraded vision in loadmasters can have severe consequences. **CASE PRESENTATION:** The subject was a 41-year-old man. He was an experienced aviator with 5500 total flying hours. He presented to optometry with a complaint of worsened vision and a "spot" in the right eye. Symptom onset was sudden, but he waited 2 weeks before presenting. He insisted that his flying duties were not impacted as he still had a functioning left eye. Exam revealed an inferior hemiretinal vein occlusion of the right eye with macular thickening. He was removed from flight duties and followed closely. The only other abnormal clinical finding was a single elevated blood pressure reading of 144/86. After 3 months, repeat macular optical coherence tomography (OCT) showed resolution of his macular thickening. He was subsequently granted a flying waiver and returned to flying duties. **DISCUSSION:** Although retinal vein occlusion is the second most common retinal vascular disorder, not many clinicians are familiar with the condition. The occlusion is most commonly caused by vein compression by an adjacent artery. Some risk factors are hypertension, venous disease, cerebrovascular disease, diabetes, smoking, obesity, dyslipidemia, and open angle glaucoma. Decreased blood return from an occluded retinal vein can lead to hypoxic conditions in the retina, causing vision and visual field deficits, degraded stereopsis, and reduced contrast sensitivity. Although most lesions resolve over 3-6 months, some persist and require intervention. Retinal vein occlusion can occur in any aviator and the aeromedical considerations must account for the aviator's responsibilities, the present debilitation, and the likelihood of recurrence. If workup reveals no other underlying pathology and clinical resolution is achieved, the condition is expected to remain stable – and therefore safe for flight.

Learning Objectives:

1. Retinal vein occlusion is the second most common retinal vascular disorder.
2. Important risk factors of retinal vein occlusion.

[388] IMPACT OF AUTOREFRACTIVE THRESHOLD VARIATION ON MEDICAL FITNESS RATES IN MILITARY PILOT APPLICANTS

Frank Jakobs[1], Diana Hering[1], Vanessa Wahl[2], Manuela Hoffmann[3], Michael Gebhard[2], Joerg Frischmuth[1]
[1]German Air Force Center of Aerospace Medicine, Muenchen, Germany; [2]University of Applied Sciences, Jena, Germany; [3]German Forces Service Headquarters, Koblenz, Germany

(Original Research)

INTRODUCTION: As recently shown by the authors, retest reliability of automated refractometry is not sufficient to display refractometric measurements by means of zero or near-zero deviation when assessed by repeated measurements or multiple examiners. In order to model the hypothetical impact of a +/-.25 D tolerance implementation on the selection of flying personnel, we recalculated the retrospective fitness rates of a 10-years cohort of pilot and non-pilot applicants seen at the German Air Force Centre of Aerospace Medicine. **METHODS:** Refractometric data of pilot applicants of the years 2005 to 2015 were extracted and retrospectively analyzed with regard to their empirical sensitivity on optometric threshold variation. Modelling was performed for spherical refraction, cylindric refraction, and spherical equivalents. In accordance with real-life conditions, unilateral threshold excess in one eye was assessed as unfit to fly. Data were compared with the respective limits in rotary and fixed wing applicants as well as additional crew members (ACM) and non-flying ground personnel. **RESULTS:** We assessed n=4,451 military pilot applicants, n=951 additional crew members, and 2,307 non-pilot/non-ACM applicants. Implementation of a .25 D tolerance revealed a decline in medical unfit rates from maximally 24.7% to 14.8% for fighter jet, while the effect was considerably lower for rotary/fixed wing aircraft (5.4% vs. 4.8%), and only marginal for ACM (2.8% vs. 2.2%) or ground personnel (1.0% vs. 0.9%).

The critical threshold parameter was cylindric refraction being responsible for 19.8% of hypothetical unfitness rates in fighter jets without, and 9.6% with inclusion of metric tolerance. **DISCUSSION:** Our results indicate that implementation of a minimal-dioptric measurement tolerance under real-life conditions would result in a considerable increase of refractometric fitness rates in first-time fighter jet applicants. Within the German Air Force, this accounts for 437 applicants over the past 10 years who could have been selected for duty on EF Typhoon, Phantom F-4F, or Tornado aircraft, but were missed due to device-specific limitations. Adoption of respective policies is highly recommended.

Learning Objectives:

1. The participant will learn the critical dioptric values for pilot assessment as well as the influence of dioptric threshold variation on medical fitness rates.
2. The participant will learn to deal with applied physical optics.

[389] OCULAR FATIGUE IN BIOCULAR HELMET-MOUNTED DISPLAYS

Logan Williams[1], Eric Palmer[2], James Gaska[1], Marc Winterbottom[1], Eleanor O'Keefe[2], Elizabeth Shoda[2], Steven Hadley[1]
[1]USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA; [2]KBRwyle, Dayton, OH, USA

(Original Research)

INTRODUCTION: Perception of misalignment between biocular HMD images depends upon the magnitude and direction of the relative displacement and the visual capability of the observer. This study evaluated performance with the use of bi-ocular vs. monocular viewing conditions, including the relationship between stereo acuity and fusion range with self-reported fatigue. **METHODS:** Thirty-nine observers performed a simulated targeting task in an HMD. Under separate conditions, subjects viewed HMD symbology monocularly, biocularly, or mixed monocular/binocular symbology. Several well-controlled levels of intentional misalignment were also tested. Performance was evaluated by task throughput (i.e. correct answers/second). Subjects were asked to report their ocular fatigue on a 10 point scale at regular intervals. All subjects participated in a battery of vision tests to measure overall visual capabilities. **RESULTS:** In the targeting task, biocular throughput was higher, on average, than monocular presentation except for severely misaligned conditions (>0.6 degrees). Right-eye monocular stimuli produced significantly lower throughput (average difference -0.06) than biocular presentation with moderate misalignment (<0.3 degrees) (n=39; t_{38}=2.38, p=0.022). Multiple measures of self-reported fatigue exhibited moderate correlations to horizontal fusion across all conditions (n=40; r=0.35, p=0.027), indicating that increased fatigue was more common in subjects with lesser horizontal fusion range. **DISCUSSION:** Higher biocular throughput, even under moderate misalignment, suggests improved performance with the use of biocular vs. monocular HMDs. Although misalignment did not have a large effect on targeting task performance, subjects reported increased fatigue in the presence of misalignment. Further, subjects with poorer ocular alignment (small fusion range) reported more fatigue.

Learning Objective:

1. The audience will learn about the correlation of various ocular health metrics to self-reported ocular fatigue when using biocular helmet mounted displays.

[390] HUMAN PEFORMANCE MISALIGNMENT THRESHOLDS FOR BIOCULAR HELMET MOUNTED DISPLAYS (HMDS)

Eric Palmer, Logan Williams, James Gaska, Marc Winterbottom, Eleanor O'Keefe, Elizabeth Shoda, Steven Hadley
Operational Based Vision Assessment Laboratory, Wright-Patterson AFB, OH, USA

(Original Research)

INTRODUCTION: Perception of misalignment between biocular HMD images depends upon the magnitude and direction of the relative displacement and the visual capability of the observer. This study measured human performance thresholds for detection of biocular misalignment within an HMD. **METHODS:** The just noticeable difference (JND) of misalignment was measured for 45 observers performing a simulated targeting task using carefully misaligned target designation symbology in a 4-alternative forced choice design. In each set of 4 stimuli, one symbol was intentionally misaligned either horizontally or vertically, with the magnitude determined by an adaptive threshold estimation (PSI) algorithm used to determine the just-noticeable threshold of misalignment. All subjects participated in a battery of vision tests to measure overall visual capabilities. **RESULTS:** In the JND task, subject stereoacuity threshold measured at 4m significantly correlated to the detection threshold of horizontal disparity (n=45; r=0.60). This translated to a significant difference in average 4m stereoacuity threshold between low-performing subjects (2.04±0.12SE log arcsec) and high-performing subjects (1.27±0.08SE log arcsec) when detecting horizontal disparity at threshold. Vertical disparity did not significantly correlate with any ocular health metrics. However, both the minimum and mean JND for vertical misalignment were substantially higher than the minimum and mean JND of horizontal misalignment (~1.4 log arcsec greater), suggesting subtle vertical misalignment is not readily noticed, regardless of ocular health. **DISCUSSION:** The correlation of horizontal disparity detection to stereoacuity illustrates that detection of HMD misalignment is related to the stereoacuity of the subject. The significant difference in minimum and mean horizontal vs. vertical disparity thresholds suggests vertical misalignment is not readily noticed to the same degree as horizontal disparity.

Learning Objective:

1. Gain insight into the connection between ocular health metrics and the ability to detect misalignment in helmet mounted display systems.

[391] NAVIGATION ABILITIES AND DIRECTIONAL JUDGMENTS IN PILOTS DURING DAY AND NIGHT VISION GOGGLES (NVGs) CONDITIONS

Giuseppe Bizzarro[1], Marco Lucertini[2], Marco Fagiolo[2], Paola Verde[2]
[1]Italian Air Force, Roma, Italy; [2]Aerospace Medicine Department, Roma, Italy

(Original Research)

INTRODUCTION: Individuals are more accurate and faster in making directional judgments when the "up" on the map is the same as the "forward" direction in the environment which is when a map is aligned with the perspective of the spatial layout they have learned (alignment effect). The aim of this study was to explore whether military pilots, would show the alignment effect in NVGs conditions when compared to the day conditions. **METHODS:** 40 pilots were recruited and divided in two groups of 20 pilots. One group had to perform the test in day condition while the other in NVGs conditions. The two groups were matched for age and education. Subjects were asked to learn a map and to perform directional judgements to verify whether the alignment effect was present considering absolute angular errors, both in day and night conditions. **RESULTS:** The MANOVA for mixed designs, on absolute angular errors, revealed no main effect for "group": pilots performed equally well in aligned and contra-aligned judgement in both conditions. A main effect of "directional judgments" concerned the time needed to execute the task: the aligned judgments were faster than contra-aligned (F=5.183) (p=0.02). The test showed that there are no statistically significant differences in performing the task with NVGs vs day vision. **DISCUSSION:** Pilots due to their selection and training have high visuo-spatial abilities which preserved them from having alignment effect bias. They are not influenced by the increased cognitive effort requested by the changing perspective both in day and NVGs conditions.

Learning Objective:

1. The aim of this work is to explore whether or not the ability of military pilots, could be influenced by the use of NVGs in making map directional judgments.

[392] VISION PERFORMANCE OF U.S. ARMY ROTARY WING PILOTS AND NON-PILOTS USING THE OPERATIONAL BASED VISION ASSESSMENT

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(Original Research)

INTRODUCTION: To quantify operationally important aspects of vision, the U.S. Air Force has developed a computer-based test battery: the Operational Based Vision Assessment (OBVA). The test evaluates color vision, depth perception, and vergence, key skills necessary for Pilots. Here we report thresholds for these three assessments measured in a sample of U.S. Army Pilots, Soldiers, and civilians. **METHODS:** Participants were recruited from the civilian and military population in the geographic area of Fort Rucker, AL, drawing heavily from the aviation community. The Automated Vision Tester (AVT) version of the OBVA was used to determine the contrast sensitivity of the chromatically isolated long (L), middle (M), and short (S) cones. Depth perception was evaluated with the near and far threshold tests and the eTitmus test while vergence was assessed using the Fusional Range Test. Additionally, basic demographic information was collected through a survey. **RESULTS:** In addition to reporting descriptive statistics, no statistically significant differences in the L, M, and S cone performance of Pilots (n=12), Soldiers (n=30), and civilians (n=11) were found with the Kruskal-Wallis rank sum test, used to account for a violation of normality. Of the three depth perception threshold outcomes, only the eTitmus Test emerged significant (H=9.30, p<0.05). The Pilots' depth perception was better (1.28 log arcseconds) than the Soliders' (1.82 log arcseconds) and the civilians' (1.94 log arcseconds). No statistically significant differences were found in vergence among the groups. **DISCUSSION:** These data contribute to the developing normative database charactering the AVT instrumentation and these populations. Better Pilot performance on the eTitmus Test may be due to selection criteria in place for Pilots or task familiarity as the Titmus Test is used for screening. Pilots may develop finer depth perception due to occupational demands. With a larger sample, other significant differences may emerge from the use of this battery.

Learning Objectives:

1. The audience will learn about the Operational Based Vision Assessment (OBVA) and its use to quantify operationally important aspects of vision.
2. The audience will learn about the observed differences in visual performance between U.S. Army rotary wing Pilots, Soldiers, and civilians.

[393] MACULAR PIGMENT OPTICAL DENSITY IN U.S. ARMY ROTARY WING PILOTS COMPARED TO NON-PILOTS

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(Original Research)

INTRODUCTION: Macular pigment (MP) is a deposit of the carotenoids lutein and zeaxanthin in the retina and it is most concentrated over the fovea where it effectively filters short wavelength (blue) light, serving to protect the sensitivity of cone photoreceptors. MP optical density (MPOD) varies among people based on nutritional intake and other factors. Prior literature demonstrates that higher MPOD improves visual performance. The purpose of this project was to establish the MPOD and associated behavioral correlates known to influence MPOD in U.S. Army rotary wing Pilots, Soldiers, and civilians. **METHODS:** Heterochromatic flicker photometry (The Macular Densitometer, Macular Metrics, Rehoboth, MA) was used to measure MPOD in volunteers (n = 77) recruited from the Fort Rucker, AL area. A self-report survey collected basic demographics, and factors that are reported in the literature to impact MPOD (e.g., servings of leafy green vegetables consumed over an average week, tobacco use, ocular health, etc.). **RESULTS:** The data set was not normally distributed thus the Kruskal-Wallis rank sum test was used. Between Pilots, Soldiers, and civilians there was no significant difference in MPOD (H=1.17, p=0.56), body mass index (BMI) (H=4.28, p=0.12), or current tobacco use (H=3.08, p=0.21). However, servings of green leafy vegetables consumed per week was significantly different (H=7.62, p=0.02) with Pilots most frequently reporting "5-6 servings" (33%), versus Soldiers reporting "3-4 servings" (39%), and civilians reporting "0-2 servings" (41%). Additionally, age differed significantly (H=7.49, p=0.02) with means of 34.9, 30.8, and 39.1 for Pilots, Soldiers, and civilians, respectively. **DISCUSSION:** It is worthwhile to note that MPOD values found in this study are higher than those in the literature, which are generally reported between 0.20 and 0.30 units using the same measurement technique. The difference may have resulted from the unique population from which the sample was recruited, as participants were associated with an Army installation and the health and fitness required of Soldiers might be better than that of the general population.

Learning Objectives:

1. The audience will learn about the factors that contribute to macular pigment optical density.
2. The audience will learn about the differences between Soldiers, Pilots, and civilians in terms of macular pigment optical density.
3. The audience will learn about the differences in consumption of leafy green vegetables and tobacco usage between Soldiers, Pilots, and civilians.

[394] MACULAR PIGMENT AND CONTRAST SENSITIVITY UNDER GLARE CONDITIONS

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(Original Research)

INTRODUCTION: Lutein and zeaxanthin are dietary carotenoids which, when deposited into the retina, form the macular pigment (MP). MP is a selective filter for shorter wavelengths of visible light, with a peak absorption of approximately 460 nm. Common sources of high intensity light that may cause disabling glare (e.g., sunlight, xenon and LED headlights, etc.) typically have a significant short-wave component. MP is a potential countermeasure to the reduction in visual contrast caused by glare, and thus is of potential importance to the aviation community. **METHODS:** Participants were recruited from the civilian and military populations of the Fort Rucker, AL area, drawing heavily from the aviation community. As part of a larger experiment, MP density was assessed using heterochromatic flicker photometry (The Macular Densitometer, Macular Metrics, Rehoboth, MA) and contrast sensitivity was assessed using a novel instrument. This device was used to produce glare over a wide range of luminances, randomly generate targets of varying contrast and size settings, and illuminate the targets at photopic or mesopic levels. **RESULTS:** Relative contrast sensitivity thresholds for two tested target sizes correlated with MP density for the moderate glare condition (n=76; larger target: rho=-0.28, p<0.05; smaller target: rho=-0.24, p<0.05). Lower intensities did not produce adequate glare to cause a significant effect and higher intensities produced a ceiling effect. A comparison of relative contrast sensitivity thresholds between Army pilots, non-pilot Soldiers, and civilians showed significant differences for the highest tested glare condition with the larger target size (H=6.40, p<0.05). Under the lowest comparable glare condition, 5 subjects (6.58%) were able to mesopically detect the larger of the two contrast sensitivity targets even at its highest contrast. **DISCUSSION:** Nutritional supplementation to increase levels of MP may be desirable for pilots, as they are expected to be capable of quick assessments of low-contrast targets while facing solar glare beyond normal terrestrial levels. Furthermore, our mesopic testing approach does appear to be feasible, as 38.16% of subjects' contrast thresholds were found at the lowest glare setting the hardware could produce, but target luminance should be increased for subsequent studies.

Learning Objective:

1. The audience will learn about the effects of macular pigment on contrast sensitivity under glare conditions.

[395] INTERNATIONAL AEROMEDICAL AUTOMATED VISION TEST RESEARCH AND DEVELOPMENT

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(Original Research)

INTRODUCTION: Current military vision screening procedures can be traced to the World War II era. These antiquated tests do not have the accuracy and precision to predict operational performance or support human performance optimization. The Operational Based Vision Assessment Laboratory is working with labs in Australia, Canada, Japan, and Singapore to develop more accurate and repeatable automated vision tests (AVTs) to address this limitation, collect normative data, and support commercialization of improved military vision screening technology. **METHODS:** The AVT color, contrast/acuity, stereo acuity, and motion tests use precise calibration and a sophisticated adaptive procedure to estimate threshold level visual performance. The fusion range test uses a three-dimensional display to characterize binocular fusion break and recovery, and the phoria test uses automated shutters, lenses, and a three-dimensional display to estimate near/far phorias. Across tests and labs, over 900 subjects were tested to obtain normative data and evaluate test-retest reliability. The AVT was also compared against selected analogous alternative tests in different labs (e.g., 3-bar depth test, Precision Vision eye chart, etc.). **RESULTS:** Test-retest reliability was excellent for the AVT color and contrast sensitivity tests (L-, M-cone, luminance r = 0.81-0.96). For 347 subjects, mean stereo acuity was approximately 1.67 log arcsec (47 arcsec), with a standard deviation of 0.63 log arcsec. Test-retest reliability was also very good (r = 0.79). In general, results were very similar across labs for the same AVT test. This presentation will summarize the normative data, test-retest reliability, and relationship to other alternative tests for each AVT test. **DISCUSSION:** The research collaboration between the U.S., Australia, Canada, Japan, and Singapore has enabled far more data collection to support vision screening modernization than could be achieved independently. Additionally, the AVT has supported head-mounted display research (U.S., Australia), KC-46 remote vision system research (U.S.), degraded visual environment research (U.S. Army), depth perception standards research (Canada, Japan), and color vision research (U.S., Australia, Canada, Singapore). This research is also supporting the refinement and commercialization of the AVT through the Small Business Innovative Research program and through a Cooperative Research and Development Agreement with Konan Medical.

Learning Objectives:

1. The audience will learn about the limitations of existing vision screening tests and advantages of newer computer-based vision tests.
2. The audience will learn about the normal range of performance for threshold-based acuity, contrast, color, stereo acuity, and ocular alignment tests.

[396] OPERATIONAL BASED COLOR VISION TEST: REPEATABILITY INDICES

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(Original Research)

INTRODUCTION: The Operational Based Color Vision Test (OBCVT) has been developed to measure chromatic thresholds in the clinic. It is the prototype of ColorDx® CCT HD® (Konan Medical, Irvine, CA) that has recently been introduced. In this study, we determined the OBCVT repeatability for normal/abnormal result, between-eye differences in thresholds within a session and the between-session results for each eye. **METHODS:** Monocular chromatic thresholds were measured for the L-cone, M-cones and S-Cones. Twenty stimuli for each cone were presented in a random order using the Ψ adaptive threshold procedure. Sixty color-normal (CVN) subjects and 68 subjects with a red-green color vision defect (CVD) participated in the study. Color vision was classified using the Rayleigh color match. Ninety-three percent of the CVNs and 86% of the CVDs returned within 10 to 15 days to repeat the tests. **RESULTS:** The between-session AC1 coefficients of agreement in terms of normal/abnormal color vision were 0.95 for each cone mechanism. The small number of discrepancies were mostly individuals who failed the first session, but passed at the second session. Regarding the log contrast thresholds, none of the between-eye or between-session mean differences were significantly different from zero. The between-eye limits of agreement (LOA) at the first session were approximately 0.20 for the L-cone and M-cone, whereas the S-cone value was 0.35. The larger value for the S-cone was significantly higher than the L-cone and M-cone values. At the second session, the LOA values for all 3 cones were near 0.30. The between-session coefficients of repeatability (CORs) for each eye were near 0.25 for the L and M-cones and 0.40 for the S-cone. Again, the S-cone value was significantly larger than the L and M-cone values. CVD subjects who had cone thresholds within the normal range had similar CORs. CVD subjects who had abnormal thresholds for either the L or M-cone had slightly higher LOAs and CORs, but the values were not significantly different. The LOAs and CORs were 3 times larger than the mean standard deviation for an individual subject's threshold that was calculated by the Ψ adaptive procedure. **CONCLUSION:** One can expect between-eye and longitudinal thresholds to vary by ±0.25 log unit for L and M-cones and ±0.35 log unit for the S-cone. This variability is not enough to erode the classification performance.

Learning Objectives:

1. The audience will learn about the repeatability of a clinical color vision test for measuring chromatic thresholds.
2. The information can be applied to determine a clinically important difference between eyes or test-retest.

[397] EXPLORING THE DEMAND OF EMERGENCY MEDICINE AT TAOYUAN INTERNATIONAL AIRPORT (TAOYUAN, TAIWAN)

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(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: The volume of air traffic at Taoyuan International Airport (TIA) has risen steeply in recent years. In 2016, the number of passengers reached 40 million. This study explores the demand for emergency medicine at TIA between 2014 and 2016. **BACKGROUND:** This study analyzes the emergency medical records of the medical clinic of TIA from January 1, 2014 through December 31, 2016. Emergency medical records refer to patients who needed emergency medical services but were unable to reach the airport clinic by themselves. Medical records include information such as when and where the event occurred, the chief complaints, the diagnosis (using the ICD-9 -CM), management, and personal profile of the passengers. **CASE PRESENTATION:** TIA Medical Clinic offers 24-hour general and emergency medical services and outreach services around the airport region 365 days per year. TIA handled approximately 116.5 million passengers and 674,529 flights during the study period. There were a total of 1,752 emergencies over this time period. Of these, 1626 (92.8%) involved passengers, 65 (3.7%) airport employees, and 61 (3.5%) aircraft crew members. The timing of the occurrence of emergency medical events in order of frequency was 6pm to midnight (39.0%), 5am to noon (28.4%), noon to 6pm (25.5%) and midnight to 5am (7.1%). Regarding the treatment of these cases, 751 (42.9%) passengers continued their scheduled trip, 479 (27.3%) went home, 65 (3.7%) where transferred to a neighboring hospital for further care. The top three most commonly diagnosed diseases were neurological-related condition trauma (19.4%), a gastrointestinal-related affliction (18.0%), and trauma (17.4%). **DISCUSSION:** Outreach emergent medical services are important services for maintaining health of the passengers and airport employees. We can accordingly enhance the training of our medical team and airport staff. These data also remind us how to improve medical facilities at airports to increase the effectiveness and quality of emergency care.

Learning Objective:

1. Understand the operation of an international airport medical clinic and relationship with the health of travellors, also cooperation with airline company.

[398] DIVERSION OF AIRPLANES FOR MEDICAL EMERGENCIES AT TAOYUAN INTERNATIONAL AIRPORT (TAOYUAN, TAIWAN)

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(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: Since 2016, the annual number of commercial flight passengers from Taoyuan International Airport (TIA) reached 40 million. If severe medical events happened on commercial airliner, diversion or not is considered of both medical and operational issues. This study discusses the events for diversion or reentry after taxiing of airplanes for medical emergencies at Taoyuan International Airport. **BACKGROUND:** This study analyzes the emergency medical records of the medical clinic of TIA from January 1, 2017 through June 30, 2018. Emergency medical records refer to patients who needed emergency medical services but were unable to reach the airport clinic by themselves. Besides, we collected the events which showed diversion from other airport or reentry after taxiing due to medical emergencies. Medical records include information such as when and where the event occurred, the chief complaints, the tentative diagnosis (using the ICD-9 -CM), management, and personal profile of the passengers. **CASE PRESENTATION:** TIA handled approximately 67 million passengers and 372,792 flights during the study period. There was a total of 1,087 emergencies over this time period (2017:712, 2018: 375). There were 15 medical emergencies were meet diversion or reentry, including of 11 cases of diversion and 4 cases of reentry after taxiing. Moreover, 10 diversion cases were Asia-Pacific flight and one was from Hong Kong to Vancouver. The age of the passengers with diversion emergencies ranged from 6 years to 64 years (mean, 38±19 years). The most common problems were syncope or presyncope (33.3%), chest tightness (20%) and possible stroke (20%). Only one case who was near fainting after drink could be suitable of fit for flight. Another 14 cases were transported to Landseed hospital and the common diagnosis were seizure (20%), dizziness (13.3%) and other diagnosis were only once such us myocardial infarction, asthma and sepsis. **DISCUSSION:** Most aircraft diversions were related to syncope, chest tightness and possible stroke. The decision of diversion depended on medical and operational consideration. Because of emergency conditions were often serious, how to improve the effectiveness of airline and medical team cooperation together is our challenge.

Learning Objective:

1. The audience will learn about disease type of diversion cases.

[399] THE ANALYSIS OF OUTREACH MEDICAL SERVICES AT TAOYUAN INTERNATIONAL AIRPORT IN TAIWAN

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(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: The number of tourists which were from all over the world visited to Taiwan continues to grow, and more and more people travel abroad. The volume of air traffic at Taoyuan International Airport (TIA) (Taoyuan, Taiwan) has risen steeply in recent years. In 2016, the annual number of commercial flight passengers from this airport reached 40 million. In 2017, the passengers reached up to 44 million. TIA medical clinic offers 24-hour general and emergency medical services and outreach services around the airport region 365 days per year. This study explores the demand of outreach medical services at TIA from January 1, 2017 to June 30, 2018. The outreach medical services means patients who needed emergency medical services but were unable to reach the airport clinic by themselves. **BAKGROUND:** This study analyzes the emergency medical records of the medical clinic of TIA from January 1, 2017 through June 30, 2018. Medical records include information such as personal profile of the passengers, flight information, the chief complaints, vital sign, physical examination, the diagnosis and management. We also track the patients after emergency medical treatment. **CASE PRESENTATION:** There were a total of 1,087 outreach records over this period (2017: 712, January to June 2018: 375). Among those cases, 1018 (93.7%) involved passengers, 22 (2.0%) involved airport employees, and 38 (3.5%) involved aircraft crew members. The top three of most common diagnosed were non-surgical gastrointestinal disease (18.7%), trauma (10.9%) and motion sickness (8.5%). The timing of we received notification in order of frequency was 9pm to midnight (23.7%), noon to 6pm (21.7%), 5am to 8am(17.3%), 6pm to 9pm(17.0%), 8am to noon(14.3%) and midnight to 5am (6.0%). Following up these emergencies, the three most common managements as following: 462 (42.5%) passengers continued their scheduled trip, 261 (24.0%) transferred to Landseed hospital for further care, 251 (23.1%) recommend rest and observed by themselves. **DISCUSSION:** As the number of passengers increases, the demand of emergency medical care also grows. The most common emergencies are gastrointestinal upset. Most patients can continue to fly. We advised travelers assess their physical condition before travelling and avoid eating uncooked food to reduce the chance of getting sick.

Learning Objectives:

1. The participant will be able to understand which kind of disease is most commonly at Taiwan Taoyuan International Airport.
2. The participant will be able to understand what the prognosis of the passengers who received the outreach medical services at TIA.

[400] FITNESS TO FLY ADVICE IN THE EMERGENCY DEPARTMENT

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(Original Research)

INTRODUCTION: In 2016, Aviation and Space Medicine was formally recognized by the General Medical Council (GMC) as a specialty in the UK. However, it is not currently part of the UK undergraduate medical teaching curriculum. Consequently, doctors may not be able to offer appropriate fitness to fly advice or be aware of relevant reference sources. This survey aimed to assess the aviation medicine knowledge of doctors in Emergency Departments (EDs) across Scotland and what, if any, resources they used. **METHODS:** An electronic survey was emailed to trainees and consultants in EDs across Scotland over a one-month period. The survey was voluntary and anonymous. Four ED scenarios were used to assess participants' knowledge of aviation medicine, and answers were marked against national guidelines. Participants were asked to list any aviation medicine resources they knew of and if they had any prior training in the subject. **RESULTS:** 197 responses were received from 637 surveys distributed (31% response rate). 54% of trainee doctors had been asked fitness to fly advice 2-5 times, with 29% being asked more than 5 times. 42% of consultants were asked fitness to fly advice annually, with 39% being asked on a monthly basis. In the four respective medical scenarios, 52%, 32%, 51% and 33% of participants were unsure, and did not give an answer. Of the remaining respondents, 33%, 35%, 71%, and 64% answered the respective questions correctly.70% of participants were not aware of any aviation medicine resources. 7% of participants had had previous aviation medicine training, with 86% agreeing that some formal aviation medicine teaching would be useful. 93% of participants thought a staff website detailing aviation medicine guidelines and resources for doctors would be useful, and 88% thought a leaflet in their department for patients with aviation medicine resources would be useful. **DISCUSSION:** These findings suggest that few ED doctors are aware of aviation medicine resources and may be issuing incorrect advice. There is support and a desire for aviation medicine to be taught to non-aerospace medicine professionals in the UK, in keeping with the House of Lord Science and Technology report (2000). In addition, EDs may benefit from aviation medicine resources in their department, in the form of a website, printed guideline, poster or leaflet.

Learning Objectives:

1. To better understand the evidence supporting the need for aviation medicine to be taught in the UK medical undergraduate curriculum.
2. To gain insight into how we can support non-aviation medicine physicians in providing fitness to fly advice in the Emergency Department.

[401] EMERGENCY REFERENCE CARDS: LESSONS TO BE LEARNED FROM AVIATION IN THE MANAGEMENT OF EMERGENCIES

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(Original Research)

INTRODUCTION: Aviation is a high-risk industry with a remarkable safety record. Flight hours worldwide continue to rise yet the

number of fatalities continue to fall. In contrast, around 850,000 patients in the UK are harmed by medical error a year, with around 50% of these incidents being avoidable. In both civil and military aviation, aide-memoires and checklists form a vital role in flight safety. Previous attempts to introduce aviation safety techniques to the clinical environment have had positive impacts on medical error. This project was deigned to assess the confidence of doctors in managing medical emergencies and whether this may be improved by the introduction of Emergency Reference Cards (ERCs). **METHODS:** 17 Foundation Year 1 doctors who performed on-call ward cover duties (including holding an emergency bleep) at a busy London teaching hospital participated in an anonymous survey January 2017. The survey assessed exposure to and confidence in managing 10 medical emergencies. Prior to the survey a brief introduction of Quick Reference Handbooks and Flight Reference Cards was delivered and participants recorded if they felt inclusion of each emergency on the ERCs would improve their confidence when faced with that emergency. For each emergency, the survey recorded the number of cases managed with senior support, number managed alone, confidence to manage alone without prompts and confidence to manage with prompts. Responses were reviewed, data entered into Microsoft Excel and analyzed. **RESULTS:** The survey highlighted varying levels of exposure to medical emergencies amongst the doctors and highlighted a low level of confidence in doctors in managing common emergency presentations on their own. On average, the presence of prompts would increase confidence in the ability to manage these emergencies by 38.8%. Moreover, doctors appear to support the idea of ERCs with an average of 97.7% believing they would be useful in emergency situations. **DISCUSSION:** In both medicine and aviation management is all but standardized for emergency situations, with departure from protocol increasing the risk of negative outcomes. The introduction of ERCs may increase compliance with protocol along with improved junior doctor confidence and reduced stress. This may lead to increased performance in emergency situations. Such an intervention would be a low-cost, potentially high impact method to achieving further gains in the safety culture of healthcare.

Learning Objectives:

1. The audience will learn about the trends in flight safety and medical errors.
2. The audience will learn about the exposure of doctors to 10 medical emergencies.
3. The audience will learn about the confidence levels of doctors when dealing with emergencies.

[402] IMPLEMENTATION OF MULTI-DISCIPLINARY MEDICAL TREATMENTS TO THE EXPLOSIVE ORDNANCE AND DISPOSAL TRAINING

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(Original Research)

INTRODUCTION: The EOD training pipeline has historically suffered from a 72% attrition rate, with the majority of eliminations occurring during the preliminary phase of their training, this has affected their ability to maintain manning. EOD students undergoing the preliminary training, now have various medical assets at their disposal, our hypothesis is that integrating these medical services will increase physical performance, decrease injuries, and improve graduation rates. **METHODS:** This interventional study is a before-after trial in order distribute knowledge on how medical assets benefit the EOD career field. The study takes place at Sheppard AFB during preliminary training of EOD students. All EOD students undergoing training at Sheppard AFB are included. Medical assets were available to all students during this intervention, whereas prior years did not have this. The intervention includes; physical therapists, EMT's, strength trainer's, mental health providers, and nutritionists who will spend time evaluating and providing care for EOD students. Main outcome is number of graduates from the EOD course during a specific fiscal year. Statistical tests include Relative Risk. **RESULTS:** Number of students who underwent training in FY2018 was 221 with 114 graduates, 51.6% graduation rate. Number of students who underwent training between FY2014-2017 was 1580 with 623 graduates, 39.4% graduation rate. Comparing exposed to control there is a RR of 0.7993 (95% CI 0.69-0.92, p=0.002). The NNT is 8.23 (95% CI 5.25-19.03). Statistical power advises on a sample size of 229 students. **DISCUSSION:** Battlefield Airman undergo strenuous physical training. The importance of having immediate access to medical assets cannot be underestimated with regards to graduating battlefield airman on time. EOD leadership decided to incorporate medical assets to improve their graduation rates and this has been successful. Students in the FY2018 intervention group have a better chance of graduating EOD preliminary training versus the FY2014-2017 control based on a RR of 0.799. Also having a NNT of 8.23 shows that many students will benefit from this ongoing intervention. The leadership on the line side understand the importance of having medical assets closely associated to their program, so continuing to foster and develop this relationship will have lasting impacts in the EOD community. Further research into injury rates and fitness results could be beneficial.

Learning Objectives:

1. Understand how EOD students undergoing initial training benefit from having medical assets at their disposal when it comes to graduation rates.
2. The EOD leadership knows the importance of having integrated medical assets and the medical community should continue to foster that relationship to improve the operational USAF.

[403] THE EFFECT OF WAREHOUSE AUTOMATION ON INJURIES TO AERIAL PORTERS

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Endorsed by: Aerospace Human Factors Association, American Society of Aerospace Medicine Specialists, and the Society of USAF Flight Surgeons

(Original Research)

INTRODUCTION: The effect of warehouse automation on musculoskeletal injury rates could inform U.S. Air Force efforts to modernize aerial ports. **METHODS:** In this retrospective cohort study, we compared ton-adjusted injury rates and average lost duty time from January 2007 to December 2016 among all Airmen (active duty, Guard, and Reserve) stationed at Dover Air Force Base, which features base-specific warehouse automation, with rates at Travis Air Force Base, Ramstein Air Base, and Yokota Air Base, which perform similar missions without automation. We also calculated the percent population risk attributable to lack of automation. **RESULTS:** Dover's aerial port handled the most cargo on average (8153 tons per year), followed by Ramstein (5408), Travis (3788), and Yokota (1218). After adjusting for population size and installation workload, injury report rates per 1000 personnel per 1000 cargo-tons per year were 1.4 (Dover), 3.2 (Travis), 3.7 (Ramstein), and 7.6 (Yokota). When compared to Dover, 56% of injuries at Travis, 62% of injuries at Ramstein, and 82% of injuries at Yokota could be attributed to a lack of Dover-like automation. However, Travis, Ramstein, and Yokota had fewer lost/affected duty days due to injury than Dover (12.4), averaging 4.5, 6.1, and 8.6, respectively, suggesting automation may prevent minor injuries but not more serious injuries. **DISCUSSION:** Comparisons of non-automated bases with Dover in this report indicate that adding automation, even at Dover's current levels, may reduce ton-adjusted injury rates by over 55%, but automation's potential impact on lost/affected duty time is less clear.

Learning Objectives:

1. Describe the impact of warehouse automation on adjusted injury rates among aerial porters.
2. Explain why adjustment of injury rates by population size and workload is necessary for direct comparison.

[404] EXERCISE REGIMEN FOR PREVENTION AND MITIGATION OF ACUTE AND CHRONIC NECK PAIN IN HIGH-PERFORMANCE AIRCREW

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(Original Research)

INTRODUCTION: High-performance aviators have a 56% annual neck pain prevalence due to g-loading, helmet/vibratory loads, and fatigue. Many astronauts are former high-performance aviators at risk for further neck pathology during training or extravehicular activity. Reduced range of motion (ROM), weakness, and fatigue of segmental neck muscles are implicated. Stretching and strengthening may prevent and mitigate injury. Portable exercise devices facilitate self-guided exercise in training and deployment. The authors herein prior reported a pilot study of short-term exercise countermeasures in F/A-18 pilots. This fleet-wide study investigates a self-directed exercise program using the NeckX™, a lightweight portable device to: (1) reduce neck pain frequency and magnitude (2) increase neck ROM, strength, and endurance in USN, USA, and USAF aviators, and (3) to translate findings to the astronaut community. **METHODS:** Seven aviators (6M, 1F) completed a 6-week program using NeckX™ (3x/week). Quantitative baseline and post-program measurements (mean, triplicate) of cervical strength (resistance), endurance (repetitions), and ROM (goniometer) were obtained. Qualitative pain frequency and magnitude weekly logs were collected. Spreadsheet was used for analysis via non-parametric testing. **RESULTS:** Mean strength increased: flexion (+50%), extension (+38%), lateral bend (+35%), and rotation (+28%). Mean endurance increased: flexion (+70%), extension (+88%), lateral bend (+84%), and rotation (+136%, $p<0.05$). Decreased pain and frequency were noted (-86% frequency and -50% magnitude, both $p<0.05$). There was decreased non-steroidal anti-inflammatory drug use. Flying while injured exacerbated symptoms. **DISCUSSION:** This collaborative study between the Department of Defense and academia is limited by the small sample size to date; but has demonstrated that a portable, self-directed cervical exercise regimen, involving NeckX™, can reduce neck pain frequency and magnitude while improving strength, endurance, and ROM in high-performance aviators. This may prevent medical disqualification and increase mission success. This study is reproducible and may potentially be translatable to astronauts, preventing neck ailments before, during, and after spaceflight. Current objectives involve increasing enrollment, including astronauts. Study strengths include fleet-wide recruitment, novelty of the portable device/regimen, and breadth of qualitative and quantitative data captured.

Learning Objective:

1. The audience will learn about common causes of neck pain in high-performance aircrew and potential ways to mitigate and prevent recurring incidences of neck pain.

[405] FOOTWEAR AND THE MANAGEMENT OF COMMON BIOMECHANICAL PROBLEMS AMONGST CABIN CREW

Margaret Grace
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(Education - Program / Process Review Proposal)

BACKGROUND: Common lower limb mechanical problems tend to exist among cabin crew populations. Many of such problems can either contribute or be the sole cause of an industrial injury resulting in long term absence or failure to perform designated duties. Management of such injuries can sometimes be complex, largely due to expectations from various individuals. In all instances a holistic approach must be taken, involving the patient themselves and, since many crew industrial injuries are lower limb related, an aviation specialist podiatrist and physiotherapist should be called upon to assist with rehabilitation. Whilst orthotic therapy is often a preferred treatment option in improving lower limb mechanics and helping to either rehabilitate or avoid injury in the first place, footwear considerations are often overlooked. Aviation podiatrists must therefore consider footwear, orthotic therapy, physical therapies and education when dealing with such issues.

Learning Objectives:

1. The participant will be able to understand the role footwear has in rehabilitation and injury prevention of cabin crew.
2. The participant will understand the importance of taking a holistic approach regarding the management and prevention of industrial injuries that are related to the lower limbs.

[406] MAGNETIC RESONANT SYNCRONIZATION OF BRAIN WAVES IMPROVES COGNITIVE AND BEHAVIORAL FUNCTION IN VETERANS WITH POSTTRAUMATIC STRESS DISORDER

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(Original Research)

INTRODUCTION: According to the National Center for PTSD [posttraumatic stress disorder], about half a million American veterans of the Iraq and Afghanistan wars have suffered PTSD and/or depression sometime in their career. Treatment options for PTSD include medication, cognitive behavioral therapy, eye movement desensitization and reprocessing, and stress inoculation therapy. Repetitive transcranial magnetic stimulation (TMS) is a noninvasive and well-tolerated modality with treatment potential for a broad range of neurological and psychiatric disorders including severe depression and migraine. Patients diagnosed with PTSD often have comorbidity such as depression and sleep disturbance. Clinic trials by others and our pilot study have produced promising results in improving symptoms of PTSD by TMS. Researchers have shown that the efficacy of the magnetic stimulation improves if the pulse frequency is guided by individual electroencephalogram. We have conducted a prospective, randomized, double-blinded, sham controlled study to investigate the effect of electroencephalogram-guided TMS therapy on veterans suffering from combat-related PTSD. **METHODS:** 13 subjects between 18-55 year of age were enrolled and completed EEG guided TMS treatment up to 8 wk. Each subject signed a 59th Medical Wing Institutional Review Board-approved consent form. Mag Venture (Model: MagPro R30) was used to deliver the magnetic stimulation. Subjects were randomly assigned to receive active or sham treatment for the first 2 wk. After that, it becomes an open label study, in which all subjects received a total of 4 wk of active treatment. The PTSD Checklist-Military Version and Cognitive and Physical Functioning Questionnaire scores were used as measurements. **RESULTS:** After 4 wk of active treatment, compared to baseline, TMS reduced the PTSD Checklist-Military Version score from 66 to 37 and from 79 to 50 in both groups, respectively. Cognitive and Physical Functioning Questionnaire scores also improved in areas of motivation, alertness, energy level, focus, recall, ability to find words, and mental acuity. **DISCUSSION:** Transcranial magnetic stimulation is a promising alternate method to help veterans suffering from PTSD. One of the advantages of TMS vs medication therapy is its lacking drug induced side effects. More importantly, this noninvasive neuromodulation may potentially improve warriors' cognitive functions and play a significant role in military readiness and beyond.

Learning Objective:

1. The participant will be able to understand that TMS is an alternate method to help veterans suffering from PTSD. Compared to medication therapy TMS lack of drug induced side effects. This noninvasive neuromodulation may potentially improve warriors' cognitive functions and play a significant role in military readiness.

[407] HITHERTO UNDIAGNOSED APPARENT CONGENITAL TRITANOPIA IN A MATURE-AGE EXPERIENCED INTERNATIONAL JET PILOT

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(Education - Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report highlights the potential problem of an experienced jet pilot flying with a profound congenital color vision defect (tritanopia). **BACKGROUND / LITERATURE REVIEW:** Color vision standards are important in aviation, particularly for safety critical tasks. While there are international standards for pilots for red/green (protan and deutan) defects, which affect 1 in 12 men and 1 in 200 women; there are few, if any, standards for the rarer blue/yellow (tritan) defects, which affect around 1 in 10,000 men and women. **CASE PRESENTATION:** Routine screening of a mature age, experienced international jet pilot revealed an apparently congenital profound tritan defect. Demographic details including flying history and molecular genetic testing results are presented, followed by the detailed workup of his defect, including Moreland equation anomaloscopy, HD-CCT (High Definition Cone Contrast Test), CAD (Color Assessment & Diagnosis) Test, and electroretinography. Detailed analysis of the case including risk assessment of the tasks involving color that are carried out by the pilot in the course of his flying duties are presented. **OPERATIONAL / CLINICAL RELEVANCE:** This case highlights the anomaly that this pilot has a profound color vision defect (tritanopia) for which there is no civilian aviation medical standard. The operational significance is further discussed, and whether there is a need for an aviation medical standard for tritan defects.

Learning Objectives:

1. The audience will learn about the incidence of congenital tritan color vision defects.
2. The audience will learn about the operational significance for civilian jet pilots of flying tasks involving blue/yellow vision.
3. The audience will be taken through a risk assessment of the safety of a congenital tritanope in carrying out the tasks of an international jet pilot.

[408] AEROSPACE PSYCHIATRY: "WHAT'S YOUR DIAGNOSIS AND POSITION?"

Amit Mistry, Charles Dukes, Chauncey Atterberry
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(Education - Case Study: Clinical / Human Performance)

BACKGROUND: Posttraumatic Stress Disorder (PTSD) is marked by increased anxiety following exposure to a traumatic event, which may include witnessing or being involved in a horrific accident, natural disaster, assault, physical/sexual abuse, or military combat. PTSD is characterized by a persistence of fear and reliving the event, avoiding trauma reminders, and having negative mood/thoughts. The physiological response is a state of hypervigilence/hyperarousal. PTSD often occurs with depression, anxiety, and substance use. The Federal Aviation Administration (FAA) requires aviators and air traffic controllers to be evaluated for medical certification. A referral for psychiatric and psychological evaluations may be part of medical certification if there is concern for a psychiatric issue and/or substance misuse. **CASE REPORT:** MH is a veteran who has served three combat tours and who, on discharge from the military, was given a diagnosis of PTSD due to his clinical symptoms at the time: nightmares, flashbacks, hypervigilance, depression, and survivor's guilt. He was treated with bupropion and trazodone, though he was noncompliant. He followed up with his psychiatrist for three years and symptoms improved without medications. During this time he pursued a career as an air traffic controller, completing training and achieving exemplary marks and performance. However, due to the past PTSD diagnosis, the FAA referral requested psychiatric and psychological evaluation to determine continued eligibility for medical certification. FAA approved aerospace psychiatrist and psychologist revealed no evidence of active PTSD symptomatology. Thorough psychiatric evaluation revealed no evidence for concern of substance misuse. Collateral information confirmed his performance as well as the clinical findings. He was recommended for reinstatement of medical certification with an updated diagnosis of adjustment disorder with mixed disturbance of conduct and emotions, resolved. **DISCUSSION:** In this case, a past misdiagnosis almost ended a successful career of an air traffic controller. Thankfully, the FAA has a system of oversight which referred him for a psychiatric and psychological examination. The role of the aerospace psychiatrist was to evaluate for aeromedically significant psychiatric and substance use disorders. This requires a comprehensive psychiatric evaluation, with extensive review of records and collateral information from family, peers, and other healthcare professionals.

Learning Objective:

1. This case presentation will illustrate the approach to aerospace psychiatric evaluations and highlight the psychiatrist's role in national aerospace industry's ongoing efforts to mitigate risks, protect public safety, and ensure the health of aviators.

[409] BIRT-HOGG-DUBÉ SYNDROME - IS IT TOO RISKY TO FLY?

Sofya Ilmer
U.S. Air Force, Tinker AFB, OK, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This case describes an aviator diagnosed with a rare genetic disease. **BACKGROUND:** Birt-Hogg-Dubé (BHD) syndrome is a rare autosomal dominant disease which is associated with patients developing cutaneous lesions such as fibromas, pulmonary cysts and pneumothorax, renal cysts and tumors. The disease has been identified in approximately 200 families worldwide. **CASE PRESENTATION:** 30M Air Surveillance technician on E-3 presented to flight medicine requesting genetic testing due to his father's recent diagnosis of BHD syndrome. His father has a history of kidney cancer, colonic polyps and facial lesions (fibrofolliculomas). Member underwent testing of the folliculin (FLCN) gene which was positive for a pathogenic variant of FLCN, consistent with a diagnosis of BHD syndrome. FLCN encodes the protein folliculin, which is a tumor suppressor. The geneticist recommended baseline evaluation including a dermatological exam, CT of the chest for visualization of pulmonary cysts and a baseline abdominal/pelvic CT scan with contrast to screen for renal tumor. Member was examined by a dermatologist with no specific dermatologic findings of BHD syndrome found. A CT Chest w/o contrast showed no evidence of cystic lung disease. However, a few micronodules were noted in the lungs, so follow-up CT was recommended to ensure stability. A CT Abdomen and pelvis with and w/o contrast showed a 3.2 cm enhancing mass in the lateral interpolar region of left kidney, concerning for renal cell carcinoma. There was no definite metastatic disease within the abdomen and pelvis. A left partial nephrectomy was performed. The pathology report was positive for renal cell carcinoma with negative margins. Repeat CT for surveillance was recommended. He was referred to GI for a colonoscopy due to the association of colon cancer and BHD syndrome. The colonoscopy showed multiple small sessile polyps that were 2 to 4 mm in size. Due to high risk of spontaneous pneumothorax and sudden incapacitation, the member was disqualified from flying status but was returned to duty via medical evaluation board. **DISCUSSION:** The member's genetic disease predisposes him to cystic formation in his lungs. Although he has no cysts currently, he does have micronodules which increase his risk of pneumothorax and sudden incapacitation. The member was ultimately disqualified from flying due to disease burden and risk of developing pneumothorax. He will require life-long surveillance for his disease.

Learning Objectives:

1. The participant will learn about diagnosis of Birt-Hogg-Dubé Syndrome and its clinical manifestations.
2. The participant will learn about disease surveillance recommendations in patients with Birt-Hogg-Dubé Syndrome.
3. The participant will learn about aeromedical considerations of Birt-Hogg-Dubé Syndrome.

[410] ASSESSING COGNITIVE FUNCTION AMONG HIV-POSITIVE AIRMEN OVER A 10-YEAR PERIOD

Valerie Skaggs[1], Ann Norris[1], Eduard Ricaurte[2], Tom Chidester[1]
[1]FAA/Civil Aerospace Medical Institute, Oklahoma City, OK, USA;
[2]Venesco, LLC, Oklahoma City, OK, USA

(Original Research)

INTRODUCTION: This project assesses the potential criteria for when neuro-cognitive testing should be required in airmen infected with HIV. Literature suggests viral load (VL) and CD4 cell count might serve as surrogate indicators of potential cognitive impairment. We assessed whether deferring cognitive testing where specific criteria are met would miss any cases where airmen were denied certification due to cognitive impairment. **METHODS:** Data were extracted from the Federal Aviation Administration (FAA) Data Information Workflow System (DIWS), which

houses all the records for airmen applying for pilot medical certification. All airmen who were assigned an HIV or AIDS pathcode and had at least one physical exam (PE) between 2007 and 2016 were reviewed for inclusion. Airmen were followed longitudinally, tracking their neuropsychological evaluations, viral loads, and CD4 cell counts. **RESULTS:** Of the 298 airmen in the study, 76% were under the age of 50, 85% had undetectable viral loads, 68% had a CD4 cell count ≥ 500, and 16% had an abnormal cognitive assessment following their HIV diagnosis. For those that had 2 or more cognitive assessments (N=198), 54% were under 50, 97% had undetectable viral loads, 83% had CD4 cell count ≥ 500, and 7% had an abnormal cognitive assessment on their most recent medical certification. Overall, 8% had a history of an AIDS defining illness, and 11% presented with HIV associated neurocognitive disorders. Statistical tests between those under 50 and those 50 and older showed significant differences between the CD4 cell counts and abnormal cognitive assessments at their baseline assessments. **DISCUSSION:** Assessed the effect of changing the AAM policy under criteria recommended by literature review, there were only 2 airmen who would have been incorrectly certificated. Our results support findings from current literature. Evidence suggests that our current criteria of cognitive assessment frequency may be too stringent for modern HIV treatment.

Learning Objectives:

1. The audience will learn about the implications of potentially changing the HIV medical certification policy for US civilian pilots.
2. The audience will be educated about the demographics of the medically certificated US pilot population that have an HIV diagnosis.

[411] INITIAL PRESENTATION OF COAT'S DISEASE IN AN F-22 PILOT: A CASE REPORT

William Van De Car
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(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This case report describes an F-22 pilot who developed a mild decrease in visual acuity who was eventually diagnosed with a rare retinal disease. **BACKGROUND:** Coat's Disease is an often unilateral, idiopathic and progressive condition characterized by telangiectatic and aneurysmal vessels with a tendency to manifest near the macula. These abnormal vessels are leaky and can result in exudation, and ultimately reduced visual acuity. This usually presents in young males less than 20 years old, however it has been observed in older individuals as well. There are no known risk factors or predisposing conditions. Treatment is aimed at reversing exudate and includes scatter laser photocoagulation or cryotherapy. **CASE PRESENTATION:** The subject was a 44-yr-old male who was referred to the optometrist for mild decrease in vision bilaterally (20/25 OD, OS). Perifoveal retinal deposits and hemorrhage were seen in his left eye upon examination and was referred to a retinal specialist. Examination again showed vascular changes and maculopathy, and a diagnosis of Coat's Disease was suspected. He was referred to the National Eye Institute and it was agreed to observe his condition as opposed to starting treatment. During his time of observation, it was noticed that his cystoid macular edema was starting to encroach upon his fovea via OCT, and his visual acuity had worsened to 20/30. At this time, it was decided the best course of action was to treat with focal laser photocoagulation, which was performed without complications. After the procedure he was having improved macular edema although not resolved (OCT showed that the edema was no longer affecting the fovea), and a return to 20/20 vision. The member had waiver submitted but was disqualified due to the progressive nature of his condition, with guidance to resubmit once edema has resolved. **DISCUSSION:** This case highlights a rare ophthalmological condition and creates a difficult challenge regarding aeromedical disposition. While treatment can provide resorption of exudate and return of good visual acuity, this condition is generally progressive. Retinal exudate and subtle vision loss can recur and is a future risk, though presentation in an older population with milder disease has a better prognosis.

Learning Objectives:

1. The audience will be able to understand the pathological changes associated with Coat's Disease.
2. The audience will be able to understand the natural progression of Coat's Disease.
3. The audience will be able to understand treatment of Coat's Disease.

[412] " HAY FEVER" TREATING TO PILOTS IN JAPAN AIR SELF-DEFENSE FORCE

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Aeromedical Laboratory, Japan Air Self Defense Force, Tokyo, Japan

(Education - Case Study: Clinical / Human Performance)

OVERVIEW: "Hay fever" caused by Japanese cedar pollen antigens has recently been interrupting flight operations in Japan Air Self-Defense Force (JASDF) due to its high prevalence and strong symptoms. While medical treatment to hay fever to common people has many options, the treatment to pilots is limited under various regulations. For example, 15 second generation antihistamines are approved by Japan Ministry of Health, however only four (fexofenadine, loratadine, desloratadine and bilastine) are approved to pilots to do flying duty under the treatment by Japanese Civil Aviation Bureau. Therefore, it is under pressure to clarify the optimal treatment and drug usage to pilots in Japan. To our knowledge, there is no report with respect to the real situation of treatment to hay fever to pilots. Therefore, using an original questionnaire, we conducted this survey to realize the real situation of JASDF pilot's drug usage and the changes in the symptom under the treatment. General staff of JASDF are registered as a reference. We will present the results at the conference.

Learning Objectives:

1. Japan Civil Aviation Bureau (JCAB) has approved fexofenadine, loratadine, desloratadine, virastine to be to do flying duty under their usage.
2. JCAB has newly approved desloratadine, bilastine to be to do flying duty under their usage oral in June 2018.
3. JCAB has newly approved desloratadine, bilastine to be to do flying duty under their usage oral in June 2018.

[413] OPTOTENSOMETRY– DEVELOPMENT OF AN OPTIC METHOD FOR MEASURING TUBAL FUNCTION IN A MIDDLE EAR MODEL

Thorsten Zehlicke
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(Original Research)

INTRODUCTION: The amount of pressure in the middle ear depends mainly on the function of the Eustachian tube. Currently there are no continuous recording techniques measuring Eustachian tube function in clinical context and under physiological conditions over extended periods of time. In this paper we investigate the suitability of an active optic triangulation method on the basis of a projected laser-point-pattern in measuring tympanic membrane movement during pressure variations in a middle ear model and a temporal bone model. **METHODS:** For projection we used a green semiconductor laser with an output of 1 mW and a diffractive optical element (DOE). As our measured object we used purple latex-foil (Kimberley-Clark®), fixed airtight on the cut-off end of a 2 ml syringe-tube. The movement of the foils was measured by an active optic triangulation method. To simulate pathological variations of the tympanic membrane we prepared the latex-foils in specific ways. One foil was perforated and then covered again (simulating tympanic membrane perforation), another one was partly strengthened by sticking a piece of thick, hard paper to it from the inside (simulating calcification). In a second step we measured tympanic membrane movements in a temporal bone model. **RESULTS:** The test-setup, as well as the appliance of pressure-changes worked fine and measurement of foil movement in all the modified foil surfaces was possible. This shows that it is possible to record foil-movement with this system even in tympanic membranes with pathological variations. Recording tympanic membrane movements in the temporal bone model need a different set up of the measuring system. **DISCUSSION:** In the course of this study we were able to show that it is possible to assess and record foil movement and tympanic membrane movements using a system of optic triangulation and to simulate different tympanic membrane pathologies. This could be used both in ENT medicine, as well as in aviation and diving medicine.

Learning Objectives:
1. The audience will learn about triangulation method.
2. The audience will learn about the movement of the tympanic membrane.
3. The audience will learn about a temporal bone model.

[414] A CONCEPT FOR THE ESTABLISHMENT OF MOLECULAR PATHOLOGY IN THE DIAGNOSIS OF DEPRESSIVE DISRORDER IN AVIATION MEDICINE

Sven Marquard[1], Oliver Peschel[2], Matthias Graw[2], Michael Schwerer[3]
[1]Bundeswehr Medical Service Headquarters, Koblenz, Germany; [2]Institute of Legal Medicine, Ludwig-Maximilians University, Munich, Germany; [3]Air Force Centre of Aerospace Medicine, Fuerstenfeldbruck, Germany

(Original Research)

INTRODUCTION: Depressive disorders are comparably rare observations in aviators. Nevertheless, diseases from this spectrum also do occur in license holders and their timely recognition is of absolute relevance for flight safety. A variable proportion of unreported cases among aviators should be assumed, when considering the effects on a pilot's career when depression should be diagnosed. **METHODS:** A literature review for novel techniques, independent from self-reporting or clinical testing for depressive symptoms was carried out. From this, a concept for laboratory-based testing was developed. **RESULTS:** Molecular methods, based on marker panels in blood samples were selected from the literature (Kim D *et al.*, doi:10.1136/ bmjopen-2015-009790; Wan Y et al, doi:10.1371/journal.pone.0121975). DNA and RNA were prepared according to standard laboratory procedures. Bisulfite conversion of DNA, with subsequent end-point PCR and pyrosequencing of the amplificates was carried out to study promotor methylation regulating disease related gene expression. In addition, SybrGreen-based real-time PCR assays were compiled to investigate microRNAs involved in post-translational regulation of disease associated genes. For a first application study, material from patients with overt depression was selected. To ensure the applicability of the findings in aircraft accident investigation, post mortal blood samples from suicide victims, both positive and negative for antidepressive medication, as was determined via toxicological analysis, were employed. Otherwise healthy subjects, who died instantly in road accidents, were selected as a control group. In addition, blood samples from healthy aircraft personnel were assessed for verification. In these initial investigations, material from altogether 40 individuals, was analyzed. In all specimens the DNA and RNA based procedures were realized successfully. **DISCUSSION:** Mood disorders are accompanied by qualitative and quantitative changes in circulating nuclear acids, which are detectable in blood samples. The concept and its initial findings on a limited number of cases presented here should provide soil for more extensive studies. The detection of previously undiagnosed mood disorder in fatalities from aircraft crashes should be possible. Furthermore and apart from clinical assessment, the diagnosis of depression from blood samples could be established as an additional diagnostic feature during routine aeromedical examinations.

Learning Objective:
1. Knowing about the possibility to establish the diagnosis of unreported depression employing newly developed molecular pathology methods.

Thursday, 05/09/2019 ***1:30 PM***
Brasilia 1

[S-77] PANEL: PREVENTION COMPREHENSIVE MEDICAL READINESS PROGRAM FOR FLIGHT SURGEONS

Chair: Douglas Files

PANEL OVERVIEW: Aerospace medicine professionals need to prevent as many threats as possible facing aircrew. Through shop visits, sanitation assessments, or travel medicine evaluations, flight surgeons and allied professionals defend aircrew from a myriad of threats. This panel will engage participants with hands-on interactive experiences addressing a military unit's deployment to South America. After participants complete a travel briefing and identify health risks of a deployment to that continent, the scenario will progress to the deployed location where water safety is in jeopardy. Participants will need to investigate the water and the working conditions for their people in the deployed setting. As the operational tempo intensifies, non-pharmacologic fatigue countermeasures may be needed for mission completion. The session format will include updated didactic material addressing preventive efforts. Attendees will engage in the deployment sequence by splitting into groups and working through each section using examples of findings on site visits. At the conclusion, attendees will enhance their ability to prevent illness and defend against various contingencies that face deployed aerospace medicine professionals.

[415] PREVENTION AND FOOD AND WATER SAFETY

Jeffrey Lawson, Douglas Files
USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Aerospace medicine professionals are often consulted on preventive medicine operations at their worksites. Performing sanitation or food/water vulnerability assessments may be required. This presentation will assist aerospace medicine professionals to maintain currency in a core flight medicine activity by participating in a prototypical virtual food/water vulnerability inspection. **OVERVIEW:** Aerospace medicine professionals take responsibility for the safety, health, and well-being of their populations. Flight medicine experts perform sanitation and food/water vulnerability assessments to ensure mission completion and flying safety. However, guidelines change and aerospace medicine professionals can lose currency. This program will update aeromedical and allied professionals on sanitation and food/water vulnerability inspection issues by participating in a virtual inspection regarding water safety cases. **DISCUSSION:** Sanitation and water vulnerability inspections are performed regularly, especially in deployed settings. Lapses can affect mission completion and flying safety. This session will allow preventive medicine personnel to review techniques on how to perform these inspections. U.S. and international professionals will gain insight into food standards and how performing these inspections might positively affect airfield safety in their own countries. Thus, professionals from all services and all countries will benefit from these water inspection cases.

Learning Objective:
1. Participants will be able to state the factors involved with conducting a water inspection in conjunction with bioenvironmental engineers.

[416] PREVENTION THROUGH WORKSITE SHOP VISITS

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

(Education - Program / Process Review Proposal)

BACKGROUND: Numerous potential hazards exist around deployed flight line worksites including chemicals, airborne hazards, ergonomic hazards, infectious agents, and injury threats. Aerospace medicine professionals often serve in an occupational medicine capacity with its traditional focus on preventive medicine. **OVERVIEW:** Many industrial hazards occur on a flight line, and investigating physical and chemical hazards can prevent illness and injury. This is particularly true in a deployed setting. Professionals in occupational medicine also cannot overlook common threats such as hygienic conditions, airborne dust, and worksite smoking. Participants in the current exercise will discuss potential hazards in aviation environments and what might be done to mitigate those hazards. **DISCUSSION:** Performing a worksite visit can link physical manifestations with environmental hazards.

Aerospace medicine professionals from multiple disciplines and countries can benefit in obtaining comprehensive medical readiness skills delivered during this session.

Learning Objective:

1. Participants will be able to conduct worksite shop visits in deployed and aviation workplaces.

[417] PREVENTION AND TRAVEL MEDICINE UPDATE

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

(Education - Program / Process Review Proposal)

BACKGROUND: Aerospace medicine professionals may be responsible for overseas airfield operations that potentially affect the safety and health of populations. Thus, military flight surgeons and allied professionals need to be prepared to deploy worldwide. This session will assist aerospace medicine professionals to maintain currency by participating in travel medicine briefings and associated administrative tasks. **OVERVIEW:** Assigned duties of flight surgeons include serving as the medical expert on travel health issues. This task is complicated by the wide variety of locations where airfield operations can occur. Medical travel guidelines also change frequently. This program will allow aeromedical professionals to discuss and participate in travel medicine briefings and administrative tasks. The sample case provided will focus on the health risks of a deployment to South America. **DISCUSSION:** Health risks to aircrew have expanded with global travel. Thus, currency in travel medicine must include regular participation in briefings and administrative tasks. While there are numerous venues for flight surgeons to work and keep abreast of immunizations and health risks, they must also learn about planning and presenting briefings on the subject. This program offers international aerospace medicine specialists an opportunity to incorporate some of the latest medical guidelines along with tips and techniques on how to present a briefing of this kind.

Learning Objectives:

1. Assist participants in developing methods and techniques required to provide travel medicine specific briefings and administrative tasks through focus on resource review and planning.
2. Provide participants with current trends and resources available to aerospace medicine experts as needed to prepare knowledge-based assessments and education in the field of travel medicine.

[418] PREVENTION AND FATIGUE COUNTERMEASURES

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

(Education - Tutorial Proposal)

BACKGROUND: Aerospace medicine professionals attempt to support maximal aviator performance. One special interest item in this field involves the use of medication. But professionals also address non-pharmaceutical countermeasures which can sustain performance in their aircrews. The current session will instruct aerospace medicine professionals in performance enhancement without medications. **OVERVIEW:** Aerospace medicine professionals study the physiologic effects and risks of flight. In order to ensure mission completion, flying safety, and individual health and well-being, flight surgeons sometimes prescribe fatigue countermeasures. This program will update flight surgeons on various non-pharmacologic countermeasures in a deployed environment in South America. **SIGNIFICANCE:** The U. S. Air Force requires annual training regarding fatigue countermeasures. Many other military services also train in how to support aircrew alertness and performance. This program will model techniques and is designed to aid all attendees participating in the session.

Learning Objective:

1. Participants will learn about non-pharmacologic fatigue countermeasures and their application to aircrew.

Thursday,05/09/2019 ***1:30 PM***
Brasilia 2

[S-78] PANEL: RESEARCH TO ADVANCE TRAINING AVIATORS FOR HYPOXIA SYMPTOM RECOGNITION & MITIGATION

Chair: Beth Atkinson

Co-Chair: Tyler Scheeler

PANEL OVERVIEW: This panel presents the results of research and lessons learned from Navy hypoxia training environments. Current Navy instruction (Department of the Navy, CNAF M-3710.7, 15 Aug 2018) outlines annual hypoxia awareness training as well as a biennial dynamic hypoxia training requirement. However, ensuring that the instructional community has an understanding of the strengths and limitations of existing training is imperative to delivering quality instruction during this life-saving training. A review of the current training environment involved data collection of observed, perceived, and physiological symptoms of hypoxia during aviator survival training. In addition to this empirical data, case study lessons learned have been captured to discuss instructional strategies and debriefing practices and potential enhancements. The first presentation describes the results of observed and self-report symptoms from an empirical study conducted within the training environment. Based on this data, a comparison will be made to symptoms reported in previous hazard reports to highlight the correspondence between what is experienced in-flight and in training, providing a general understanding of the fidelity of training. The second presentation will discuss the specifics of air hunger symptoms within training environments. While this sensation of not being able to breath is a potential symptom of hypoxia, this discussion will provide data to highlight the potential artificialities of this symptom experienced in training that may minimize the fidelity of the training. A third symptom focused discussion will provide an overview of a regression analysis focused on understanding any predictive relationships between demographic factors and experienced symptom severity, providing additional information to inform discussions during training. The fourth presentation will focus on technology enhancements that will augment the instructor-student debrief and provide additional diagnostic data for feedback. The final presentation discusses a preliminary analysis of a new more realistic hypoxia training device.

[419] A CHECK ON FIDELITY: A COMPARISON OF THE PSYCHOLOGICAL EXPERIENCE OF HYPOXIA IN-FLIGHT AND IN MASK-ON NORMABARIC TRAINING

Jacob Entinger, Mitch Tindall
NAWCTSD, Orlando, FL, USA

(Original Research)

INTRODUCTION: Recently the Navy has shifted its hypoxia awareness and mitigation training away from hypobaric chamber training toward mask-on and mask-off normabaric environments. Despite the cost savings, reductions in safety issues, and an increase in realism pertaining to tasking, there is no assurance on whether or not there has been a cost in the form of psychological fidelity. A high correspondence between what is experienced in-flight and in training is imperative to meet training goals. This investigation represents a qualitative comparison of two separate and distinct datasets. Subsequent research needs to be conducted to determine degree of difference between individual's hypoxia experiences in these two environments. As a result, this review is intended to be exploratory and a precursor to future experimental or quasi-experimental designs. **METHODS:** In the current study our team qualitatively compared two datasets regarding the physiological and psychological experience of hypoxia in-flight with mask-on normabaric training. In the training dataset symptoms were recorded by an observer (N = 109). In the live-flight dataset symptoms were reported by aviators after the flight and only when a physiological event occurred (N = 160). Specifically, we are interested in evaluating the frequencies and/or the percentages of symptoms reported in each environment. **RESULTS:** In the training environment the majority of symptoms reported and

observed were air hunger (*15.31%*), difficulty concentrating (*14.86%*), confusion (*11.93%*), dizziness (*11.83%*), and hot flashes (*7.29%*). For live-flight reports paresthesias (*37.5%*), nausea (*16.88%*), dizziness (*13.13%*), euphoria (*3.74%*), and fatigue (*3.13%*) were the majority of symptoms reported or observed. **DISCUSSION:** The comparison of these two datasets represents a preliminary qualitative evaluation of the experience of hypoxia in training versus that in live-flights. Differences in these datasets can be explained by things other than a lack of fidelity (e.g., idiosyncratic nature of hypoxia, demographic, physiological characteristics). While we are limited in the conclusions we can draw from this comparison, it still serves as an excellent starting point to future research and development efforts for advancing training.

Learning Objective:

1. Attendees should be able to tell the differences in symptoms experienced training versus those experienced in live flight.

[420] UNDERSTANDING THE CAUSES OF AIR HUNGER DURING MASK-ON HYPOXIA TRAINING

Mitchell Tindall[1], Jacob Entinger[2], Beth Atkinson[1]
[1]NAWCTSD, Orlando, FL, USA; [2]Zentex, Orlando, FL, USA

(Original Research)

INTRODUCTION: The continuous advancement of survival training pertaining to physiological events is imperative. Research has shown the Reduced Oxygen Breathing Device (ROBD) can cause air hunger in as many as 44% of trainees. It is not clear whether the experience observed in ROBD training is the result of breathing reduced O2 or something else (e.g., mask fit, unfamiliarity with mask). In the current study we hypothesize: H1: There will be significantly more reports of air hunger at O2 concentrations less than 14.5% than reports of air hunger at or above 14.5%. H2: There will be significantly more reports of air hunger by individuals with no flight experience when compared to individuals with flight experience. H3: There will be significantly more reports of air hunger by individuals with no flight experience breathing O2 concentrations < 14.5% than reports at O2 concentrations >14.3%. **METHODS:** In the current study our team observed and tracked the symptoms of Navy aviator trainees (N = 97) during their indoctrinal or refresher mask-on hypoxia training. Symptoms were recorded with a software tracking application. 90% of the sample were male, 66% of the sample reported little to no flight experience while 34% were veteran pilots. **RESULTS:** The first hypothesis was supported; there were significantly more reports of air hunger at O2 concentrations less than 14.3% ($t = 9.02$, $p = .001$, $m = .936$, $SD = .104$) than O2 ≥ 14.3% ($m = .083$, $SD = .363$). While there were significant differences in the number of reports of air hunger between experienced and non-experienced aviators ($f = 69.3$, $p = .000$), the difference was not in the hypothesized direction. Experienced aviators reported significantly more air hunger ($m = 1.5$, $SD = 1.42$) than inexperienced aviators ($m = .767$, $SD = .92$). In support of the third hypothesis there was a significant difference (t = 7.07, p = .000) between the total number of reports of air hunger for inexperienced aviators < 14.3% O2 compared to reports at or above 14.3% O2. Specifically, there are significantly more reports of air hunger below 14.3% O2 ($m = .698$, $SD = .844$) than ≥ 14.3% O2 ($m = .069$, $SD = .254$). **DISCUSSION:** These findings indicate that the mask or regulator are not causing air hunger in trainees but the ROBD itself may be the culprit. Inexperienced aviators may think the difficulty in breathing is a normal part of breathing on a mask.

Learning Objective:

1. Attendees should better understand the causes of air hunger in normabaric mask-on hypoxia training.

[421] RELATIONSHIP BETWEEN DEMOGRAPHIC AND SYMPTOM FACTORS IN HYPOXIA TRAINING

Joseph Keebler, Richard Simonson
Embry-Riddle Aeronautical University, Daytona Beach, FL, USA

(Original Research)

INTRODUCTION: It is pertinent to best understand psychological and physiological correlates of hypoxia. Current understanding of hypoxia indicates that an individual is susceptible to hypoxia at altitudes at or above 10,000 feet. However, there is a lack of research that ties demographic factors to the likelihood of a hypoxic event. Furthermore, little is known about how symptoms emerge during hypoxia as a function of individual demographic factors such as health, BMI, etc. In this presentation we will describe the results of an empirical study that utilized a sample of a variety of novice and expert pilots in hypoxia training. The intent was to investigate demographic and symptom data regarding simulated hypoxic events. **METHODS:** We collected data on 91 individuals who underwent hypoxia training. Principle Component Analyses (PCA) were utilized to best understand the underlying factor structure of the demographics of these individuals, as well as symptom severity. Following, we aimed to conduct regression analyses to understand if specific demographic factors predicted specific symptom severity factors. **RESULTS:** The PCA resulted in 9 factors for the symptom variables and 4 factors for the demographic variables, for a total of 13 factors. We then conducted regressions utilizing the 4 demographic factors as predictors on each of the 9 symptom factors. The 4 demographic factors were experience (flight hours and previous number of hypoxia trainings), mental health (anxiety levels, stress levels, and BMI), physical health (BMI, diet concern, hours of sleep, and amount of exercise), and drug use (amount of alcohol consumed in the past 24 hours, amount of caffeine consumed in the past 24 hours, and BMI). For brevity, we will only be reporting the factors that were significant in the regression models. Factor 1 (belligerence and twitching) is predicted by mental health, physical health, and drug use $R^2 = .204$, $p = .001$, factor 2 (cyanosis, dizziness, hot flashes, and nausea) is predicted by mental health, physical health, and drug use $R^2 = .184$, $p = .002$, and factor 3 (apprehension and blurred vision) is predicted by drug use and experience $R^2 = .207$, $p < .000$. **DISCUSSION:** These results contribute to establishing a baseline foundation for future research to best understand predictive correlates of various symptoms of hypoxia. Our results indicate that indeed some individual difference variables can predict specific symptoms with some level of certainty.

Learning Objectives:

1. High level overview of factor analysis and regression techniques, and how they can be applied in this setting.
2. How hypoxia can be studied in an aviation training environment.

[422] TECHNOLOGY ENHANCEMENTS TO INCREASE DIAGNOSTIC FEEDBACK ON HYPOXIA EXPERIENCES

Christopher Gilg
U.S. Navy, Pensacola, FL, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: Due to the continued visibility and potential catastrophic outcomes of hypoxic episodes, aircrew awareness training is an essential part of the mitigation plan. The training goal is to recognize psychological and physiological symptoms at the onset of hypoxia, to enable self-treatment before they are no longer capable. Students fly a flight simulator, while executing cognitive and motor skill tasks 1 on 1 with the observing instructor. During the debrief, the instructor queries what the student experienced and then provides an assessment of signs exhibited. Effectiveness hinges on the instructor's ability to provide diagnostic performance feedback, however they are limited by their ability to recall observations and symptoms verbalized by the student. **BACKGROUND:** Given the dynamic nature of hypoxia training requiring interaction with students and observation of physiological signs, instructors' workload can be reasonably high, impacting performance assessments. Factors that affect instructors' assessments in high workload settings include: rapid task saturation, memory decay, multitasking, and task switching. Each of these factors affect their ability to identify or recall performance and can result in inaccurate assessments or biases due to high memory demands. **CASE PRESENTATION:** While the current debrief state is sufficient, there are critical areas for improvement and enhancement via available technology upgrades, increasing the fidelity and impact of post exposure feedback. Specifically, inclusion of audio and video recording for replay, as well as post event visualizations to display performance characteristics reinforcing aspects critical to the training. Previous research suggests that training effectiveness improves by 10-20% through diagnostic feedback incorporation. This presentation will highlight proposed methods for incorporation of a multi-sensory based

debrief and the expected benefits. **DISCUSSION:** Providing aircrew with a more robust debrief will reinforce the recalled experiences and highlight aspects of the training that may not be recalled due to cognitive deficiencies associated with hypoxia. As a result, aircrew should be better able to identify their symptoms if and when they are experienced in an operational setting. This serves to advance hypoxia training by providing guidance for standard debrief practices that will advance performance through increased ability to recognize and mitigate hypoxia symptoms.

Learning Objectives:

1. Describe the current naval hypoxia training environment.
2. State the possible factors which could impact instructor feedback.
3. List the hypoxia training debrief limitations, and ways to overcome them.

[423] PRELIMINARY ANALYSIS OF A PRESSURE ON DEMAND HYPOXIA TRAINING DEVICE FOR AVIATION SURVIVAL TRAINING

Beth Atkinson[1], Jonathan Reeh[2], John Zbranek[2], Ashwin Balasubramanian[2], Janet Marnane[3], Daniel Immeker[4], David McEttrick[5], Tyler Scheeler[6], James Netherland[2], Seth Berry[2]
[1]Naval Air Warfare Center Training Systems Division, Orlando, FL, USA; [2]Lynntech Inc., College Station, TX, USA; [3]Embry-Riddle Aeronautical University, Daytona Beach, FL, USA; [4]Naval Air Training (CNATRA), Corpus Christi, TX, USA; [5]Marine Corps Systems Command, Quantico, VA, USA; [6]Aviation Survival Training Center, Pensacola, FL, USA

(Original Research)

INTRODUCTION: Normobaric Hypoxia Training (NHT) has been adopted by the Navy as a means for meeting annual, biennial and unit annual training requirements due to the effectiveness of increasing awareness through exposure. However, research has indicated some limitations with up to 44% of students experiencing air hunger when using a constant flow system. As part of on-going efforts to overcome this with positive pressure-on-demand airflow, data was collected from participants to evaluate the On Demand Hypoxia Trainer (ODHT). **METHODS:** Researchers provided participants with an overview of hypoxia symptoms, which mirror material presented to U.S. Navy students at Aviation Survival Training Centers. During the study, participants interacted with a flight simulator and completed both a slow onset and rapid onset hypoxia training profile. During the training profiles, participant blood oxygen saturation levels (SpO2) were monitored by researchers, and were queried throughout the profile on the experience of symptoms. **RESULTS:** All participants (n = 20) experienced symptoms similar to those they had experienced in other hypoxia training environments. Most common symptoms experienced were difficulty concentrating, dizziness, tingling, and fatigue. Investigation of SpO2 and heart rate data indicate expected profiles with SpO2 dropping as altitude increases and heart rate increasing. While air hunger was reported by participants, a review of the reported breathing symptoms when compared to flow rate and pressure data indicate that only ~18% of the tests conducted resulted in participants experiencing air hunger; this finding is a significant reduction when compared to the studies conducted with alternative NHT devices. Analysis of average flow rates indicate that participants required a range of average flow rates between 15 and 35 standard liters per minute. **DISCUSSION:** RESULTS observed during this study were in line with expectations. Findings suggest that individuals' subjective experiences of hypoxia with the ODHT are similar to those with chamber and NHT training devices. The results of this study continue to support a reduction in symptoms of air hunger at altitudes that would not be indicative of hypoxia experiences. While some air hunger reports appear to remain due to individuals exceeding average flow rates of this prototype device, the final redesign of the system prior to production should eliminate this issue based on data collected to date.

Learning Objective:

1. The audience will learn about the benefits of a pressure on demand hypoxia training symptom compared to other Normobaric Hypoxia Training devices.

Thursday, 05/09/2019 ***1:30 PM***
Brasilia 3

[S-79] PANEL: PROCESSES TO MANAGE ETHICAL CHALLENGES IN AEROSPACE MEDICINE

Chair: Jeff Jones

[424] PROCESSES TO MANAGE ETHICAL CHALLENGES IN AEROSPACE MEDICINE- A PANEL REVIEW AND DISCUSSION

Jeffrey Jones[1], B.K. Bohnker[2], G.W. McCarthy[3], P. Illig[4], Nora Johnson[5], E.M. Ricaurte[6], K. Ruskin[7], A.J. Parmet[8]
[1]Baylor College of Medicine, Houston, TX, USA; [2]COMBI, Clear Water, FL, USA; [3]AvMedSafe, Portland, OR, USA; [4]Aviation Medical Service of Alaska, Anchorage, AK, USA; [5]USAFR, Retired, Austin, TX, USA; [6]Venesco, LLC, FAA Civil Aerospace Medical Institute, Oklahoma City, OK, USA; [7]Anesthesia and Critical Care, University of Chicago, Chicago, IL, USA; [8]Aviation Safety & Security, University of Southern California, Kansas City, MO, USA

(Education - Program / Process Review Proposal)

BACKGROUND: The flight surgeon, aviation medical examiner and affiliated aerospace medicine providers may face cases of ethical consideration, which challenge their integrity and diplomatic skills. It is important for practitioners of aerospace medicine to be prepared to handle such cases in a compassionate and appropriate manner, while maintaining the highest ethical standards of the Aerospace Medical Association and other governing bodies. **OVERVIEW:** The process for management of ethical conundrums in aviation and space medicine must not only draw upon the knowledge of ethical principles espoused by professional organizations, but also employ diplomacy, compassion, and powers of negotiation to effectively defuse these case scenarios. There is an expectation that aerospace medicine practitioners maintain the highest ethical standards of the Aerospace Medical Association and other governing bodies, such as the American Medical Association and federal, state local, as well as international bodies which oversee / govern aerospace medical practice and personnel. Defining the process for recognition and management of ethical conflict or consideration is an important element to preventing short- and long-term sequelae. **DISCUSSION:** This panel will review case studies which pose potential ethical challenges to the practitioner and discuss the thought processes and action pathways which may be employed by the aerospace medicine provider, as well as those of the airman/ pilot, to improve the process of management. After participation, the attendee of the session should be better able to understand the impact of various actions associated with many ethical challenges and feel better prepared to handle ethical concerns which may arise in their practice.

Learning Objectives:

1. To learn of a process-based approach to ethical challenges.
2. To develop possible strategies to implore when ethical dilemmas present themselves.
3. To assess the impact of ethical stressors on the practitioner's relationship with airman and governing organizations.

Thursday, 05/09/2019 ***1:30 PM***
Brasilia 4

[S-80] PANEL: AEROMEDICAL RISK ANALYSIS PRACTICE UPDATES – PART 1

Sponsored by The American Society of Aerospace Medicine Specialists

Chair: Dan Van Syoc

Co-Chairs: Edgar Rodriguez, Richard Allnutt

PANEL OVERVIEW: During this panel, aeromedical clinical experts and Aerospace Medicine residents will present risk analysis-based clinical updates on topics related to the assessment and treatment of aviators

and special operational duty personnel suffering from specified medical conditions of aeromedical interest. Presentations will include recommendations for treatment and discussions of the aeromedical implications of the specified disease conditions.

[425] WHAT YOU NEED TO KNOW ABOUT SOMATIC SYMPTOM DISORDERS IN U.S. AIR FORCE AVIATORS

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

(Education - Tutorial Proposal)

INTRODUCTION: Among the most frustrating, difficult to understand, and difficult to treat mental disorders, somatic symptom disorders (SSDs) are relatively common and often overlooked. It is important for flight surgeons and others to consider them and to understand the aeromedical waiver possibilities. **TOPIC:** The stigma against individuals with somatic symptoms disorders is significant in part because it can be difficult for the professional healthcare worker to appreciate the validity of a person's suffering in the absence of reasonable medical explanation and due to the professional's sense of helplessness. Despite the prevalence in the general population of approximately 5 to 7%, it is relatively unusual for aviators to recover and seek a waiver with evaluation at the U.S. Air Force's (USAF) Aeromedical Consultation Service. In the past 5 yr, only two individuals have received a waiver recommendation, and each case required significant accommodation from flight medicine and leadership. The personality trait of neuroticism has been hypothesized as a major correlate with the development of SSDs, and its relatively low prevalence among aviators could be protective. Also, many demographic features associated with SSDs are less representative of USAF aviators and this may also be protective in this population. Most clinicians will be familiar with older classifications and nomenclature and less familiar with updated diagnostic guidelines and nomenclature. Designed to improve reliability as well as sensitivity, disorders have been redefined and mental health clinicians have moved away from somatization disorder and hypochondriasis. Data from the Aeromedical Information and Waiver Tracking System will be discussed as will a review of the diagnostic criteria and treatment options for this newly defined class of disorders. **APPLICATIONS:** Appropriate identification and treatment of somatic symptom and related disorders are crucial in reducing distress and suffering, but also for preserving an aviator's career. Understanding of this topic is useful for the military flight surgeon, as USAF experiences will guide the discussion, but the information is also generalizable to commercial and general aeromedical practitioners. **RESOURCES:** American Psychiatric Association. Diagnostic and statistical manual of mental disorders, 5th ed. Washington (DC): American Psychiatric Association; 2013.

Learning Objective:

1. The participant will be familiar with the new classification of somatic symptom disorders and be able to explain the rationale of the changes.

[426] SOMATIC SYMPTOM AND RELATED DISORDERS – PART 2

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

(Education - Tutorial Proposal)

INTRODUCTION: Somatic symptom disorders including, but not limited to, illness anxiety disorder or conversion disorder are disqualifying for all classes of flying in the U.S. Air Force. Therefore, they have a significant impact on individual and mission readiness. Somatic symptom disorders including, but not limited to, illness anxiety disorder or conversion disorder are disqualifying for all classes of flying in the U.S. Air Force. Therefore, they have a significant impact on individual and mission readiness. **TOPIC:** Consideration for a waiver for those with somatic symptom and related disorders will only be entertained if the aviator is successfully treated and remains off all psychotropic medication for 12 months. Factitious disorders are disqualifying for all flying classes to include retention on active duty; however, for retention, factitious disorders are handled administratively as unsuiting conditions in accordance with Department of Defense Instruction 1332.38 E5.1.3.9.7. Malingering is not considered a mental illness. In the *Diagnostic and Statistical Manual of Mental Disorders,* Fifth Edition, malingering receives a V-code as one of several presenting problems that may become a focus of clinical attention or that may exacerbate or otherwise affect the diagnosis, course, prognosis, or treatment of a patient's mental disorder. As such, it, too, is considered unsuiting rather than unfitting for continued military service, and any patient exhibiting such behavior should be referred to the chain of command. As specified in Article 115 of the Uniform Code of Military Justice, any person who for the purpose of avoiding work, duty, or service feigns illness, physical disablement, mental lapse, or derangement, or intentionally inflicts self-injury, shall be punished as a court-martial may direct. Thus, before submitting a case for waiver consideration, the base-level flight surgeon must first discern whether the condition is unsuiting vs. unfitting for service. If the airman requires a fit/unfit determination, the case needs Medical Evaluation Board action; if the airman requires a suited/unsuited determination, the case needs consideration of an administrative separation or discharge via the chain of command. **APPLICATION:** This presentation will simplify the flight surgeon's job by elucidating these concepts and describe effective management strategies for somatic symptom and related disorders.

Learning Objective:

1. This presentation will simplify the flight surgeon's job by elucidating and describing effective management strategies for somatic symptom and related disorders.

[427] MIGRAINE

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

(Education - Case Study: Clinical / Human Performance)

Migraine is disqualifying for aviation duties, but with appropriate management, many aviators with migraine are able to be returned to flight duties. Aeromedical concerns with migraine include impact on operational safety from the migraine attack itself, medication effects, and risk of recurrence. Aeromedical disposition of migraine is based on attack severity, frequency, absence or presence of associated symptoms such as aura or neurologic deficits, and effects of treatments used for management. The diagnosis, evaluation, treatment options, and aeromedical disposition of migraine will be discussed in this presentation.

Learning Objectives:

1. List the major aeromedical concerns of migraine.
2. State the International Headache Society criteria for migraine with and without aura, and for migraine aura without headache.
3. List factors that favor a return to fly recommendation for aviators with migraine.

[428] MOTION SICKNESS IN THE AVIATOR: AN AEROMEDICAL UPDATE

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

(Education - Program / Process Review Proposal)

BACKGROUND: Motion sickness in the aviator population can occur as a "normal" response to unusual and unfamiliar motion, resulting in aeromedically significant sequelae ranging from distraction and decreased situational awareness to incapacitation. The author will present an overview of this topic, as well as an update regarding treatment modalities, to include non-pharmacologic and pharmacologic therapies. **OVERVIEW:** Motion sickness can occur in response to actual motion (e.g., traveling in an automobile or via boat) or apparent motion (e.g., during simulator training). Motion sickness is thought to occur in response to conflicting inputs to the brain from visual, vestibular, and/or proprioceptive systems. Signs and symptoms typically progress from stomach "awareness" to cold sweats, dizziness, nausea/vomiting, and lethargy, with associated decrease in situational awareness and potentially incapacitation. Motion sickness incidence peaks at age 12 yrs old, and declines with age. Susceptibility to motion sickness is variable, but most individuals adapt with repeated exposures to the inciting environment. The treating provider should conduct a thorough history of the affected flyer's motion sickness symptoms and physical examination to rule out organic pathology prior to referring the patient to a formal airsickness management program. Prevention education and early intervention through the USAF and USN Airsickness Management

Programs (AMP) have proved effective in helping pilot and navigator trainees to overcome airsickness. Several medication classes have been shown to aid in the prevention and/or treatment of motion sickness. The anticholinergic medication scopolamine is considered the single most effective medication for the prevention of motion sickness and has been used in combination with the sympathomimetic dextroamphetamine sulfate to counteract the performance decrements associated with using scopolamine alone. However, the potential for degradation of situational awareness and performance limits the role of pharmacologic intervention in military aircrew. **DISCUSSION:** Motion sickness in the aviator can have a range of potentially harmful effects, from distraction and loss of situational awareness to incapacitation. It behooves the flight surgeon to understand both the non-pharmacologic and pharmacologic management options currently approved and available.

Learning Objectives:

1. The participant will be able to identify the aeromedical implications of motion sickness in the aviator.
2. The participant will learn about current airsickness management options, both non-pharmacologic and pharmacologic, for the prevention and mitigation of motion sickness.

Thursday, 05/09/2019 ***1:30 PM***

Brasilia 7

[S-81] PANEL: THE IMPACT OF TRANSLATION SCIENCE ON BUILDING NEW MULTIDISCIPLINARY FIELDS IN RESEARCH – PANEL II

Chair: Ilaria CINELLI

Co-Chairs: Marian B. Sides, Smith L. Johnston

PANEL OVERVIEW: The Bellagio II Summit sought to identify the major advances in aerospace medicine that can be translated and applied to the field of terrestrial medicine. The preservation of the human health in outer space could be seen as detached from terrestrial medicine as it focuses on the needs of the astronaut population only, a small population with high physical and mental performance. However, the findings of aerospace medicine are applicable to terrestrial populations through translation science. Translation is based on an exchange of knowledge and technology between scientific fields for improving current clinical care, during which scientists try to answer opened questions by looking at the same phenomenon in a different domain. From this multidisciplinary interaction, new research fields result as the most appropriate way to filling in gaps of on-going research. Looking at aerospace and terrestrial medicine, this panel will present four examples of new research fields born within space medicine with high potential of having remarkable terrestrial applications. These fields are identified in alignment with the objectives of the Bellagio II Summit. First, microbial behavior and virulence is shown to be altered in space and in analogue space environment on Earth. Interest is in translation of altered microbial virulence into the development of vaccines and antibiotics and other Terrestrial applications. Second, advances in the use of human stem cells, tissue-engineering, and organ-on-chip technologies allow to replicate complex in vivo tissue systems in vitro. These miniaturized constructs are ideal for high throughput drug screening and can significantly improve the treatment of both ground- and space-based medical problems. Third, successes and failures associated with translation and implementation of NASA protocols for operational military unit psychological screening, treatment, and educational support are discussed based on a 2-year period of evidence. Organizational culture influences the operational effectiveness of implementing translation of NASA protocols. In the end, looking at commercial space-flight, there is a need to establish a Commercial Space Travel Medical Training Program and Certification for screening tourists regarding medical risks. A detailed risk assessment analysis is carried for anticipating psychological/physiological events during space travel, covering pre- to post-flights implications.

[429] TRANSLATION OF SPACEFLIGHT RESEARCH ON MICROBIAL BEHAVIOR AND VIRULENCE TO HEALTH AND INDUSTRY

Laurel Kaye
Yale School of Medicine, Oxford, United Kingdom

(Education - Program / Process Review Proposal)

PROBLEM STATEMENT: The Bellagio II Space Medicine Summit identified multiple studies that have shown changes in microbe behavior and virulence in spaceflight and in terrestrial analogue settings. Such findings have multidisciplinary terrestrial implications for infection control and vaccine development. **TOPIC:** Several studies report changes in spaceflight-associated changes in virulence of common pathogenic microbes. Microgravity-induced changes in certain pathogens include increases in growth rate and higher cell densities, increased membrane integrity, differential secondary metabolite production, elevated transfer rates of genetic material between cells, and increased biofilm formation. Changes in virulence associated gene expression can be observed in *Salmonella enterica, Escherichia coli*, and *Pseudomonas aeruginosa*. Further, studies into antibiotic resistance have shown high rates of mutation in spaceflight in resistance genes in *Staphylococcus epidermidis* and *Salmonella enterica*. Additional reports show reactivation of latent herpes virus as well as subclinical activation of cytomegalovirus, Epstein-Barr virus, and varicella zoster virus secondary to spaceflight. Such increased microbial virulence can potentially pose a serious risk to missions. **APPLICATIONS:** Microbial monitoring and vessel disinfection are significant factors to be taken into consideration in habitat design, engineering, and operation of all spacecraft and such measures can be translated for the management of infections in hospitals, nursing homes, military barracks, prisons and similar confined environments where infection control proves difficult and critical. Changes in virulence induced by the space environment offer molecular targets for the development of vaccines and antibiotics that can be greatly beneficial to terrestrial medicine. Against this background, new avenues of research are emerging from multidisciplinary perspectives, including genetics, pharmacology, engineering, and architectural habitat design industries. **RESOURCES:** Ott CM, et al. Evidence Report: Risk of Adverse Health Effects Due to Host-Microorganism Interactions. Human Health Countermeasures (HHC) Element. 2017. Taylor PW. Impact of Spaceflight on Bacterial virulence and antibiotic susceptibility. Infect Drug Resist. 2015; 8: 249-262.

Learning Objectives:

1. Be able to describe spaceflight associated changes in virulence of common pathogens and their significance to vaccine and antibiotic development.
2. Describe the potential for translation of countermeasures in containing infectious agents in spaceflight for use in terrestrial settings.

[430] SPACE AND TERRESTRIAL BIOMEDICAL APPLICATIONS OF RECENT ADVANCES IN STEM CELL, TISSUE-ENGINEERING, AND MICROPHYSIOLOGICAL SYSTEMS RESEARCH

Peter Lee
The Ohio State University, Columbus, OH, USA

(Original Research)

INTRODUCTION: Advances in medicine rely greatly on the ability to carry out experimental research. Practical, financial, and ethical limitations of human and animal research significantly impact their more widespread use. *In vitro* studies often do not adequately represent 3D *in vivo* tissues and organs. Recent advances in the use of human induced pluripotent stem cells (hiPSC), tissue-engineering (TE), and microphysiological systems (MPS) technologies are revolutionizing our ability to replicate complex *in vivo* tissue systems *in vitro*, enabling physiologically relevant, high-throughput, and cost-effective studies. These technologies allow for a more rapid translation of basic research to clinical applications. **METHODS:** A thorough review of the academic literature was carried out to ascertain the current status of research in hiPSC, TE, and MPS technologies as they relate to their application for research in space and the potential impact of this research on terrestrial medicine. **RESULTS:** Biomedical space research is notoriously difficult and expensive to carry out due to the practical limitations of access to space. Therefore, new research technologies that allow researchers to carry out *in vitro* experiments using models that are more physiologically

relevant can have significant implications for spaceflight research. And because many of the physiological changes seen in spaceflight are similar to an accelerated form of aging, lessons learned from spaceflight experiments may inform terrestrial researchers as well. Additionally, the engineering requirements for spaceflight hardware has also led to the development of sophisticated, miniaturized, and automated hardware systems that can also significantly benefit researchers on Earth. Advances in the use of hiPSCs allow for the development of human tissue-based models. 3D tissue-engineered constructs better mimic *in vivo* tissues than their monolayer counterparts. These miniaturized constructs are ideal for high throughput drug screening and can significantly improve the treatment of both ground- and space-based medical problems. **DISCUSSION:** The rapid progress of research in hiPSC, TE, and MPS technologies has enabled the development of more sophisticated high fidelity *in vitro* model systems and has now penetrated the spaceflight research realm. There is much excitement in these new areas of research that have the potential to lead to future medical treatments both in space and on Earth.
Learning Objectives:
1. To provide an update on recent advances in hiPSC, tissue-engineering, and microphysiological systems technologies.
2. To provide an overview of the applications of hiPSC, tissue-engineering, and microphysiological systems research to the spaceflight environment and how they relate to treatment of medical problems on Earth.

[431] TRANSLATIONAL OF NASA BEHAVIORAL HEALTH AND ORGANIZATIONAL CULTURE IMPROVEMENT PROTOCOLS IN AN OPERATIONAL MILITARY UNIT: THE SUCCESSES AND FAILURES

D. Schuettler, K. Klingenberger
Williamsburg, VA, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Translational medicine practices may be key in maintaining readiness and mission outcomes in highly specialized operational military units. However, organizational culture and mission requirements can create significant barriers and actively work against the application and implementation of performance enhancement protocols, even in the most at-risk populations. The necessity of matching translational medicine with unit readiness for change is a complex and difficult task, and key to the survival of medical support efforts. **OVERVIEW:** Highly specialized operational military units support no fail, high tempo missions with unpredictable agendas/itineraries. Attrition from these units is extremely detrimental due to lengthy and expensive security clearance and training procedures. This presentation summarizes a 2-year period of evidence-based efforts made towards the improvement of psychological screening, treatment, and educational support of operational military members. NASA behavioral health and organizational culture improvement protocols were utilized as primary resources and models of intervention. Psychological assessment, countermeasures, and education were applied in an effort to enhance human performance optimization. Application of these efforts required complimentary participation and collaboration of both personal and organizational level behavior, ability to gather and analyze data on newly implemented approaches to improve readiness, and a reliable collective effort from all unit members. Success and failures of these dynamic efforts are discussed, with particular emphasis on the applicable organizational culture elements that moderated and mediated the effectiveness of these efforts to improve overall unit readiness and resilience. **DISCUSSION:** Organizational culture plays a large role in the effectiveness of implementing translational medicine strategies. For this operational military unit, successful implementation of translational medicine efforts hinged on the utilization of timely unit feedback, the collected efforts among like-minded individuals across the agency, the flexible and expedient delivery of tailored interventions, the match of the delivery style with individual and unit readiness of change, and the maintenance of motivation for change once motivation is achieved.
Learning Objectives:
1. Describe successes and failures associated with translation and implementation of NASA protocols for operational military unit psychological screening, treatment, and educational support.
2. Understand applicable organizational culture elements that impact and/or influence translation of NASA protocols for use with operational military units.
3. Understanding the importance of high operational effectiveness in military units.

[432] CERTIFICATION OF NURSES AND MID-LEVEL PROVIDERS TO SUPPORT SPACE TOURISM AND COMMERCIAL SPACE OPERATIONS

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(Original Research)

PROBLEM STATEMENT: Commercial space flight, including tourism, is in the initial stages of development and marketing to the public. Space tourism success will depend upon travelers' positive space experience. Positive travel experiences begin with appropriate medical screening, risk stratification and risk mitigation of commercial passengers. Though regulations regarding commercial space travel are evolving, one gap to be addressed is certification of properly trained medical professionals to screen tourists regarding risks: - FAA 14 CFR Part 460, Subpart B. § 460.45 does not address medical issues: "An operator must inform each space flight participant in writing about the risk of the launch and reentry, including the safety record of the launch or reentry vehicle type." However, the literature indicates "Space doctors are finding that the most significant barrier to flying ordinary people may not be their physical ailments but something that is much less understood: anxiety." **TOPIC:** Key to space tourism will be risk assessments by trained providers (e.g., converging indicators for assessing individual differences in adaptation to extreme environments) with individualized mitigation of anticipated psychological/physiological events during space travel. A space travel case management team would be comprised of registered nurses, a mid-level medical provider (Advance Practice Nurse/Physician Assistant) and a clinical psychologist knowledgeable of a traveler's medical/psychological condition to: 1. Review medical records and quantify initial assessments. 2. Coordinate evaluations to evaluate psychological and physical risk stratification. 3. Provide coaching for the evaluation experience (example: centrifuge) and flight experience. 4. Monitor for changes in medical/psychological status prior to flight. 5. Follow up medically and psychologically post flight. **APPLICATIONS:** The proposal is that a Commercial Space Travel Medical Training Program and Certification be developed and offered by AsMA at the Annual Scientific Meeting to train registered nurses and mid-level providers to the appropriate level of operational medical knowledge regarding the exposures and risks of commercial space operations and travel. **RESOURCES:** NASA Database and Center of Excellence Commercial Space Travel.
Learning Objectives:
1. Understand the need for multidisciplinary commercial space travel case management teams.
2. Describe proposed commercial space travel case management of commercial space tourists.
3. Understanding the needs of different medical certification for commercial astronauts.

Thursday, 05/09/2019 ***1:30 PM***

Miranda 5/7

[S-82] SLIDE: CELLS IN SPACE

Chair: Jeff Myers

Co-Chair: Andrew Mergl

1:30 PM

[433] GERMROVER: A NOVEL UVC DRONE FOR SPACECRAFT INTERIOR DISINFECTION

M. Kreitenberg[1], Arthur Kreitenberg[2]
[1]Industry, Los Alamitos, California, USA; [2]University of California Irvine, Los Angeles, CA, USA

(Education - Tutorial Proposal)

INTRODUCTION: Routine disinfection of human occupied spacecraft interiors is currently performed by crewmembers using disinfectant wipes. This method suffers several disadvantages including

marginal effectiveness, chemical toxicity, launch and return of wipes. Crewmembers may spend up to 4 very expensive hours per week in an arduous and dreaded task. A novel yet viable method and device are described using a unique integration of evolving technologies. **TOPIC:** The "GermRover" is a NASA TRL4+ smaller than shoe box sized device with strategically located LED arrays emitting germicidal Ultraviolet "C" (254nm) light. Sensors determine the position, orientation and velocity of the platform. An on-board microprocessor activates propellers to control these parameters and LED powering. Disinfection time estimate is 1 hour per module, and performed during crew sleep time. Disinfection pattern may be predetermined and module specific or random, similar to a home floor cleaning robot. A docking station recharges the onboard battery. Earth-based drones require the vast majority of their stored energy to remain aloft. Drones in a microgravity environment are freed of battery weight constraints and can use the energy for the payload, in this case powering the UVC-LEDs. Spaceflight certified LEDs are already on orbit. The GermRover may also be used in a hand-held mode for specific surface disinfection, including food prior to consumption. This technology was a 2018 NASA iTech innovation award winner. **APPLICATION:** The International Space Station has an immediate need for an effective, chemical-free, disposables-free, crew independent, consistent and reliable method for interior disinfection. The GermRover meets these criteria. A prototype will be part of the presentation. Beyond ISS, planned human-occupied spacecraft for LEO and interplanetary will predictably require such disinfection technologies. **RESOURCES:** Mermel, LA, Infection prevention and control during prolonged human space travel, Clin Infect Dis. 2013 Jan;56(1):123-30. doi: 10.1093/cid/cis861. Epub 2012 Oct 9.

Learning Objectives:

1. The participant will be able to describe the problem of germs on human occupied spacecraft and current disinfection methods.
2. The participant will be able to describe an evolving technology and novel approach to disinfection of human occupied spacecraft.

1:45 PM
[434] SPACE MEDICINE AND GENOMICS: CONSIDERATIONS FOR FUTURE EXPLORATION

Christopher Haas[1], Anna Fogtman[2], Virginia Wotring[3], Edward Powers[1]

[1]University of Texas Medical Branch, Galveston, TX, USA; [2]European Space Agency and European Astronaut Centre, Cologne, Germany; [3]Baylor College of Medicine, Center for Space Medicine, Houston, TX, USA

(Education - Program / Process Review Proposal)

BACKGROUND: To date, genomics has not been studied at great lengths in human spaceflight research. The field of genomics and more broadly omics has been advancing rapidly both in terms of technologies and bioinformatics opening new research pathways that should be considered within the space medicine field. Organizations worldwide such as the NIH Precision Medicine Initiative and the UK's Biobank programs are collecting large libraries of genetic and environmental exposure data and biological samples across millions of individuals. These studies follow a structured approach to collecting physiological and molecular data so that near-term and future discoveries can be made across programs on the drivers of disease and their potential cures. **OVERVIEW:** In considering future challenges of human spaceflight beyond low earth orbit, international space agencies should consider implementing compatible voluntary genomic surveillance programs for astronauts, to support health risk assessments for deep space missions. In line with current NASA policy, data sets should be created with the understanding that no astronaut should be selected to the corps or for a mission based on genetic data. In fact, every individual has inherited genetic variants and additional genetic variants arise *de novo* or as the result of environmental exposures over an individual's lifetime. The mere existence of a genetic variant is not necessarily predictive of future disease. However, there is considerable benefit to be gained from identifying genetic variants in the astronaut population. **DISCUSSION:** Genetic information such as whole genome sequences or epigenetic data can further our understanding on how individuals respond and adapt to the space environment. For example, in space flight-associated neuro-ocular syndrome (SANS), astronaut genetic variant data may help us understand why some astronauts are affected more than others. The information obtained from genetic studies can be used to tailor countermeasures and medications for future missions, as well as individual mission scenarios. Furthermore, clinicians' toolkits are expanding and becoming increasingly individualized with the continued evolution of precision medicine. Similarly, an astronaut's genomic profile could be used to minimize the risk of developing disease throughout an astronaut's lifetime by helping guide medical care of the astronaut both on the ground and during spaceflight.

Learning Objective:

1. Understand the potential benefits and limitations of an astronaut genomic surveillance program based on current terrestrial programs and standards.

2:00 PM
[435] NANOPORE GENETIC SEQUENCING FOR HUMAN SPACEFLIGHT: CURRENT UNDERSTANDING AND POTENTIAL APPLICATIONS

Tim Donahoe[1,2], Alexa McIntyre[2], Charles Chiu[3], Christopher Mason[2]

[1]National Institutes of Health, New York, NY, USA; [2]Weill Cornell Medicine, New York, NY, USA; [3]University of California, San Francisco School of Medicine, San Francisco, CA, USA

(Education - Tutorial Proposal)

INTRODUCTION: Nanopore technology has led to the development of small, lightweight, and portable devices for the study of DNA and RNA. A thorough understanding of how this method opens new avenues for research and health monitoring can guide development of next-generation spaceflight systems. **TOPIC:** Most modern genetic sequencers are too heavy and bulky for spaceflight applications and require complex procedures for genomic library preparation. Although the development of next-generation sequencing techniques has greatly accelerated sequencing speed and accuracy since 2005, miniaturization has not been a priority for most devices. These limitations have hindered their use in austere environments including the International Space Station. Nanopore sequencing is the only available technology that has overcome the major impediments to in-flight sequencing. After applying a voltage across a synthetic polymer membrane containing organic pores, the sequence is determined by measuring changes in the current as DNA or RNA molecules pass through the pore. This technology allows for genetic sequencers that are cheap and field-portable. Accompanying miniaturized automatic library preparation devices are also in development, which aim to improve the ability of a field scientist to set up the instrument without need of a full set of laboratory equipment. **APPLICATION:** Nanopore sequencers have been shown to function on the International Space Station with no decrease in output or accuracy. The ability to sequence DNA and RNA during spaceflight will improve the design of genetics studies by allowing for more frequent sampling and lower freezer burden. In-flight, real-time sequencing analyses could help investigate and reduce the detrimental health consequences of spaceflight by periodic assaying of RNA expression in crew members, rapid diagnosis of infectious causes of acute illness, and monitoring of the clinical and environmental microbiome for pathogenic microorganisms. **RESOURCES:** Castro-Wallace SL, Chiu CY, John KK, et al. Nanopore DNA Sequencing and Genome Assembly on the International Space Station. Sci Rep. 7(1):18022, 2017.

Learning Objectives:

1. Understand how nanopore genetic sequencing technology currently works, and the advantages it has for spaceflight applications.
2. The ways in which nanopore sequencing has already been used in space, and potential applications that have yet to be tested.

2:15 PM
[436] FUTURE REPRODUCTION CONCERN FOR SPACE TRAVEL AND MARS SETTLEMENT

Luton Dominique

APHP Université Paris VII, Paris, France

(Education - Program / Process Review Proposal)

BACKGROUND: Space will soon be opened to some kind of tourist and ultimately to settlement. Although these attempts of settlement do

not yet consider seriously the reproduction dimension there is no doubt that the question will become crucial when a human group will be driven for example to Mars without a return ticket. Will this part of humanity be sentenced to a definitive contraception/sterilization or alternative procedures be developed to provide the possibility of a full Human cycle in this extraterrestrial life. Although actual biological knowledge does not support such an option a full review of current scientific data and theoretical solution is presented here. **OVERVIEW:** When reviewing the literature about reproduction in the context of space mission or settlement many aspects arise. Our goal is to identify and to point out the different problematic areas. At least the following are crucial: is classical physical reproduction feasible in space? what would be the consequences of microgravity or low gravity for fetal, neonatal, or child development? What impact would have cosmic radiation on embryonic and fetal development and further? This list is not exhaustive and deserves particular attention with the scope to anticipate problems. **DISCUSSION:** About 300 articles in pubmed have developed partly or in totality some knowledge on our topic. Concerning reproduction the main concern is about effect of radiation on our germ cell lines and unless special isolation measures (very difficult to obtain) for selected crew, one solution could be that each individual be allowed to bring his own gamete in special container, that would of course make further assisted reproductive technology mandatory and complicate the whole mission by increasing the need for competence and technology. Even in this option concern would still arise when for example analyzing the result of the twin study indicating mandatory further shelter during the development period. Microgravity or low gravity might not be a concern for fetal development as already a part of its physiology but there is no doubt that once after birth the impact might be dramatic. Many questions arise about how to manage properly in low resource setting reproductive emergency (ectopic pregnancy). Many unsolved questions arise, regardless of also justifiable ethic issues and a multidisciplinary task force should be created in order to anticipate the next step of spatial exploration.

Learning Objective:

1. The audience will learn about main medical and ethical related to reproductive option in future space exploration or Mars settlement.

2:30 PM
[437] WORMS IN SPACE: YAY OR NAY? IS THE NEMATODE *P. SUPERBUS* AN IDEAL MODEL ORGANISM FOR SPACE RADIATION EXPOSURE RESEARCH IN DEEP SPACE TRAVEL?

Stephen MacLean
Transport Canada, Ottawa, Nova Scotia, Canada

(Original Research)

INTRODUCTION: July 20, 2019 marks the 50th anniversary of the first moon landing as part of the Apollo 11 mission. Space travel is experimental and includes a number of risks. Radiation exposure is one of the most significant health issues facing astronauts, with only a few humans (twenty-four) having had real-life exposure to deep space. There is a need for "model organisms" to help quantify biological effects of radiation. Roundworms are potential candidates as they are small (~1mm long), reproduce rapidly, and have well-described protocols used in maintaining and analyzing them. They also share many common genes with humans. Leicester University's DSPP (Deep Space Petri Pod) is an encouraging, small and portable environmental cabinet. The DSPP is hoped to be used for nematode transport in order to help quantify effects of deep space radiation. AIMS: To expand knowledge on using nematodes (Panagrolaimus superbus) as biological models for space travel and space radiation exposure. To identify "Kill Switch" temperatures needed to ensure sterilization in the context of "planetary protection." **METHODS:** Worms were exposed to thermal stressors (40-80°C) for 5-15 minutes to assess sterilization tolerance. Escalating doses of gamma rays (Co-60 source) were used to quantify effects on worm survival and population growth. One Way ANOVA was conducted for statistical analysis with SPSS, using Tukey or Games-Howell post-hoc tests depending on results of homogeneity of sample variances (Levene test). **RESULT:** Lethal heat shock temperatures were 55°C x 15 minutes for worms exposed on solid growth media, and 50°C x 15 minutes for M9 (liquid-based) worms. For radiation, survival and population growth were diminished ($p<0.05$) compared to controls for worms exposed to large doses of radiation (475Gy to 9000Gy) but not for lower doses (0.24Gy to 23Gy). At least small numbers of live worms were found in all exposed samples, even at MEGA doses (9000Gy). **DISCUSSION:** *P. superbus* organisms are very resilient in the face of massive doses of gamma radiation, enormously greater than what humans can withstand (~2000x). Future analysis should concentrate on aspects such as genetic and/or molecular assays, as the worms aren't effective as "canaries in the coal mine" given their impressive tolerance. Sterilization, in the face of planetary protection for normal, hydrated organisms, is more effective using thermal exposures at modest temperatures (50-55°C x 15 minutes).

Learning Objectives:

1. To understand the rationale for determination of "Kill Switch" temperatures needed to ensure sterilization in the context of "planetary protection."
2. To understand the rationale for using animal models and in particular nematode species (*P. superbus* and *C. elegans*) to help expand knowledge on deep space radiation exposures while appreciating their limitations when extrapolating biological effects to humans.
3. To have a better understanding of deep space radiation composition and its relevance to deep space travel and appreciating its biological effects on humans and nematodes.

2:45
[438] PREDICTING THE CAPABILITY OF INDIVIDUALS TO ACCLIMATE TO THE CORIOLIS CROSS-COUPLED ILLUSION FOR ARTIFICIAL GRAVITY

Kathrine Bretl, Torin Clark
University of Colorado at Boulder, Boulder, CO, USA

(Original Research)

INTRODUCTION: The "Coriolis" cross-coupled (CC) illusion has historically limited the feasibility of fast-rotation, short-radius centrifugation for artificial gravity (AG) due to human tolerability concerns. The CC illusion is a provocative tumbling sensation induced when individuals undergoing constant rotation tilt their head out of the plane of rotation. Previous research has investigated the capability of humans to acclimate to the CC illusion, and our recent results show compelling capacity of subjects to both acclimate and retain gained acclimation. However, there exists substantial inter-individual differences in acclimation rate, and prior investigations showed no insight into the source of this variability. We tested several potential predictors of an individual's ability to acclimate to the CC illusion and hypothesized that lower vestibular "noise" (i.e., lower thresholds) would enable faster acclimation. **METHODS:** Eleven subjects (10 male, 1 female) were exposed to the CC illusion for up to 50 sessions (one 25-minute session per day) using a personalized, threshold-based protocol. Subjects were spun in yaw and performed roll head tilts approximately every 30 seconds. Spin rate increased by one rotation per minute (RPM) when a subject reported that he/she felt no CC illusion *at all* at the current spin rate. As predictors for acclimation rate, we considered each subject's age, gender, demographics, and history of activities. Further, we measured vestibular perceptual threshold (i.e., how small of a motion can reliably be perceived) for yaw, pitch, and roll rotation. All protocols were approved by the University of Colorado Institutional Review Board. **RESULTS:** We found a statistically significant correlation between the rate at which the acclimation occurred (RPM/session) and each subject's *roll* rotation threshold (Spearman rank, $r = -0.73$, $p = 0.01$). Correlates between acclimation rate and other measures (age, gender, etc.) were not found, but were difficult to assess with limited variation in our subject sample. **DISCUSSION:** It is useful to predict how quickly a subject can acclimate to the CC illusion to understand the length of training required. We have shown that in preliminary studies ($n=11$), there was a significant correlation between roll rotation threshold and ability to acclimate. This knowledge is critical for the development of optimized training regimens to improve feasibility of fast-rotation, short-radius centrifugation for AG.

Learning Objective:

1. The audience will learn about several potential predictors of an individual's ability to acclimate to the "Coriolis" cross-coupled illusion, which is extremely relevant in determining the length of training regimens necessary to ensure the feasibility of fast-rotation, short-radius centrifugation for artificial gravity implementation.

Thursday, 05/09/2019 ***1:00 PM***
Exhibit Hall

[S-83] POSTER: SAFETY AND FATIGUE

Chair: Eric Friedman

[439] AN AVIATION MODELLED RESET (ROOT CAUSE ANALYSIS EVENT SUPPORT AND ENGAGEMENT TEAM)

Nicole Powell-Dunford Powell-Dunford[1], Stephen Yoest[2], David Romine[3], Mark McPherson[4]
[1]AMEDD Center and School, San Antonio, TX, USA; [2]MEDCOM Quality and Safety Center, San Antonio, TX, USA; [3]U.S. Army Combat and Readiness Center, Ft Rucker, AL, USA; [4]HQDA, Office of the Surgeon General, Falls Church, VA, USA

(Education - Program / Process Review Proposal)

MOTIVATION: As aviation modelled patient safety practices are increasingly implemented, aerospace medicine specialists have a special role in their evaluation. The US Army has established such an investigation organization, called RESET (Root Cause Analysis Event Support and Engagement Team). Commiserate and divergent aspects of this model, as compared to an aviation model, will be presented. **OVERVIEW:** The US Army Root Cause Analysis Event Support and Engagement Team (RESET) has undertaken a number of aviation modelled investigations. In each, a specially trained group of patient safety experts has led investigations at various locations of significant adverse events. Although lessons learned are not currently disseminated across the enterprise they are briefed to General Officers, Command teams and safety meetings such as the monthly Obstetric Quality Safety Forum. Similar to the aviation model, analysis by environmental, engineering and human factors experts is undertaken. Augmenting the aviation model, RESET also conducts a satisfaction assessment with briefed Commanders, a practice that the aviation community may wish to adopt. **SIGNIFICANCE:** Aviation modelled central investigation is of particular interest in the realm of patient safety. The US Army's unique application of the aviation model warrants critical analysis, with some aspects potentially superior to those in the aviation model itself. This area is of broad interest to Aviation and patient safety experts as well as aeromedical specialists.

Learning Objectives:

1. The participant will be able to define the word RESET.
2. The participant will be able to understand the differences between aviation accident investigation and RESET investigation of medical error.
3. The participant will be able to understand the similarities between aviation accident investigation and RESET investigation of medical error.

[440] MOBILE PHYSIOLOGIC LABORATORY (mobPhysioLabTM) INFIELD MONITORING OF SOLDIERS MAINTAINING EMPLOYABILITY, HUMAN PERFORMANCE, AND WELFARE

Andreas Werner[1], Tanja Drews[2], Raman Tandon[3], Karola Hagner[4]
[1]Centre of Aerospace Medicine, Koenigsbrueck, Germany; [2]Aviation Physiology Training Centre - Diagnostic and Research, Koenigsbrueck, Germany; [3]Wehrwissenschaftliches Institut für Werk- und Betriebsstoffe GF 330, Erding, Germany; [4]Wehrwissenschaftliches Institut für Schutztechnologien GF410, Munster, Germany

(Original Research)

INTRODUCTION: It would be impossible to imagine in today´s clinical service without "mobile health" or "telemedicine" (eHealth). In many aspects, the most modern and latest information and communication systems are applied in the health system. In some areas, the only wireless transfer is possible, namely in field applications or in Space. The so-called "soldier of the future" with the possibility to track human performance is in the development for years. The knowledge of the situational and operational status of personnel being entrusted by commanders is highly required during training and deployment. For the medical service, physiological data could help in the treatment, but preventional support before an incident occurs is for sure the better answer saving lives. **METHODS:** Germany is developing for at least two decades a mobile physiological laboratory (mobPhysioLab™) with a high rate of increase in the last years. The presented digital system is fully operational with excellent results obtained in several infield studies up to date, even on International Space Station (ISS). The actual stage of development is a relatively small mobile system; sensors have to be stuck, the data transfer is realized up to 8000m using a radio. **RESULTS:** Addicted to the physiological parameter the sampling rate can be chosen up to 1000Hz (e.g., ECG). The modular multi-flexible and open system allows the implementation of nearly every sensor type. The data were displayed synchronized with the provided software on a laptop, tablet, or smartphone. The acceptance of users being instrumented during their duty is already very high; they don't feel influenced nor disturbed; the other way around, they embrace such a system regarding health and safety. **DISCUSSION:** Remote health monitoring in hazardous environments has the potential to improve operational safety in identifying exposures that influence short and long-term health conditions. Until now, it was up to impossible for medical advisors to analyze the causes of health complaints in individuals during a mission. The mobPhysioLab™ is the solution, but has to be miniaturized and has to consist of a washable smart textile sensor garment; instrumentation while clothing. For transferring and monitoring, the investigation was started in a Human-Centric Cyber-Physical System (HCCPS). By creating complex systems and transferring agile software engineering techniques, commanders and medical advisors can monitor the health status.

Learning Objectives:

1. Remote health monitoring in hazardous environments.
2. commanders and medical advisors can monitor the health status of humans.
3. medical advisors can analyze the causes of health complaints in individuals during a mission.

[441] IS ABSTRACT REASONING A VIABLE CONSTRUCT FOR IMPROVING THE PREDICTION OF NAVAL AVIATION TRAINING PERFORMANCE?

LT Michael Natali[1], LT Heidi Keiser[2], CDR Michael Lowe[2]
[1]CNATRA, Corpus Christi, TX, USA; [2]Naval Aerospace Medical Institute, Pensacola, FL, USA

(Original Research)

INTRODUCTION: The Naval Aerospace Medical Institute 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 as well as identify those likely to perform well and complete training. Numerical and verbal reasoning are explicitly measured in the ASTB. However, there are currently no explicit measures of abstract reasoning on the ASTB, suggesting an important component of cognitive ability may be neglected in the selection battery. Abstract reasoning differs from verbal and numerical reasoning and assesses more novel problem-solving ability not dependent on prior knowledge or education. The current examines whether adding a measure of abstract reasoning to the ASTB improves the prediction of aviator performance. **METHODS:** Participants were 267 aviation students from the USN, USMC, and USCG enrolled in initial flight training at Naval Aviation Schools Command on NAS Pensacola (85% male, 15% female). Participants completed the Math Skills and Reading Comprehension subtests of the ASTB during their application process to flight training. They were asked to complete an abstract reasoning test where they choose the next logical symbol in a sequence. Participants' performance in the initial academic phase of flight training was tracked and linked to their scores on the math, reading, and abstract reasoning assessments. **RESULTS:** Scores on the Math Skills (r = .38*) and Reading Comprehension (r = .31*) tests showed stronger relationships with academic flight training performance than the abstract reasoning test (r = .21*). Hierarchical regression analyses revealed the abstract reasoning test did not provide incremental validity in predicting academic training performance beyond the math and reading subtests. Examining gender differences, females slightly outperformed males on the Math (d = .05) and Reading (d = .09) tests, but males outperformed females on abstract reasoning (d = .15). **DISCUSSION:** RESULTS showed abstract reasoning did

not aid in predicting initial academic performance after accounting for numerical and verbal reasoning. This follows past research showing Math/Reading tests predict academic type performance strongly, but abstract reasoning may add incremental validity in less-defined scenarios (flying). Research will continue to examine scores in relation to flight performance.

Learning Objective:

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

[442] BIOMETRIC INDICES OF MENTAL WORKLOAD PREDICT PILOT PERFORMANCE AND ARE SENSITIVE TO VARIATIONS IN TASK DEMANDS

Kathleen Van Benthem, Chris Herdman
Carleton University, Ottawa, Ontario, Canada

WITHDRAWN

[443] INSTRUMENT FLIGHT SCANNING PATTERNS IN DIFFERENT TYPES OF COCKPIT

Sravan Pingali[1], David G. Newman[2]
[1]Griffith University, Brisbane, Australia; [2]Monash University, Melbourne, Australia

(Original Research)

INTRODUCTION: Instrument flight (IFR) is a demanding activity which requires a pilot to maintain good scanning patterns to constantly acquire essential information from the flight instruments. It can be even more challenging when flying in a different or unfamiliar type of cockpit. Our previous study showed that there is a difference in scanning patterns between a glass cockpit and an analogue cockpit in visual (VFR) flight conditions. The aim of this study is to see if the VFR-observed differences also exist under IFR conditions, where instrument use is vital. **METHODS:** Nine instrument-rated pilots, 6 males and 3 females, were recruited via university's mailing system. This study received ethics approval. It was conducted in a reconfigurable Baron-58 simulator, with 1-mile outside visibility. Each pilot was asked to complete a navigation flight twice, once in a glass cockpit and then in an analogue cockpit. Eye-movement data was recorded using a head-mounted eye tracker. The data showed the visual fixation time inside and outside the aircraft and the saccade rate. It showed the average fixation time for all pilots, expressed as a percentage of total flight time and separated by cockpit type. ANOVA was the statistical test of choice and an alpha level of $p<.05$ was considered significant. **RESULTS:** The subjects spent most of their time looking inside the aircraft. There was no difference in scanning of the inside instruments between the two types of cockpit; $F(1,88)=0.31$, $p>.05$. Outside world was only scanned during the take-off and landing phases. There was no difference in scanning of the outside world between the two types of cockpit; $F(1,88)=0.15$, $p>.05$. There was also no difference in the saccade rate between the two types of cockpit; $F(1,88)=3.30$, $p>.05$. **DISCUSSION:** The results showed that the scanning patterns in IFR conditions were not significantly different between the two types of cockpit. This contrasts with our previous study, which showed significant differences between the cockpit types in VFR conditions. Due to IFR conditions, pilots are unable to obtain much information from the outside world. Hence, they focus their attention on the instruments to obtain the relevant information, regardless of cockpit type. This suggests that the lack of outside visual references is the reason for the lack of difference in scanning patterns. These differences between VFR and IFR scanning patterns should be considered when conducting transition training.

Learning Objective:

1. Participants will be educated about flying in reduced visibility conditions in an analogue cockpit and a glass cockpit.

[444] GENERAL AVIATION PILOTS' PREFLIGHT WEATHER PLANNING MENTAL MODELS

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Embry-Riddle Aeronautical University, Daytona Beach, FL, USA

(Original Research)

INTRODUCTION: Previous research indicates general aviation (GA) pilots have difficulty in interpreting aviation weather products and identifying the correct weather conditions. This may be due to poor product usability and design, limited user training, and low knowledge in how to properly interpret weather information. As a result, pilots with limited knowledge and training in interpreting weather products may develop inaccurate weather expectations for their planned route and may consequently be ill-prepared to make well-informed decisions. Therefore, the purpose of this study was to investigate GA pilots' ability to obtain the appropriate weather information, interpret the data, and apply the information to a given flight route. **METHODS:** Eighty-four GA pilots (M_{age} = 22.0 ± 3.2; $Mdn_{flight\ hours}$ = 210.0) from the southeastern region on the U.S. were given a flight scenario and asked to complete a preflight weather briefing and to identify what weather they were expecting to encounter along their route. Pilot certifications ranged from private (n = 24), private with instrument (n = 20), commercial with instrument (n = 20), to certified flight instructor (n = 20). **RESULTS:** A 4x5 mixed analysis of variance was conducted to assess the impact of pilot certification (private, private w/ instr., commercial w/ instr., CFI/CFII) and route location (departure [region 1], en-route [regions 2,3,4], destination [region 5]) on correct weather recall. There was no significant interaction between pilot certificate and region, nor was there a significant main effect between pilot certifications on correct weather items identified. A main effect for region occurred, Wilks' Lambda= .415, $F(4, 77)$ = 27.11, $p < .01$, $\eta p^2 = .59$. Pilots correctly identified more weather items near region 1 than any other region. No sig. difference occurred between regions 3, 4, and 5. Additional analyses indicate a small, negative correlation exists between pilots' recall hit rate and decision to fly or not fly. Pilots who identified a higher number of correct weather conditions were associated with deciding not to fly the given route. **DISCUSSION:** Pilots held incorrect weather expectations for most of the route and at the destination airport, and made misinformed decisions to fly. This study highlights the potential need to redesign aviation weather products for more system transparency and to develop more high-fidelity preflight weather scenarios for pilots to practice flight planning.

Learning Objective:

1. The audience will learn about GA pilots' ability to apply observational and forecast weather information to a given flight scenario.

[445] DYNAMIC DROP AND STATIC LOAD VERIFICATION OF THE QUICK RELEASE EXTENSION TETHER (QRET)

Christopher Albery[1], Jason A. Smith[2]
[1]Infoscitex Corp., Dayton, OH, USA; [2]Survival Innovations LLC, Mills River, NC, USA

(Original Research)

INTRODUCTION: Incidents of inadvertent detachment by US Army Air Warrior crews from aircraft prompted an Army adaptation of the Navy's HBU-27/P restraint system. The US Army Air Warrior office and Survival Innovations designed the Quick Release Extension Tether (QRET) with input from users. The QRET serves as a personal restraint tether for helicopter passengers using the Air Warrior Primary Survival Gear Carrier (PSGC) harness. With a sharp pull of a shoulder mounted handle, the QRET will detach the wearer from the aircraft enabling rapid egress. The QRET is designed to withstand up to 22,241.1 N of load and transition the fall loads through the harness while maintaining an emergency release under suspended load of 44.5-120.1 N. **METHODS:** Infoscitex (IST) performed dynamic drop testing on the QRETs and Personal Restraint Tethers (PRT) using a tower, spring-loaded platform, 136 kg torso dummy, and load cell to measure maximum arresting forces (MAFs). The QRET and PRT were attached to the PSCG and to the load cell and lifted onto the platform. The dummy fell a distance of 1.8-2.1 m. The QRETs and PRTs were also static load tested. Each PRT static test consisted of a pull of at least 12,010.2 N and was held for 30 sec. The QRETs were loaded in all three possible load paths. Each QRET static load test consisted of a pull of 22,241.1 N and was held for two minutes. **RESULTS:** The QRETs withstood an average of a dynamic MAF

of 13,015.5 N and supported the dummy suspended for 5 minutes following the drop with no loss of load carrying capability. After each test, the quick release was initiated while the dummy was hanging thus allowing the dummy to disconnect from the QRET. The QRET configurations were statically loaded to at least 22,241.1 N and held for 2 min. The PRTs were statically loaded to at least 12,010.2 N and held for 30 sec. There was no loss of load carrying capability for the QRETs or PRTs and only 0.3175 cm of fabric slippage through the adjuster. **DISCUSSION:** This destructive First Article Testing (FAT) program was required prior to production of the QRET and PRT. Infoscitex and Survival Innovations completed a series of dynamic drop tests and static load tests that resulted in a "Pass" for all tests. With a design solution in urgent demand, this verification program substantially contributed to the rapid fielding of the QRET by executing qualification test plans put forth by the US Army to verify integration acceptability and ANSI compliance.

Learning Objective:

1. The audience will be informed of the successful verification testing completed on a newly developed Quick Release Extension Tether (QRET) for helicopter passengers that will detach the wearer from the aircraft enabling rapid egress.

[446] U.S. STATEMENT OF DEMONSTRATED ABILITY AEROMEDICAL WAIVERS

Joshua Davis, William Mills
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(Original Research)

INTRODUCTION: The Statement of Demonstrated Ability (SODA) is a type of U.S. aeromedical waiver used for disqualifying conditions that are not expected to change. These waivers do not expire and are often based on a medical flight test. About 21,000 (2%) U.S. pilots possess a SODA waiver but little is known regarding the relationship between these waivers and aviation safety. **METHODS:** We matched all pilot medical exams from the FAA's medical certification database from 2002 through 2011 to their respective accidents in the National Transportation Safety Board accident database. The association of SODA waivers with the odds of an accident were explored using logistic regression techniques. **RESULTS:** For third-class flight exams overall, the presence of a SODA waiver was not associated with the odds of an accident. For the first- and second-class exams, the accident odds ratio (OR) was statistically significant (OR = 1.45, p = 0.020). Crop dusting operations accounted for 17 of the 40 commercial accidents where SODAs were present and returned a significant accident OR (OR = 1.68, p = 0.035). SODAs were not associated with the odds of accidents from other commercial flight operations. Several specific SODA conditions (amputation, internal eye, external eye, visual fields, bone and joint, and miscellaneous) were also found to have elevated ORs but the numbers of accidents for each was very small (2 to 11.) All of these accidents and the crop dusting accidents were individually reviewed. Although the medical condition for the SODA was related to the performance of a function involved in the accident in 10 of 37 cases, the SODA condition was not cited as a factor in any of the accidents. The only finding from our accident review that may benefit from further consideration concerns leg amputation/dysfunction and loss of directional control. **DISCUSSION:** SODA waivers were not associated with increased accident odds except for crop dusting operations. Six SODA medical conditions also had elevated odds of an accident based on very small accident counts. Review of these accidents plus the 17 crop dusting accidents failed to elucidate why this might be. Overall, U.S. pilots with SODA waivers appear to have a very satisfactory safety record.

Learning Objective:

1. The audience will be able to understand the role of Statement of Demonstrated Ability waiver on pilot safety.

[447] AEROSPACE MEDICINE AND HUMAN PERFORMANCE- OFFICIAL JOURNAL OF THE AEROSPACE MEDICAL ASSOCIATION

Frederick Bonato, Pam Day, Debra Sventek, Rachel Trigg
Aerospace Medicine and Human Performance, Alexandria, VA, USA

(Education - Tutorial Proposal)

Aerospace Medicine and Human Performance (AMHP) has existed under other titles since 1930. It is the world's most cited and respected journal in its field, publishing articles pertaining to health, safety, and human performance related to all aspects of flight, spaceflight, and related topics. Publication in AMHP is a worthwhile achievement and can benefit authors and readers alike. Here the process of preparing and submitting manuscript to AMHP is described. **TOPIC:** This poster provides authors with a systematic overview of the journal and some guidance on writing an informative, readable manuscript and submitting it to AMHP using our web-based system, Editorial Manager. It describes various article types as set forth in the Information for Authors and how each type should be formatted. Guidance is provided in avoiding some common pitfalls that can delay or even prevent eventual acceptance of a manuscript. **APPLICATION:** In following these guidelines, authors can maximize their potential for publishing in AMHP and hence of contributing to the advancement of the fields related to aerospace medicine and human performance. **RESOURCES:** https://www.asma.org/journal.

Learning Objectives:

1. Provide an overview of *Aerospace Medicine and Human Performance*, the official journal of the Aerospace Medical Association.
2. Provide authors with a systematic approach to writing and submitting a manuscript for publication.

[448] DIFFERENTIAL EFFECTS OF MODAFINIL ON THE SPEED ACCURACY TRADE-OFF VOLATILITY OF FATIGUE-VULNERABLE AND FATIGUE-RESILIENT INDIVIDUALS

Jonathan Sagan[1], Henry Stephenson[1], Dain Horning[2], J. Lynn Caldwell[2]
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[2]*Naval Medical Research Unit- Dayton, Wright-Patterson AFB, OH, USA*

(Original Research)

BACKGROUND: Sleep deprivation is problematic for those in our military. The effects on judgement, reaction time, and accuracy to make a decision are clear and potentially devastating. When all other options have failed, pharmacological intervention is a choice to counter the effects of sleep deprivation. But, instead of wide-spread enactment, perhaps treatments could take into account the individual differences between those who are fatigue resilient (FR) and fatigue vulnerable (FV). This study investigated whether modafinil would improve the performance of FV individuals more than FR individuals. **METHODS:** The double-blind, repeated measures study tested research participants over a period of 35 hours of continuous wakefulness on two separate runs. For one of these runs, all participants received 200mg of modafinil at midnight and a placebo for the control run. A Rapid Decision Making task was administered every 4 hours beginning at approximately 1340. The speed/accuracy trade-off metric used was the signed residual time (SRT) score. Unlike other speed accuracy trade-off rules, SRT penalizes a participant for fast incorrect responses. The volatility of the SRT, via moving standard deviation (MSD), was analyzed. The sample was divided into two groups, FV or FR, based on their mean SRT scores from the placebo run. The volatility between the two groups under placebo and modafinil was compared. **RESULTS:** Data from all 22 participants were included; 9 in the FV group and 13 in the FR group. An MSD was used to calculate the volatility of the SRT scores, and the area under the curve was used to describe the data. Mixed model analysis of variance using fatigue response as the grouping variable and session as the repeated-measures variable did not show a significant interaction between group and session ($F(4,80)=1.95$, $p=.108$), but did show main effects for both group ($F(1,20)=18.30$, $p=.000$) and session ($F(4,80)=6.82$, $p=.000$). Overall results indicated that the FV group benefited more from modafinil than the FR group. **DISCUSSION:** Identification of FV individuals should allow for more efficient implementation of fatigue countermeasures, including aids such as modafinil. Metrics such as SRT volatility are a new and meaningful approach to explain an individual's fatigue vulnerability. Tailoring countermeasures based on this approach will aid in overall mission safety, and effectiveness will increase without over-reliance on medication.

Learning Objectives:

1. The audience will learn a new way to analyze fatigue vulnerability via moving standard deviation, a metric that takes into account the volatility of decision making performance over time.
2. The audience will learn about a new way to quantify decision making performance with the Signed Residual Time score, a metric that examines the speed-accuracy trade off.

[449] RESPONSE SPEED ON THE PSYCHOMOTOR VIGILANCE TASK PREDICTS PERFORMANCE ON A VARIETY OF COGNITIVE TASKS DURING EXTENDED WAKEFULNESS

Henry Stephenson[1], Jonathan Sagan[1], Christina Kunkle[1], Nicole Beasley[2], Chelsea Levin[1], J. Lynn Caldwell[3]
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(Original Research)

BACKGROUND: Individuals differ in their vulnerability to cognitive declines during sleep loss, but it remains unclear how this can be detected on a trait to trait basis. Prior studies point to the psychomotor vigilance task (PVT) as a general index of cognitive resilience, but many rely on the dichotomization of PVT metrics to rank participants as vulnerable or resilient making the actual predictive validity of the PVT unclear. The purpose of this project is to use linear regression to examine whether baseline and sleep deprived response speed on the PVT predict performance on various higher order cognitive tasks during extended wakefulness. **METHODS:** Data were taken from placebo runs of a double-blind study on the effects of modafinil on performance during 35 hours of continuous wakefulness (N=20). The PVT was administered hourly from 1200 to 1700 the next day while cognitive tasks were administered once at baseline and four times over sleep deprivation (0100-1500). Data from the sleep-deprivation (SD) period were averaged to create overall SD scores for each cognitive task. Mean response speed from 1200-2300 during the baseline period (BL) was averaged to create a BL score for response speed. Cognitive metrics included number incorrect on a Rapid Decision Making task (RDM), Match-to-Sample task (MTS), and the incongruent condition of the Stroop task. A paired sample *t*-test was conducted to see if baseline and sleep-deprived response speed differed. Simple linear regression models were generated to predict performance on each task with BL and SD response speed. **RESULTS:** Response speed was significantly slower during the sleep deprivation period than the baseline period, $p<.001$. BL response speed was a significant predictor of performance on RDM and the Stroop task, $R^2=.30$, $p<.05$; $R^2=.23$, $p<.05$, respectively. SD response speed was a significant predictor of performance on RDM, MTS and the Stroop Task, $R^2=.32$, $p<.01$; $R^2=.38$, $p<.01$; $R^2= .31$, $p<.05$, respectively. Additionally, the Stroop task was a significant predictor of performance on RDM and MTS, $R^2=.71$, $p<.001$; $R^2=.30$, $p<.05$, respectively. **DISCUSSION:** Baseline and sleep-deprived response speed on the PVT predicted performance on putative measures of rapid decision making, working memory, and executive function. This affirms the PVT as a reliable index of cognitive performance during sleep loss and suggests that baseline performance may be as well.

Learning Objectives:

1. The audience will learn about gaps in our knowledge of the psychomotor vigilance task and its diagnostic validity for cognitive declines during extended wakefulness.
2. The audience will learn about the negative predictive relationship between response speed on the psychomotor vigilance task and errors in more complex cognitive processes during extended wakefulness.

[450] FINDINGS FROM A U.S. ARMY AVIATOR SURVEY ON ENERGY DRINK USAGE

Claire Goldie, Amanda Kelley
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(Original Research)

INTRODUCTION: Use of energy drinks (EDs) is widespread and unregulated in the US military, despite the potential health effects of these products and unknown impacts on operational performance. Particularly, use amongst US Army aviators is poorly understood. **METHOD:** An anonymous survey was distributed to a convenience sample of US Army aviators at Fort Rucker, AL looking at experiences relating to a variety of operational stressors, such as fatigue and health (including ED usage). A total of 215 aviators completed the survey, representing 3.1% of the Army aviator population. The results were reviewed to determine the prevalence, demographics and reasons for ED usage and to evaluate any associations with work schedules, fatigue and sleep patterns. **RESULTS:** Of 215 respondents, 68 (31.6%) declared regular ED usage, 140 (65.1%) did not use EDs and 7 (3.3%) did not respond. In general ED users were younger, with less time in military service and less aviation experience, compared to non-users. The predominant reasons for ED usage were to stay awake (72.1%), to improve physical performance (13.2%), for the taste (10.3%) and to improve flight performance (5.9%). ED usage was independent of day or night flying scheduling, regular or irregular work-rest schedules, sleep quality at home and in the field and whether napping was used as an additional fatigue countermeasure. However, ED users reported using significantly longer nap times to alleviate fatigue. The average *required* sleep period to feel refreshed was no different between the 2 groups, but the mean *actual* amount of sleep obtained per night was significantly less for ED users. **DISCUSSION:** These results support previously reported reasons for ED use and demographic data on wider military and civilian usage. The apparent differences in sleep quantity and required nap lengths to counter fatigue between the 2 groups is of concern. Whether ED use is paradoxically compounding fatigue in the aviation community requires further research. Limitations include the sample size and how representative it is of the wider Army aviation community.

Learning Objectives:

1. The audience will learn about the demographics of energy drink users and the predominant reasons for use among a sample of US Army aviators.
2. The audience will learn that the data collected suggests that use of energy drinks may be negatively affecting sleep quantity and could be compounding fatigue, albeit further research is required in this area.

[451] DIFFERENTIAL EFFECTS OF MODAFINIL ON MOOD STATE IN FATIGUE -VULNERABLE VERSUS FATIGUE - RESISTANT INDIVIDUALS

Kayelin Tiggs[1], Christina Kunkle[1], Nicole Beasley[2], Chelsea Levin[1], Jo Lynn Caldwell[3]
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(Original Research)

BACKGROUND: Modafinil is effective in restoring deficits in performance induced by sleep loss. Some individuals tend to be more resilient to decrements of reduced sleep while others are more vulnerable. However, previous studies focused primarily on cognitive performance and are based on averaged responses which did not account for individualized reactions to sleep loss. While some studies have shown that positive mood increases with modafinil, no studies have examined modafinil's effect on changes in mood state based on vulnerability to sleep loss. It was hypothesized that modafinil would elicit greater changes in mood in fatigue vulnerable individuals than fatigue resistant individuals. **METHODS:** In a double blind, repeated measures study, participant data were collected during 2 separate 35-hour periods of continuous wakefulness. Modafinil was administered at midnight during one period and placebo at the other period. Cognitive tests and mood questionnaires were administered every 4 hours, beginning at 21:00. The psychomotor vigilance task (PVT) lapses obtained during the deprivation sessions were used to group participants according to fatigue vulnerability. The mood scores from the Profile of Mood States (POMS) questionnaire and the Visual Analogue Scale (VAS) of both groups under modafinil and placebo were compared. **RESULTS:** Data from 19 participants were included in the analysis, 9 in the fatigue-resistant group and 10 in the fatigue-vulnerable group. Difference scores between the placebo and modafinil were calculated for each of the factors from the POMS and VAS questionnaires. Mixed model analysis of variance using fatigue resistance as the grouping variable and session as the repeated-measures variable showed a significant interaction between group and session for the Vigor and Total Mood Scores from the POMS. Post hoc analyses showed that the fatigue-vulnerable group benefited more from modafinil during the early morning session than the fatigue-resistant group. No interactions were shown for any of the factors from the VAS. Analyses showed a significant session effect for several factors in both questionnaires. **DISCUSSION:** RESULTS show that the vulnerable group benefited more from modafinil than the resistant group. Understanding the effects of modafinil on individual reactions to sleep loss, including changes in mood state, will allow tailored implementation of fatigue countermeasures, providing pharmacological aid to those who will benefit most.

Learning Objective:
1. The audience will learn about the significance of examining individualized reactions to sleep loss so that pharmacological countermeasures can be tailored to whom will benefit the most, while avoiding the unneccesary dosing of those who may be more resilient to sleep loss.

[452] AIRCRAFT EXCEEDANCES ARE ASSOCIATED WITH PILOT PERFORMANCE AND SLEEP TIME

Lucia Arsintescu[1], Bryan Matthews[2], Michael Feary[3], Jessica Nowinski[3], Nikunj Oza[3], Erin Flynn-Evans[3]
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(Original Research)

BACKGROUND: The Flight Operational Quality Assurance (FOQA) programs have been implemented in US and Europe to collect and analyze flight data in an effort to improve flight safety. Several methods have been developed to support the analysis of FOQA data, yet it is unclear how FOQA data relates to pilot performance. Our goal was to determine whether there was a relationship between flight exceedances extracted from FOQA data and pilot performance during a controlled pilot schedule from a short-haul airline. **METHODS:** Forty-four pilots (mean age 30.8 +/- 7.1 years) flew a roster consisting of a cycle of five days of short duty hours followed by four days off, five early duty followed by three days off, five mid-day time starts with many sectors followed by three days off and then five late duties with finishes that generally ended during the night followed by four days off. Participants completed a Psychomotor Vigilance Task (PVT) and a Samn-Perelli scale of subjective sleepiness several times per day on duty and rest days. In addition, they wore an actiwatch for measuring sleep time. FOQA data was collected via onboard sensors from 1146 aircrafts and was evaluated through exceedance detection. Exceedances were classified into three levels of severity (low, medium, high) based on predefined parameters. **RESULTS:** Eighty-two percent of the flights had at least one exceedance. The total number of exceedances was n=2951. The highest number of exceedances was of low severity (n=2506, 92%) followed by medium (n=358, 13%) and high (n=87, 94%). The rates of exceedances were positively correlated with lapses (reaction times > 500ms; $p < 0.05$) showing an increase in exceedances when lapses increased, negatively correlated with response speed ($p < 0.01$) showing an increased in exceedances when response speed was low and negatively correlated with the sleep time obtained on the previous night ($p < 0.05$) showing an increase in exceedances when sleep time was shorter. There was no correlation between subjective fatigue as measured by Samn-Perelli and the rates of exceedances. **DISCUSSION:** We found that the majority of the flights examined had at least one exceedance. When pilots' response speed was slower and the number of lapses was higher the rates of exceedance were higher. The rates were also higher when pilots had less sleep.

Learning Objective:
1. The audience will learn about the relationship between pilot performance and aircraft events.

[453] EFFECTS OF SLEEP DEPRIVATION ON EEG-BASED MEASURES OF CRITICALITY AND COMPLEXITY

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(Original Research)

INTRODUCTION: Sleep Deprivation is known to adversely affect basic cognitive abilities such as object recognition and decision-making. Assessing the effects of sleep deprivation using non-invasive measurements of brain activity provides novel insights into the dynamical changes that take place in the brain. **METHODS:** During an integral part of their training, Israeli Air Force pilots and drone operators (n=34; All males; Mean age=21.3, range: 19-24) underwent a full or partial sleep deprivation exercise (32h of continuous wakefulness or 3h sleep limit) in which EEG measurements were taken under a rest condition (eyes open) for 4 min and under a cognitive task condition for 3 min every few hours and after a recovery sleep of 8 hours. The cognitive task condition included a psycho-motor vigilance task aimed to measure the effect of sleep deprivation on reaction time (RT). The measurements were taken using different EEG headsets (a gel-based system and a dry system), both using 64 electrodes. All data were bandpass filtered and pre-processed to remove muscle, eye and heart beat artifacts. After pre-processing, the signal analysis utilized Multiscale Entropy algorithms to infer signal complexity and Neuronal Avalanche Analysis to infer metrics of critical dynamics, which reflect the balance between excitation and inhibition. **RESULTS:** Entropy-based metrics have shown significant changes, increasing up to 380% from baseline rates. Criticality metrics increased by 50% during peak sleep deprivation. Both metrics correlated with the sleep deprivation states. Those changes were consistent with a shift of the underlying neural dynamics towards an excitation-dominated state. Across experiments, the average RT, baselined at ~230ms, degraded as the sleep deprivation progressed, reaching 300ms at peak, and returned to baseline after recovery sleep. Importantly, there was significant correlation between the EEG-based metrics and behavioral performance. **DISCUSSION:** The results form a promising potential for these metrics to monitor sleep deprivation effects and generate relevant alerts. The stated metrics and the correlation to behavioral performance pave the way for both military and civilian applications in fields that require vigilance and high cognitive capabilities, and potentially deeper insight into sleep deprived brain dynamics.

Learning Objectives:
1. Understand critical and entropy based metrics of brain dynamics.
2. Correlate these metrics with behavioral effects of sleep deprivation.

[454] IMPACT OF ON-DUTY AND OFF-DUTY MISHAPS ON THE AIR FORCE MAINTAINER POPULATION

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

(Original Research)

INTRODUCTION: Although mishaps are recognized as an occupational hazard in aerospace maintenance, the relative contribution of on-duty and off-duty mishaps has not been described. **METHODS:** In this retrospective cohort study of the active duty U.S. Air Force population, we compared mishap rates, classes, location (on-duty and off-duty), work days lost, and trends among maintainers and all other airmen from January 2013 through December 2017. We also stratified maintainers as aerospace, missile, and transport. **RESULTS:** Maintainers sustained 8298 mishaps during the 5-yr period, of which 6738 (81%) occurred on-duty. Off-duty mishaps accounted for 94% of the lost duty time, mostly from motor vehicle crashes. While on duty, Class D (69.4%) and C (27.6%) mishaps predominated. The mishap rate of maintainers was 11% higher than the rate across the rest of the Air Force (relative risk = 1.11; 95% confidence interval: 1.08, 1.14), although their rate of lost duty time from mishaps was 18% lower (relative risk = 0.82; 95% confidence interval: 0.80, 0.83). The mishap rate was higher among aerospace maintainers (2.13 per 1,000 person-months) than transport (1.99) and missile (1.52) maintainers. The overall mishap rate of maintainers decreased by 22% ($p<0.001$), while the rate of on-duty mishaps remained constant ($p=0.736$). **DISCUSSION:** In the Air Force maintainer community, off-duty mishaps are less common than on-duty mishaps and declined over a recent 5-yr period, but they cause significantly more lost duty time. Preventive efforts aimed at decreasing serious off-duty mishaps may have the greatest operational impact.

Learning Objectives:
1. The participant will be able to describe the burden and trend of on-duty and off-duty mishaps among Air Force maintainers.
2. The participant will be able to utilize epidemiology to identify opportunities for mishap reduction.

Thursday, 05/09/2019 ***3:30 PM***
Brasilia 1

[S-84] SLIDE: CLINICAL AEROSPACE MEDICINE AROUND THE WORLD

Chair: Danny Pizzino

3:30 PM

[455] PILOT WITH A FAMILY HISTORY OF ARRHYTHMOGENIC RIGHT VENTRICULAR CARDIOMYOPATHY: A CASE REPORT

Heather Langille
Transport Canada, Ottawa, Ontario, Canada

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This case report describes a civilian pilot with a family history of an inherited cardiomyopathy. **BACKGROUND:** Family history is useful in the assessment of aeromedical risk. Although rare, certain hereditary conditions, such as inherited cardiomyopathies, can have a profound impact on an individual's risk of incapacitation and pose a serious danger to flight safety. It is important that aviation medical examiners take a thorough history, including a thorough family history, when performing aeromedical assessments. **CASE PRESENTATION:** The subject pilot was a 41-year-old civilian helicopter pilot. He was asymptomatic and took no medications. He was a non-smoker and an avid athlete, exercising for at least an hour a day. He denied any family history of cardiac disease. The regulatory authority became aware that his mother had been diagnosed with arrhythmogenic right ventricular cardiomyopathy (ARVC) type 5, an autosomal dominant condition, and had an implantable cardioverter-defibrillator (ICD). A brother had also been diagnosed with this condition and had undergone heart transplant. The pilot had one child who was well. He had refused genetic testing, apparently out of concern for his career. Once the details of his family history came to light, he was asked to undergo a Cardiological consultation that included genetic testing. This confirmed that he was a carrier of the mutation for ARVC type 5 in the TMEM 43 gene. Based on published data for this condition in males there is a 50% risk of sudden death prior to the age of 40. Treatment is with prophylactic ICD. The pilot is presently unfit. **DISCUSSION:** This case highlights several important issues in civil aviation medicine. First, a good history, including family history, is of upmost importance. Specific questions should be asked about the presence of relevant medical conditions in family members. In this case it is possible that, even if questioned directly, the pilot may have denied this history. Therefore, it is also important that there is a simple and reliable method by which concerns can be reported to the regulatory authority, and such reporting should be protected by legislation. Finally, the regulator must have the right to request any further information necessary to determine medical fitness. This case illustrates the importance of having a complete history, including a family history, in the assessment of medical fitness.

Learning Objectives:

1. The audience will learn about the importance of family history in the determination of aeromedical risk.
2. The audience will learn about a situation where genetic screening is relevant to the assessment of aeromedical risk.
3. The audience will learn about the disposition of pilots with certain inherited cardiomyopathies.

3:45 PM
[456] 24-HOUR AMBULATORY BP MONITORING (ABPM): A USEFUL TOOL FOR SCREENING OF LATENT HYPERTENSION AMONG INDIAN AIR FORCE (IAF) PERSONNEL WITH HIGHER BMIs

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Indian Air Force, Jaisalmer, India

(Original Research)

INTRODUCTION: Prevalence of hypertension in overweight and obese personnel is higher than in the normal population. It is possible that a single clinical BP reading, as being practiced currently in the IAF, may not be able to establish the hypertensive status among these personnel. The present study was conducted to examine whether at higher BMIs, 24-hour ABPM would serve as a better tool for detecting latent hypertension vis-à-vis clinic BP recording. **METHODS:** 230 healthy IAF male, clinically normotensive (BP<140/90 mmHg) between 20-40 years of age participated in this study. 50 participants with normal BMI (<25 kg/m^2),120 participants in overweight group (BMI 25-29.99 kg/m^2) and 60 participants in obese group (BMI ^{3}30 kg/m^2) were included. Each participant underwent BMI measurement using Digital Height-Weight-BMI measurement equipment, clinic BP recording by standard mercury sphygmomanometric apparatus and 24-hour ABPM using 'Oscar2 AccuWinpro' apparatus. Correlation analysis, ANOVA and chi-square tests were used for statistical analysis of the data. **RESULTS:** A statistically significant positive correlation was observed between MAP and BMI. 24-h ABPM revealed a significant effect of BMI on MAP, which was not observed in clinic BP measurement. The hypertensive response shown by ABPM was statistically significant between obese and normal BMI as well as obese and overweight groups. Such a response was not statistically significant between normal BMI and overweight groups. ABPM also revealed a consistent statistically significant blunting of nocturnal dip response with increasing BMI. **DISCUSSION:** 24-hour ABPM was found to be a useful tool for screening of hypertension in individuals with higher BMIs specifically in obese (BMI^{3}30 kg/m^2). It is recommended that 24-hour ABPM may be used as an assessment tool for screening of hypertension in medical evaluation of obese IAF personnel.

Learning Objectives:

1. There is a significant positive correlation between BMI and mean arterial blood pressure among Indian Air Force personnel.
2. 24-hour Ambulatory BP Measurement is a more useful tool for screening of hypertension in individuals with higher BMIs specifically in obese.
3. Distinct advantages of ABPM over clinic BP measurement are provision of a 24-h BP profile including awake and asleep state BP response, ability to provide BP variability such as nocturnal dipping pattern and provision of derived measures such as systolic and diastolic overload.

4:00 PM
[457] PREVALENCE OF HYPERTENSION AND OBESITY IN CIVIL PILOTS IN INDIA AND THEIR CORRELATION: IS IT TIME TO CHANGE FITNESS CERTIFICATION GUIDELINES?

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(Original Research)

INTRODUCTION: Hypertension (HT) is a common cardiovascular disease with prevalence 20-24%. Obesity has reached epidemic proportions. Their prevalence and correlation in Indian Pilots not studied. **METHODS:** In a cross-sectional observational study, 1185 consecutive civil pilots who underwent routine medical examination were included after due consent, necessary permission and ethics committee approval. Height, Weight and Blood Pressure (BP) were measured. BMI calculated. ABPM was recorded before final diagnosis of HT or White Coat Hypertension (WCH). They were also analyzed as per new ACC/AHA criteria of 2017. The data were also analyzed for overweight and obesity as per Asia- Pacific guidelines for the region. **RESULTS:** A total of 1185 pilots were studied. The mean age of the pilots was 34.8±13.7 years, with 91.4% males. The highest number of hypertensives was noted in 26 to 35 years age group! 89.1% had normal casual office BP; 10.9% had average casual BP ≥ 140/90 mmHg. After 24 h ABPM, 4.1 % had HT; 6.8% had WCH. As per ACC/AHA criteria, 18.7 % had HT (additional 14.6 %). Additional 6.2% qualified for drug therapy. 39% were overweight and 7.3 % were obese. When Asia Pacific criteria applied, 46.3 % were obese and 23.3 % overweight. When BMI ≥ 23, likelihood of hypertension increased [OR 2.432; 95% CI 1.050 - 5.632, p < 0.05]. **DISCUSSION:** The prevalence of Hypertension in our civil pilots was 4.1 %; much less compared to general population but consistent with a Chinese study where it was 4.96%. However, it increased to 18.7% if new criteria were applied. Additional 6.2 % qualified for medication. Are we allowing pilots with increased ASCVD risk to fly thereby compromising flight safety? There is no similar study published on the prevalence of HT as per new criteria. The prevalence of obesity was 7.3% and overweight 39%; consistent with those in urban population where it is 30-65%. However, they increased to 46.3% for obesity and 23.3% for overweight when Asia Pacific standards were applied. There is no study which has examined such prevalence rates. The risk of developing Hypertension increased with BMI > 23 kg/m2 (OR 2.43). Hence therapeutic life style measures should be instituted at BMI of 23 and not to be delayed till it reaches 25 which is the current practice. Change in practice and use of new criteria for HT and Asia Pacific Criteria for obesity needed to reduce morbidity amongst pilots in the interest of flight safety.

Learning Objectives:

1. Assessment of blood pressure for medical fitness certification of pilots is currently on JNC VIII criteria. The new ACC/AHA criteria of 2017 will be required to be adopted gradually in the interest of flight safety.
2. Region-specific overweight /obesity criteria need to be adopted in South Asian countries to address this menace which is the substrate for other illnesses like Hypertension, Diabetes and Cardiovascular diseases.

4:15 PM

[458] TREATMENT OF EOSINOPHILIC ESOPHAGITIS WITH AN HERBAL ASTHMA THERAPY: CONFLICTING SUBJECTIVE AND OBJECTIVE FINDINGS

Danny Pizzino[1], Preston Moore[2]
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(Education - Case Study: Clinical / Human Performance)

PROBLEM STATEMENT: This case report describes a military pilot with eosinophilic esophagitis treated with non-approved herbal asthma therapy. **BACKGROUND / LITERATURE REVIEW:** Much like asthma, eosinophilic esophagitis (EoE) is an allergy mediated condition. The incidence of EoE is increasing worldwide. People usually present with symptoms of dysphagia, food impaction, chest pain, or GERD symptoms that do not respond to treatment. The comparisons between EoE and asthma are numerous. Both have similar histological and immunochemical findings, and like asthma, EoE responds well to corticosteroids. The standard treatment for EoE is a Proton Pump Inhibitor and a swallowed corticosteroid. Given the increased research into asthma, non-pharmacologic treatment options have been studied such as homeopathic herbal supplements. One such supplement, the Chinese herbal medication called ASHMI has been approved by the FDA as the first botanical investigational new drug for asthma. Eosinophilic esophagitis, first described in the 1970's, does not have as extensive research, and fewer treatment options are accepted at this time. **CASE PRESENTATION:** The subject is a 35-year-old experienced instructor pilot with 2500 total flying hours, and a history of EoE. His initial symptoms of "food getting stuck" started in 2012. He was started on a PPI and Fluticasone. Symptoms responded well, and the medicines were well tolerated. In 2014, he decided to stop the PPI after home research into the side effect profile. He continued the Fluticasone and began taking the herbal medication called ASHMI after doing home internet research. His wife had asthma and used ASHMI. Subjectively he responded well to this treatment course. Due to resolution of symptoms and not wanting to be on long term steroids, he asked to stop the Fluticasone. His dose was first halved, and then later self-discontinued altogether. He continued the ASHMI and had no additional flare-up of symptoms. Repeat EGD in 2017 however did show increased eosinophils on esophageal tissue sample, despite the continued subjective improvement in symptoms. **OPERATIONAL / CLINICAL RELEVANCE:** This case highlights several potential conflicts. First, according to USAF, Navy, and FAA regulations, EoE is a disqualifying condition. Waivers are granted for asymptomatic flyers. This flyer was subjectively asymptomatic on an unapproved herbal medication, yet objective findings from tissue biopsy showed worsening of the disease.

Learning Objectives:

1. Eosinophilic esophagitis can qualify for special issuance or waiver if the person is asymptomatic on either no therapy, or on approved medications.
2. The diagnostic criteria for eosinophilic esophagitis require three components: 1) Clinical symptoms of esophageal dysfunction; 2) a maximum esophageal eosinophil count of at least 15 eos/hpf; and 3) exclusion of other possible causes of esophageal eosinophilia.

4:30 PM

[459] MASS CASUALTY CENTERS: IMPROVING BOTH DISASTER RESPONSE AND ONGOING HEALTHCARE GLOBALLY WITH INTEGRATED EMERGENCY AEROMEDICAL RESOURCES

Russell Andrews[1], Leonidas Quintana[2], Tariq Khan[3], Sergio Aguilera[4], Roxanna Garcia[5]
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(Education - Program / Process Review Proposal)

BACKGROUND: Natural disasters average 100,000+ deaths/yr; man-made (unnatural) disasters (terrorism, building/transportation accidents) add to morbidity/mortality (M/M). Injuries (notably road traffic) cost > 2M deaths/yr in LMICs (low- and middle-ncome countries) alone. Lack of surgery immediately following the 2010 Haiti earthquake resulted in 20,000 deaths/day. Mass casualty response (MCR) in both natural and man-made disasters must be on-site in 24 hours - not the current days-to-weeks of UN, WHO, Red Cross, etc. Lack of surgery results in 1/3 of all deaths worldwide – 10 times those dying from AIDS, TB, or malaria – and annual LMICs GDP loss of > $500B. **OVERVIEW:** Trauma/stroke centers (T/SCs) evolved with evidence that immediate treatment improved M/M. We propose Mass Casualty Centers (MCCs), seamlessly integrated like T/SCs, for LMIC healthcare systems. MCCs include helicopter-portable operating rooms (with CT powered by car battery), telemedicine and robots/drones to optimize triage and identify living buried in rubble. Disasters/mass casualties evoke humanitarian responses, lifting political/cultural barriers that hinder response to other crises – improving regional healthcare since MCCs augment healthcare during non-MCR periods. The proposed US National Trauma Care System (NTCS) integrates civilian TCs with military resources, similar to MCCs. MCC efficiency is achieved by integrating civilian, military, international/NGO resources and substituting real MCRs for recurring readiness events/training. The MCC project has input/support from international agencies (WHO, UN), Chilean and Pakistani Health Ministries, military MCR, and advanced technology (telemedicine, robots/drones). Initial MCC sites: Iquique (Chile), Peshawar (Pakistan). In Iquique, local health officials, Chilean Air Force, and Office of Emergency Management have met to advance the MCC; in Peshawar, a ground ambulance system began in 2017 once medical and nursing schools were established. **DISCUSSION:** The MCC "multinational T/SC system" improves both MCR and ongoing healthcare and establishes both global medical education standards and research platforms. MCCs provide resources beyond surgery (radiology, blood bank, pathology) necessary for *Lancet Global Surgery 2030* and WHO Sustainable Development Goals (for healthcare, education, poverty). There are political and socioeconomic benefits – beyond trauma healthcare benefits - of integrating MCR into ongoing global healthcare.

Learning Objectives:

1. The participant will learn about the healthcare impact of mass casualties (both natural and man-made) worldwide, and the limitations of the current mass casualty response systems.
2. The participant will learn about the aeromedical and other resources available for immediate medical/surgical care in mass casualties.
3. The participant will learn about the benefits - both for mass casualty response and for global healthcare - of integrating mass casualty response into ongoing healthcare systems using the trauma/stroke center model.

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[460] THIS IS HAWESOME!

Joseph Novak
U.S. Air Force, Papa, Hungary

(Education - Program / Process Review Proposal)

BACKGROUND: In a small world with increasingly interconnected militaries, rapidly changing missions, unpredictable threats, and frequent humanitarian crises, there is always a crucial need for tactical and strategic airlift and airdrop. But how can most nations afford and operate an essential unit like this? The answer lies in the paradigm of the Heavy Airlift Wing (HAW), a C-17 unit comprised of 12 nations' airmen, soldiers, and sailors, resources, and funds. The HAW is the vanguard of a new model of military cooperation, and Flight Medicine plays a pivotal role in what is sure to be the first of many such international endeavors. **OVERVIEW:** In 2008 Hungary became home to a truly international unit, the first of its kind in many ways. 12 nations came together to operate C-17s for the use of each member's national requirements. But how does a unit run by 12 different nations and manned by over 20 nationalities (military and civilian members), reconcile their different standards of care, expectations, policies, and models of aerospace medicine? What concerns exist for the medical care of the non-flyers and family members? What legal considerations are show-stoppers? Can a unit like this carry out a mission as complicated as AE with a multinational medical crew? The HAW is where the theory of global aerospace collaboration meets practice. It is truly Aerospace Medicine sans Frontières. **DISCUSSION:** The HAW has demonstrated that international military organizations work, even at the weapons system level. HAW Flight Medicine, comprised of a FS and two medics, has overcome many challenges to enable full

operational and medical support to this complicated unit. International collaboration is essential now and in the future. The HAW paradigm and lessons learned can and should be used in similar units popping up around the globe.

Learning Objectives:

1. To identify potential issues and pitfalls for an operational flight medicine clinic working with multiple nations and individuals with vastly different expectations.
2. To understand the flight medicine lessons learned and solutions that have worked at the HAW.
3. To gain exposure to a novel international military unit that will likely be emulated in the years to come.

Thursday, 05/09/2019 ***3:30 PM***
Brasilia 2

[S-85] PANEL: ULTRA LONG-RANGE FLIGHTS: IMPLICATIONS FOR CREWMEMBERS

Sponsored by Aerospace Human Performance Committee, Aerospace Human Factors Association

Chair: Keith Ruskin

Co-Chair: Carlos Salicrup

PANEL OVERVIEW: Although there is no standard definition of ultra long-range (ULR), it is generally applied to flights with a duration of over 15 hours. ULR flights' ability to save fuel combined with improved aircraft efficiency have made these operations financially viable. Singapore Airlines, for example, recently introduced a 19-hour flight from Newark to Singapore (15,357 km) in an Airbus A350-900ULR and Air New Zealand and United Airlines plan to introduce flights from Chicago to Auckland in Boeing 787-9, 777-200ER, and 777-300ER aircraft. ULR flights rely upon two complete crews in order to comply with rest requirements, work hour restrictions and layover time and base rest restrictions. Circadian misalignment is caused by exposure to darkness and sunlight during the flight and after landing and while crossing multiple time zones. The effects of fatigue and circadian misalignment caused by extended flight time may, however, be partially offset by factors such as the ability to obtain sleep during inflight rest periods. This panel will discuss factors such as fatigue, circadian misalignment, and medical events that must be considered when planning ULR routes and crew scheduling. This panel also will discuss the current regulatory requirements including crew rest periods and fatigue risk management systems (FRMS) as applied to ULR crewmembers, medical events in required crew members, and the effects of circadian misalignment on performance.

[461] ULTRA LONG-RANGE FLIGHT OPERATIONS: REGULATIONS AND RESEARCH

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

(Education - Program / Process Review Proposal)

BACKGROUND: Air New Zealand established an innovative data-driven approach for crew scheduling around 1993, particularly for long-haul flight operations. An International ULR Crew Alertness Steering Committee formed in 1998 when Singapore Airlines requested Civil Aviation Authority of Singapore approval to fly from Singapore to Los Angeles. The route required flight times >16 hr and flight duty periods 18-22 hr. The Steering Committee developed procedures for an operational study and data collection requirements to establish "safety of flight" approval in 2004 for the ULR operation. Delta Air Lines proposed a JFK-BOM ULR flight operation to FAA and in response, Operations Specification A-332 was developed and required fatigue mitigations and data collection approaches similar to those of the International Crew Alertness Committee. In 2008, FAA organized a Scientific Steering Committee comprised of scientists and flight operations personnel from Delta, Continental, and American Airlines. A "generic" OpSpec was established with a common operational data collection protocol requiring the same tools/devices and methodology for all parties to follow. **OVERVIEW:** In 2012, FAA introduced 14 CFR Part 117.7--FRMS, for flight operations exceeding regulatory table limits. Stipulations required fatigue mitigation approaches, data collection, and analysis, just as proposed in ULR OpSpec A-332. The regulation now requires the certificate holder to demonstrate that their proposed ULR "alternative method of compliance" provides an "equivalent level of safety" to the safety standards set forth in Part 117. Currently, EASA Article 14 of Regulation (EC) No 216/2008 contains flexibility provisions, to grant derogations from the Basic Regulations whereby an "equivalent level of safety" is demonstrated. When applying Article 14(6) derogation, conditions the Member State must establish include, mitigation procedures to ensure an equivalent level of protection, and assessment of data demonstrating that an equivalence is achieved. **DISCUSSION:** Common elements established in all of these ULR operations include: requirements for appropriate fatigue mitigation, flight data collection, analysis, and demonstration of an "equivalent level of safety" before approval/authorization is granted by respective organizations.

Learning Objectives:

1. The audience will learn about some history of ultra long-range flight operations, worldwide, and the common elements that have carried over to contemporary regulatory mandates.
2. The audience will learn that contemporary regulations of ultra long-range flight operations require the application of scientific fatigue mitigation strategies and affiliated data collection.
3. The audience will learn that the analysis of fatigue mitigation data must provide demonstrative evidence of an "equivalent level of safety" to the safety standards set forth in the regulations before approval/authorization is granted by respective organizations.

[462] OPTIMIZING INFLIGHT REST DURING ULTRA LONG-HAUL FLIGHT

Erin Flynn-Evans[1], Kevin Gregory[2], Lucia Arsintescu[2], Cassie Hilditch[2], Amanda Lamp[3], Gregory Belenky[3]
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(Education - Program / Process Review Proposal)

BACKGROUND: As aircraft are capable of flying for longer durations, flightcrew must develop strategies to combat fatigue while flying. Ultra long-haul (ULH) flights can last >17 hours and when paired with commuting and pre-flight briefing time, crew have the potential to be awake for >20 hours. This presentation will review the factors that must be considered when scheduling inflight rest breaks for ULH flight and will further describe best practices for managing these issues. **OVERVIEW:** Although ULH flights require augmented crews (i.e. a second set of pilots to allow the operating crew rest) the sleep that a crew member obtains in flight is less than that achieved on the ground due to the limited opportunity for sleep in flight. As a result, it is imperative that ULH crew maximize their inflight sleep opportunity. The amount of sleep that a crew member can achieve on a given flight varies based on several factors. These factors can be defined as physiological, psychological, and environmental disruptors. Physiological disruptors include attempting to sleep during the wake maintenance zone, when the circadian rhythm is promoting wakefulness, or caffeine use inhibiting sleep. Psychological disruptors include rumination about personal concerns or anxiety leading to insomnia. Environmental disruptors include attempting to sleep when cabin service is occurring, leading to noise disrupting sleep, or issues such as bunk comfort and turbulence. Many of these sleep disruptors can be managed with proactive planning. For example, the timing of inflight rest can be planned relative to an individual's circadian rhythm to allow a sleep opportunity at an appropriate body clock time. Similarly, rest can be planned to avoid times when turbulence or cabin service may disrupt sleep. Despite these considerations, there may be situations where crew do not obtain enough sleep during their assigned rest break. In these cases, alternative mitigations, such as reassigning workload to a rested pilot or engaging in controlled rest may be warranted. **DISCUSSION:** Inflight rest is essential to assuring safe operations during ULH operations. The optimization of inflight rest during ULH flight requires careful planning to account for physiological, psychological, and environmental sleep disruptors. In situations where adequate inflight rest is not achieved, flightcrew should consider

alternative mitigations to reduce the risk of fatigue-related error during landing operations.
Learning Objective:
1. Understand how to best schedule inflight rest for ultra long-haul flight.

[463] ULTRA LONG-RANGE FLIGHT OPERATIONS: DATA COLLECTION AND EQUIVALENCE/NON-INFERIORITY TESTING

Amanda Lamp, Gregory Belenky
Washington State University, Spokane, Washington, USA

(Education - Program / Process Review Proposal)

BACKGROUND: The FAA 14 CFR Part 117.7--FRMS integrates scientific findings with respect to sleep, sleep loss, circadian rhythm, fatigue, and performance into the prescriptive rules governing flight and duty time limits. This innovative move provides for a data collection-enabled Fatigue Risk Management System (FRMS) as an alternative to the "one-size fits all" prescriptive approach. **OVERVIEW:** When a proposed flight does not fit within the prescriptive envelope, a route can serve as an Alternative Method of Compliance (AMOC) if it can be shown by data collected under an exemption to be as safe as or safer than a similar route that is in compliance with the regulation, ensuring an "equivalent level of safety." When applied to ultra-long-range flight operations in commercial aviation, an FRMS AMOC is compared to a similar route that is compliant with the prescriptive rule, the Safety Standard Operation (SSO). Data for the four Safety Performance Indicators (SPIs) including inflight sleep, cognitive performance, self-reported fatigue, and self-reported sleepiness is typically collected at TOD on both the AMOC and SSO routes. Throughout the data collection period, monthly reports including the AMOC and SSO data are sent to the FAA. These reports are used to ensure that the AMOC route does not show unsafe levels of sleep, fatigue, sleepiness, and/or performance during the data collection period. The data is analyzed once enough participants have data to detect statistically significant results. Statistical equivalence or non-inferiority analyses are used to demonstrate that the designated AMOC is equivalent or non-inferior to the designated SSO. The non-inferiority design can be used to test for equivalence, superiority, and non-inferiority and directly answers the question posed by the FAA in regard to safety. A final report is generated and submitted to the FAA based on the analyzed data. **DISCUSSION:** The FAA decides whether the results demonstrate the AMOC is safe to fly (as safe as or safer than the SSO). If so, an FRMS OpSpec is issued to the airline for the AMOC route. After the OpSpec has been issued, a continuing review with minimal data collected occurs to ensure the route continues to demonstrate the same level of safety.
Learning Objectives:
1. The audience will learn about Fatigue Risk Management Systems (FRMS).
2. The participant will be able to understand the FRMS regulatory process.
3. The audience will be able to distinguish between Alternative Method of Compliance (AMOC) and Safety Standard Operation (SSO) routes.

[464] PILOT PERSPECTIVE ON ULTRA LONG-HAUL FLYING

Colin Edwards
United Air Lines ALPA Fatigue Committee, Seattle, Washington, USA

(Education - Tutorial Proposal)

United Air Lines long duration flights are some of the most desired trips by our pilots and not just because they often layover at great destination. When properly prepared for, the long haul and ultra-long-haul flights (FRMS AMOC routes (Fatigue Risk Management System Alternative Method of Compliance) offer our pilots the ability to mitigate fatigue in ways not available to them on shorter routes. The long duration flights are crewed with four pilots which allows the pilots to divide the cruise portion of the flight into long rest segments not available on shorter flights. These rest segments often fall within the pilot's WOCL (Window Of Circadian Low). On many of these flights, pilots have 7 hours of inflight rest opportunity. This greatly reduces fatigue levels. Most pilots doing this type of flying remark that they feel considerably less tired on these trips than they do on shorter single augmented (3-pilot) trips or on a multi-segment domestic flight duty period that is near FAR 117 Table B limits. For example, a non-augmented crew flying two legs can work a 14-hour flight duty period without out a rest opportunity. While the longest duration flights offer a rest opportunity to each of the pilots by the 10-hour 30-minute point into the FDP. The longer inflight rest opportunity is key in reducing fatigue, and the four-pilot crew enhances CRM at points in the flight when fatigue is at its highest. The scheduling efficiency and the conditions and limitations of United's FRMS AMOCs for this type of flying allows pilots to work fewer calendar days thereby giving them more time off to prepare for the next trip and recover from previous trip. Once pilots start doing this type of flying they tend to keep doing it because of the high quality of work life it provides.
Learning Objective:
1. The audience will gain an insight to the pilot's perspective on ultra long-haul flying.

[465] IN-FLIGHT MEDICAL EVENTS AFFECTING CREWMEMBERS IN ULTRA-LONG-HAUL FLIGHTS

Paulo Alves[1], David Farnie[1], Neil Nerwich[2]
[1]MedAire Inc., Phoenix, AZ, USA; [2]International SOS, London, United Kingdom

(Original Research)

INTRODUCTION: In-flight medical events affecting crewmembers (IFMEAC) are always challenging situations. Ultra-long-haul flights (ULHF) could increase the chances for IFMEACs. We reviewed the epidemiology of IFMEACs with an emphasis in time duration. **METHODS:** MedAire's case database was reviewed for IFMEACs from January 2015 to June 2018. Demographics (age, gender, crew type) and operational data were collected for each case. Flights were divided according to the great circle distance into Short (≤ 2500 km), Medium (≤ 5,000 km), Long (≤ 13,500 km) and Ultra-Long (>13,500 km). **RESULTS:** 7,879 (167 pilots and 7,712 flight attendants) cases were retrieved. Gastrointestinal issues occurred in 24/57 cases (42%) of ULHF, increasing progressively with flight duration. Musculoskeletal symptoms were the second most frequent (9/57, 15.8%) in ULHF. There was only one diversion related to a ULHF, affecting a cabin crew member. The percentage of cases treated on board increased according to flight duration from 57.4% (Short) to 78.12% (Ultra-long). **CONCLUSION:** Gastrointestinal events (nausea, vomiting, abdominal pain) are the most frequent conditions affecting crewmembers in long-haul flights, a trend also observed for passengers. Long and ultra-long haul flights required the crewmember to be treated on board more often than shorter ones. No significant epidemiological difference was noted between long-haul and ultra-long flights.
Learning Objective:
1. Understanding how flight duration impacts in-flight medical events affecting commercial airlines crewmembers.

Thursday, 05/09/2019 ***3:30 PM***
Brasilia 3

[S-86] SLIDE: AEROSPACE MEDICINE PROFESSIONALS

Chair: Alden Hilton

Co-Chair: Ryan Peirson

3:30 PM

[466] A LOOK AT THE HISTORICAL IMPACT OF GMO FLIGHT SURGEONS ON THE RESIDENCY OF AEROSPACE MEDICINE AND FUTURE CONSIDERATIONS

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(Education - Program / Process Review Proposal)

MOTIVATION: A fairly significant change in the Graduate Medical Education (GME) process occurred in anticipation of this upcoming cycle in which applicants for the Residency in Aerospace Medicine (RAM) are now required to have a prior residency. This is a major shift in ideology as historically, General Medical Officers (GMO's) have been allowed to apply to the RAM as long as they had prior flight medicine experience. With this

change, GMO's wanting to continue in flight medicine as a RAM must now complete a residency program before the RAM and then apply or complete a hybrid RAM-family medicine program. This could have significant impacts on the RAM and subsequently on the leadership roles RAM graduates commonly fill, such as Chief of Aerospace Medicine (SGP) or Aeromedical Squadron Commander (AMDS/CC), as applicants and graduates would decline in number because of the lack of GMO's feeding into the program. **OVERVIEW:** GMO's historically have filled a significant number of RAM applicants and graduates over the years. Based on a retrospective study by Miles, et al. (Aerospace Medicine and Human Performance, Vol 87, No 3), from 1996 to 2001, out of the 106 RAM graduates, 41, or 39%, were GMO's. Looking at recent RAM classes from 2015-2019, there have been 12 out of 64, or 19%, GMO's. In total, across 10 years of class data, 53 out of 170, or 31.2%, were GMO's (average of 5.3 per year). Furthermore, in the Miles, et al. study, the authors discovered prior residency trained physicians in the RAM were approximately half as likely to recertify their aerospace medicine boards than their GMO counterparts (RR= 0.53, P= 0.0002). **SIGNIFICANCE:** Given current manning shortages across the Air Force Medical System (AFMS), exclusion of GMO's from entering into the RAM will further exacerbate the manning shortage in the Aeromedical Enterprise (AME). Additionally, if board re-certification is to be viewed long-term competency in one's field of study, then the RAM will also suffer from smaller percentages of their graduates challenging and passing their recertification boards. Unless there are additional pathways, or an increase in slots for current pathways for GMO's to enter the RAM, the AFMS could potentially see more GMO's separate or leave flight medicine as well as suffer an even greater RAM shortage which will push leadership roles such as AMDS/CC and SGP to those outside of the AME.

Learning Objectives:

1. Understand the potential impacts on the Residency in Aerospace Medicine with the exclusion of GMO applicants.
2. Consider alternative ways to allow for GMO's to apply to the RAM in order to prevent a potential manning shortage in key leadership roles.

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[467] TAG, YOU'RE IT! DEVELOPING JUNIOR FLIGHT SURGEONS IN LEADERSHIP POSITIONS

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75 AMDS, Hill AFB, UT, USA

(Education - Program / Process Review Proposal)

Flight medicine is a high ops tempo career field which is also not currently 100% manned. As a result, many junior flight surgeons find themselves in the position of flight commander and/or SGP with little to no training or available senior flight surgeons available to consult on how to fill these roles. Currently, it is difficult to specifically identify consolidated expectations or resources on how to execute these positions in a format that is easily referenced. There is significant institutional knowledge within flight medicine that these junior flight surgeons would find very helpful to tap into when they find themselves in these positions. Junior flight surgeons would benefit greatly from an online repository of information regarding up to date contact information, guidelines, and templates to help them navigate the day to day workings of flight medicine.

Learning Objective:

1. The audience will learn about the current issues facing junior flight surgeons in leadership positions, and ways to help them fulfill these roles better on a day to day basis by giving them resources to refer to when they have knowledge gaps.

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[468] UTILIZATION OF TECHNOLOGY AND SIMPLICITY TO ALLEVIATE FLIGHT SURGEON MANNING GAPS AND DEFICITS

Caleb James, Chrystal Henderson
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(Education - Program / Process Review Proposal)

BACKGROUND: The responsibility of the Air Force Flight Surgeon is to ensure medical readiness for flying squadrons and operational personnel. Manning deficits in Flight Medicine have led to increased clinical burden resulting in decreased operational presence and support. A novel approach to patient care recently tested in Air Force Family Health demonstrated improvement in access to care, patient satisfaction, and staff satisfaction. This presentation will discuss the effects of this model on one Flight Medicine Clinic. **OVERVIEW:** The role of an Air Force Flight Surgeon is wide in scope and commonly misunderstood by those outside the Aerospace Community. As such, the clinical aspect of the job, intended to consist of approximately 50% of the Flight Surgeon's time, can far exceed the 50% intended to be dedicated to Mission Essential Tasks and Line Support (METALS). Additionally, the misapplication of Air Force Instructions and Occupational Safety and Health Administration standards leads to increased workload for Team Aerospace. This greatly affects the ability to ensure medical readiness of the flying units and the base at large. Finally, manning deficits have led to an increase in clinical time for many Air Force Flight Surgeons. The RESET (Reward Efficiency, Set Priorities, and Empower Teams) model, developed for Primary Care Clinics, swept across Air Force Family Health Clinics in late 2017. This model offers the ability to serve patient needs while also decreasing face-to-face appointments. Though the Air Force approved RESET in all Primary Care settings, very few Aerospace Clinics have adopted this model. We discuss the modification of workflows as well as the implementation of RESET at Whiteman AFB and its effect on several metrics including access to care, METALS and 1041 Log. **DISCUSSION:** The RESET Model, along with several workflow modifications, had significant impact at Whiteman AFB regarding clinical workload. In turn, this alleviated clinic stresses placed on the Flight Surgeon and allowed for increased operational presence and support. RESET is being tested in multiple patient populations and electronic medical records and has appeared to confer benefits to both patient and staff. It has also been a force multiplier, allowing clinics to do more with less. This model can be applied readily across Air Force Operational Medicine Clinics but could also be easily modified for cross-service utilization with a potential for DoD-wide impact.

Learning Objectives:

1. The participant will learn about how scrubbing the patient list affects metrics inside the Air Force Aerospace and Operational Medicine Clinic.
2. The participant will learn about how simplifying workflows decreases provider's clinical time.
3. The participant learn about future technological opportunities to improve reporting and safety while decreasing workload.

4:15 PM

[469] THE GROWING ROLE OF NURSE PRACTITIONERS/ PHYSICIAN ASSISANTS IN AEROSPACE MEDICINE ACROSS THE AIR FORCE

Christopher Kelly
42nd MDG, Maxwell AFB, AL, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Since 2014, the Air Force has experienced its steepest manpower cuts in two decades yet mission demands and requirements have continued to expand. This has both increased and stretched the Flight Surgeon role beyond the historical scope. **OVERVIEW:** The aims of this discussion IS to explore the opportunities of Nurse Practitioners and Physician Assistants to help fill the long-standing deficit of the Air Force Flight Surgeon. We will discuss the cultural, clinical, operational and legal impacts of Nurse Practitioners/ Physician Assistants as Flight Surgeons. We intend to compare the credentialing requirements for the GMO Flight Surgeon, Nurse Practitioner and Physician Assistant and explore the limited difference in the clinical privileges between these roles. Additionally, we will focus on specific clinical experience that Nurse Practitioners/Physician Assistants should possess to be a suitable FS candidate. We will review the DoD Tri-service experiences with the utilization of physician extenders filling the roll of the Flight Surgeon. We will also discuss how the US Army, since 1992, has successfully utilized Physician Assistants as full flight surgeons to successfully support the US Army aviation mission. **DISCUSSION:** We will ground the discussion in the historical Flight Surgeon role as articulated by General "Hap" Arnold in 1942. In a

letter historically attributed to him, he identified the multiple roles that the Flight Surgeon must have to provide direct clinical and operational support roles to the military aviators. General Arnold mandated that all Flight Surgeons fly with the aircrews, walk the walk of the aviators and have a genuine bond with aircrew. General Arnold's vision improved the morale, familiarized Flight surgeons with aeromedical issue through shared flying experiences and defined the role of the Flight Surgeon. As the DoD opens the aperture of non-traditional airframes, limited physician flight surgeon manning and new evolving aeromedical issues, we should reflect upon General Arnold's vision and evaluate the current Flight Surgeon definition. Family Nurse Practitioners and Physician Assistants a have unique clinical skillset that can directly support the evolving Aerospace Medicine mission for tomorrow's Air Force.

Learning Objectives:

1. Understand the historical expectations of the Flight Surgeon as articulated by General "Hap" Arnold.
2. Discuss how changes in operational demands impact the practice of aerospace medicine, traditionally performed by Physician Flight Surgeons. .
3. Describe how the above changes impact the delivery of medial support to the aviator.

4:30 PM

[470] FLIGHT SURGEON SANS FRONTIÉRE- A NORWEGIAN APPROACH TO INTRODUCING A NEW WEAPONS SYSTEM

Odd-Ivar Lundseng, Anthony Wagstaff
Institute of Aviation Medicine, Oslo, Norway

(Education - Program / Process Review Proposal)

BACKGROUND: "New technology will lead to new mishaps" is a standing mantra in flight safety work. Human factors remain a common denominator in both military and civilian aircraft accidents. With the introduction of the F16 fighter in the early 1980s, Norway (NOR) repeated many of the same errors and had similar mishaps other customers already had experienced. In order to prepare and try to avoid the same situation, the Royal Norwegian Air Force (RNOAF) and the Institute of Aviation Medicine (FMI) identified a need to acquire and transfer as much pertinent knowledge as possible regarding human factors and relevant technology for the new weapons system being fielded. A flight surgeon (FS), organized as part of FMI, was deployed to the US for 2.5 yr prior to first aircraft arrival. **OVERVIEW:** Close cooperation with the Joint Program Office (JPO), USAF Training and Education Command (AETC) and senior leadership in the Armed Forces Joint Medical Service (FSAN) in Norway, opened up the opportunity to place a NOR Senior FS with the NOR training squadron at a US training wing. Program access was obtained through JPO. Completion of the pilot transition training except the flying portion gave valuable insight in relevant technology. Formal meetings with US aviation medicine personnel, and informal meetings with the operational community helped identify aeromedical challenges. Frequent meetings with RNOAF senior leadership and the rest of the team at FMI gave situational awareness and provided risk management of upcoming challenges. **DISCUSSION:** Program access, training and firsthand experience with operations contributed to a more informed introduction in NOR as a basis for more proactive flight safety activity within the aeromedical/human factors domain. This activity helped change the program focus more towards the importance of human factors. Early NOR aviation medicine presence in the introduction of- and training for the system, helped to a certain extent, to compensate for the shortcomings of aeromedical/human factors competency in the program office. Being a relatively small customer, the NOR approach to system specific aviation medicine opened up for dialogue with other partners. Information sharing within the constraints of security, increased the level of knowledge and contributed to increasing the program human factor awareness and competency base. The Institute of Aviation Medicine based some of our strategies on information obtained and shared by the NOR FS.

Learning Objective:

1. A possible solution in preparing for arrival of a technologically advanced weapons system that poses known and unknown aeromedical challenges with flight safety implications.

4:45 PM

[471] HYPEREMESIS GRAVIDIARUM IN A STUDENT PILOT REAPPLYING FOR CLASS ONE CERTIFICATION: AN EDUCATIONAL STUDY FOR THE FAA

Jennifer Keenan
Long Grove, IL, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This case report describes a 27-year-old female student pilot who experienced HEG throughout the duration of a twenty-six-week pregnancy. **BACKGROUND:** The FAA currently recommends that a pilot doesn't fly past the thirty sixth week of pregnancy or that she can fly full term without any physical or obstetrical concerns. As a result, there are many conditions of pregnancy that the FAA may not know how to respond to when presented with. Nausea occurs in 75-80% of pregnant women. Hyperemesis Gravidarum occurs in 0.8 to 2.3% of pregnancies. HEG is diagnosed typically between eight and twelve weeks and should resolve by week twenty. Occasional, HEG can last throughout a pregnancy for as long a that pregnancy lasts. Etiology and pathogenesis are relatively unknown. The most common theory is that a drastic rise in HCG is the cause of excessive nausea and vomiting. M and M states that because of intravenous fluids, mortality is very uncommon. Morbidity's include but are not limited to: Wernicke's Encephalopathy from B1 deficiency, Mallory Weiss tears, esophageal rupture, pneumothorax and acute tubular necrosis to name a few. Treatment as early as possible in pregnancy with doxylamine and vitamin B6. HEG Is typically self-limiting. The prognosis is generally good. Symptoms typically last throughout the duration of the first trimester of pregnancy. HEG symptoms can last up to twenty-two weeks and sometimes until delivery. There are also psychological complications that can occur with HG and they are as follows: depression, anxiety, irritability, mood changes and decreased concentration.

Learning Objectives:

1. To guide the FAA in objectively looking at diseases of pregnancy and assist aviation medical examiners in being able to return their pilots back to flight faster.
2. To address diseases of pregnancy and clinically investigate how and why they affect aerospace medical certification.
3. To help airlines clinically asses the need for maternity leave policies and to help airlines understand the need for maternity leave policies specific to their pilots' cases.

Thursday, 05/09/2019 ***3:30 PM***
Brasilia 4

[S-87] PANEL: AEROMEDICAL RISK ANALYSIS PRACTICE UPDATES – PART 2

Sponsored by The American Society of Aerospace Medicine Specialists

Chair: Dan Van Syoc

Co-Chairs: Edgar Rodriguez, Richard Allnutt

PANEL OVERVIEW: During this panel, aeromedical clinical experts and Aerospace Medicine residents will present risk analysis-based clinical updates on topics related to the assessment and treatment of aviators and special operational duty personnel suffering from specified medical conditions of aeromedical interest. Presentations will include recommendations for treatment and discussions of the aeromedical implications of the specified disease conditions.

[472] HEARING LOSS IN AVIATORS PART I & II

David Schall
FAA, Oklahoma City, OK, USA

(Education - Tutorial Proposal)

TOPIC: Evaluation of Hearing Loss in Aircrew. Hearing loss is one of the top causes of compensable disability in the military. While noise exposure may cause hearing loss, other etiologies must be considered

when evaluating Airmen. The first part of this talk will provide a discussion of the various causes of hearing loss that may be encountered. Part II of this talk will discuss treatment options available for Hearing Loss in Aircrew. New technologies continue to emerge and are now available for use by aircrew in both military and civilian career fields. **APPLICATION:** Evaluation and Diagnosis and treatment of Hearing Loss in Aircrew for both Military and Civilian populations. **RESOURCES:** Commercial Aviation: Pilots' and Flight Attendants' Exposure to Noise aboard Aircraft, GAO Report November 15, 2017 Hearing Impairment Among Noise-Exposed Workers — USA, 2003–2012, CDC MMWR Weekly, Vol. 65, No. 15. Hearing Loss in Adults, Cunningham LL, Tucci DL in NEJM 2017:377:2465-73.

Learning Objectives:
1. Understand the variety of causes of hearing loss that may be seen in aviators.
2. Learn about the various tools available for assessing hearing loss and site of lesion.
3. Develop knowledge about the various devices now available to the hearing impaired.

[473] ASAMS AEROMEDICAL RISK ANALYSIS - CIRRHOSIS

Charles Mathers
FAA, Oklahoma City, OK, USA

(Education - Tutorial Proposal)

INTRODUCTION: The purpose of this presentation is to provide the aerospace medicine physician an update on the aeromedical risks associated with cirrhosis and to review current practice guidelines for the management of cirrhosis. **TOPIC:** An overview of cirrhosis including epidemiology, pathophysiology, diagnosis, treatment as well as the aeromedical concerns will be presented. The authors will identify new relevant information regarding the aeromedical disposition of civilian airmen with cirrhosis. **APPLICATION:** With medical knowledge in constant change, performing aeromedical risk analysis is a fundamental process for maintaining the validity of current practice recommendations.

Learning Objectives:
1. Understand aeromedical risks associated with cirrhosis.
2. Review current practice guidelines related to the diagnosis and treatment of cirrhosis.
3. Learn common causes of cirrhosis and their implications in pilots.

[474] INFLAMMATORY BOWEL DISEASE: AN AEROMEDICAL UPDATE

Luke Menner
U.S. Air Force, Dayton, OH, USA

(Education - Tutorial Proposal)

INTRODUCTION: Inflammatory Bowel Disease (IBD) is a chronic inflammatory disease affecting the gastrointestinal tract and other organ systems resulting in significant aeromedical complications and the need for medical therapy that alters the immune system. **TOPIC:** IBD is primarily composed of ulcerative colitis and Crohn's disease. IBD is characterized by chronic inflammation of the gastrointestinal tract; however, other organs such as the eyes, skin, and joints might be affected. Aeromedical significant symptoms often arise that include fatigue, abdominal pain, diarrhea, hematochezia, malnutrition, and weight loss. Extra-intestinal manifestations of arthropathy, ocular, or skin disease may further impair aviation duties. The management of IBD centers on treatment of disease flairs, maintaining remission, and mitigating risk of developing long-term complications. There are multiple classes of medical therapeutics available that alter the immune system and effectively treat IBD. However, many of these therapies carry the potential risk of significant aeromedical adverse effects. **APPLICATION:** IBD is likely to be encountered more frequently by the aerospace medicine practitioner due to the increasing incidence of both Crohn's disease and ulcerative colitis. Advances in medical therapeutics used in the management of these conditions have allowed aviators to obtain substantially better disease control and quality of life. Appropriate treatment and monitoring of adverse effects in individuals with IBD provide the potential for continued aviation duties despite a diagnosis that carries significant morbidity.

Learning Objectives:
1. Identify the aeromedical implications of inflammatory bowel disease.
2. Review medical therapeutics, their adverse effects, and aeromedical concerns for the treatment of IBD.

[475] DERMATITIS IN AVIATION: ASAMS CLINICAL UPDATE

Joseph LaVan
Naval Aerospace Medical Institute, Pensacola, FL, USA

(Education - Tutorial Proposal)

INTRODUCTION: Dermatitis is a generic term encompassing both acute and chronic forms of atopic dermatitis and allergic and irritant contact dermatitis. While prevalence estimates in the adult population are shaky, the best data suggests around 10% of adult populations are affected. Due to the prevalence of dermatitis, it is likely that aviators, both military and civilian, will be affected. This clinical update will review aviation pertinent aspects of this diagnosis. **TOPIC:** There are many implications of dermatitis that are applicable to aviation. Most immediately, symptoms, including pruritus and pain could be distracting. Many forms of dermatitis have associations with other conditions, including allergic rhinitis, asthma and keratoconus, which may have implications of physical qualifications for flight. Many aspects of aviation have the potential to worsen or trigger dermatitis attacks, including use of safety equipment and exposure to skin irritants such as lubricants and aviation fuels. Further, treatment of these conditions often involves the use of medications that may impact safety of flight. **APPLICATION:** This update will cover epidemiology, presentation and management of the various forms of dermatitis, with a focus on the implications for the aviation environment and the safety of flight. Current aeromedical standards from FAA, ICAO, and US military services will be reviewed.

Learning Objectives:
1. The audience will learn about the clinical condition of dermatitis and its implications for aviation and safety of flight.
2. The audience will review aeromedical implications of dermatitis as it pertains to physical qualifications for aviation from various certifying agencies, including FAA, ICAO and US Military Services.

Thursday, 05/09/2019 ***3:30 PM***
Brasilia 7

[S-88] PANEL: FROM SEA TO SPACE: AEROSPACE MEDICINE WITHOUT BOUNDARIES

Sponsored by the University of Texas Medical Branch

Chair: Cheryl Lowry

Co-Chairs: Brian Pinkston, Christopher Haas, Eric Petersen, Moriah Thompson, William Edward (Ed) Powers

PANEL OVERVIEW: INTRODUCTION: The Annual Scientific Meeting provides an excellent foundation in the basic science, clinical presentation, theoretical concepts, and practical approach to the practice of Aerospace Medicine. This panel and integrated workshop is intended to provide a practical discussion and hands-on approach to key principles in providing aeromedical support in the undersea, desert, mountain, polar, and space environments. **TOPIC:** Aerospace Medicine in its purest form is the management of both normal and abnormal human physiology in extreme environments. Providing good clinical care in austere environments leverages a common set of practical principles. However, each extreme environment has its own unique considerations that influence human performance and support planning. In each case, the care provider may face limited resources in terms of equipment, medications, communication, access to specialty consultants, and unique environmental factors. Logistical constrains often require support teams to balance competing priorities to ensure mission safety and expedition success. This panel will highlight individual and collective considerations to provide attendees with a common framework with which to approach planning support for operations in extreme environments. Support for diving operations will be discussed through a special operations Blackhawk mishap response case presentation. Desert operations and their potential for use as a Mars expedition analog will be discussed. The

mountain environment will be discussed in the context of a B-25 crash recovery operation in Indonesia. Unique planning factors for the Polar environment and applications as a space analog will be presented. Finally, considerations for conducting astronaut crew recovery operations will be reviewed. **APPLICATION:** This panel and associated discussion will provide a capstone for attendees to apply scientific knowledge of aviation, space and environmental medicine to operational support in extreme environments. Support includes the application of clinical care techniques, human performance science, and risk-based logistical considerations to ensure successful operations and survival in these environments. Each of these environments may be experienced by an aviation, space, or undersea support team throughout the course of their occupational responsibilities.

[476] FROM SEA TO SPACE: AEROSPACE MEDICINE WITHOUT BOUNDARIES - MOUNTAIN MEDICINE

Brian Pinkston
University of Texas Medical Branch, Galveston, TX, USA

(Education - Tutorial Proposal)

INTRODUCTION: Polar medicine provides the challenges found in almost every other extreme environment. In Antarctica, high altitude, extreme cold, isolation, circadian rhythms and many other factors result in this continent's extreme challenges to the clinical medicine or human performance practitioner. A framework to prepare for these challenges are a matter of life and death in this setting. **TOPIC:** Aerospace Medicine in its purest form is the management of both normal and abnormal human physiology in extreme environments. The polar environment creates specific demands on humans with both normal and abnormal physiology. In the US, the National Science Foundation has medical screening criteria to reduce risk. However, the primary mission for the U.S. Antarctica Program is to conduct scientific research and much of this is conducted at remote sites. Remote site researchers have training in survival in this environment, however, many have not practiced long-duration daily living in such a hostile setting. Pre-existing disease conditions can further exacerbate difficulties encountered by daily living. This panel will briefly highlight some of the diseases than can be caused or worsened in this remote area of the planet. Isolation, sleep deprivation, fatigue, hypothermia, and altitude sickness can contribute to the factors causing a mishap. The rescue, transportation, and aeromedical evacuation of a program participant involved in an accident at a remote site will serve as the backdrop for this discussion. This operation utilized communications, self-aid and buddy care, the "walking blood bank" concept, and the first-ever use of an Airbus as an aeromedical evacuation platform in Antarctica. Common concepts to planning for such an environment will be a central theme of this discussion. **APPLICATION:** The ability to plan for operations in this type of environment is essential to aerospace medicine and human performance practitioners. Antarctica is studied as an analog for long-duration space missions as well as utilized to train aerospace medicine physicians in support to launch and recovery operations of the Soyuz program.

Learning Objectives:

1. The audience will be able to discuss the major physiologic effects of altitude and the planning considerations to prevent or treat these outcomes.
2. The audience will be able to discuss 5 major considerations when tasked to support a mountain expedition.
3. The participant will be able to compare and contrast the scenario discussed to other similar recovery and investigation operations in the mountain setting.

[477] FROM SEA TO SPACE: AEROSPACE MEDICINE WITHOUT BOUNDARIES

Erit Petersen
University of Texas Medical Branch, Galveston, TX, USA

(Education - Tutorial Proposal)

INTRODUCTION: The desert environment provides physiological and operational challenges due to temperature extremes, limited shelter options, physical isolation, difficult logistical support, and prolonged exposure to the environment. It is essential to consider these factors when providing operational support in a desert environment. **TOPIC:** Aerospace Medicine professionals must understand normal and abnormal human physiology in extreme environments. The desert environment creates specific demands on humans with both normal and abnormal physiology. With the increasing use of deserts for testing personnel and crew as an analog to Mars exploration, it is imperative that we understand the human factors associated with this environment. This panel will briefly highlight dehydration, heat illness, physical and psychological isolation, sun exposure and other desert environmental hazards. Logistical planning, personnel preparation, treatment and evacuation considerations will be discussed, as well as practical means to sustain human performance in this austere environment. Experience in a desert space exploration analog and other practical examples will serve as the foundation for this discussion. **APPLICATION:** The ability to plan for operational support in this challenging environment is essential to aerospace medicine and human performance practitioners. There is an emerging demand for expedition planning, medical support and human performance enhancement expertise in the desert environment. A common approach to planning in all extreme environments will assist in this preparation.

Learning Objectives:

1. By the ends of the presentation attendees will be able to list 4 major flora and fauna hazards in the desert environment.
2. By the ends of the presentation attendees will be able to discuss the rationale for the use of a desert environment as a Mars expedition analog.
3. By the ends of the presentation attendees will be able to discuss 2 methodologies to provide or conserve water in this setting.

[478] FROM SEA TO SPACE: AEROSPACE MEDICINE WITHOUT BOUNDARIES - SPACE MEDICINE

William Powers
The University of Texas Medical Branch, Galveston, TX, USA

(Education - Tutorial Proposal)

INTRODUCTION: Space medicine presents challenges beyond the expected norms for terrestrial medicine due to physiologic adaptation by humans to the microgravity environment. Consideration of these changes is essential when recovering those who return to the terrestrial environment. **TOPIC:** Aerospace Medicine involves the management of both normal and abnormal human physiology in extreme environments. The space environment creates unique demands on humans with both normal and abnormal physiology due to the effects of microgravity on the human body. Many adaptive measures by humans in the microgravity environment have been identified over the decades of human spaceflight including fluid shifting, decreased bone density and muscle atrophy. While these adaptive changes are suitable for the microgravity environment, they are considered maladaptations when returning the terrestrial environment. Specifically, when humans return to the terrestrial environment, they can be poorly suited for normal function at normal gravity until the body readapts to the new condition. These adaptations must be taken into consideration when recovering crews who return to earth from low earth orbit and beyond. In addition, pre-existing disease conditions can further exacerbate difficulties encountered by recovery personnel. This panel will briefly discuss some of the medical conditions encountered after spaceflight and how recovery personnel must be prepared for their treatment. **APPLICATION:** The ability to plan for recovery operations following habitation in the space environment is essential to aerospace medicine and human performance practitioners. The unique collection of medical challenges that are present when humans transition from a microgravity environment to a terrestrial environment requires careful planning and preparation.

Learning Objectives:

1. Participants will be able to list at least three physiologic changes that are unique to adaptation to the microgravity environment.
2. Participants will be able to identify at least two interventions available to assist with symptoms related to readaptation to the terrestrial environment following long duration spaceflight.

[479] FROM SEA TO SPACE: AEROSPACE MEDICINE WITHOUT BOUNDARIES-MARINE MEDICINE

Cheryl Lowry
University of Texas Medical Branch, Galveston, TX, USA

(Education - Tutorial Proposal)

INTRODUCTION: The marine environment provides unique challenges in terms of ambient pressure, environmental hazards, marine life, thermoregulation, risk of barotrauma, decompression illness and other issues. In order to effectively provide support to operations in this environment, it is essential to consider several key planning factors. **TOPIC:** Aerospace Medicine professionals must understand normal human physiology in both typical and abnormal environments. The marine environment creates specific risks for humans with both normal and abnormal physiology. This panel will review diver physical qualification requirements, followed by a discussion of typical marine hazards and unique hazards associated with in-water recovery operations. Operational diver support and accountability, as well as medical resource requirements will be discussed. Emphasis will be placed on the logistical considerations rather than individual treatment protocols. Recovery operations following a Blackhawk helicopter mishap will be utilized to highlight unique planning concerns for supporting divers in an austere environment. Nine special operations personnel perished in this mishap. Due to the location of the incident, the recovery operation was highly visible. Due to special operations personnel being involved in the recovery, a high degree of stress was experienced by the recovery team. Planning factors common to all environments will be discussed, however, managing stress will be highlighted in this scenario. **APPLICATION:** The ability to plan for operations in this type of environment is essential to aerospace medicine and human performance practitioners. The team involved in the operation were required to respond and operate on short notice and in a long-duration 24/7 shift schedule in a high-risk situation with unstable environmental factors.

Learning Objectives:

1. The participants will be able to identify 4 major flora and fauna hazards associated with the marine environment.
2. The attendees will be able to relate diving operations in a long-duration 24/7 operation to long-duration orbital spaceflight operations.
3. The audience will be able to describe methods to manage psychological and social stress in an extreme environment.

[480] POLAR MEDICINE

Moriah Thompson, Christopher Haas, Cheryl Lowry, Brian Pinkston, William Edward Powers
University of Texas Medical Branch, Galveston, TX, USA

(Education - Tutorial Proposal)

INTRODUCTION: Polar medicine provides the challenges found in almost every other extreme environment. In Antarctica, high altitude, extreme cold, isolation, circadian rhythms and many other factors result in this continent's extreme challenges to the clinical medicine or human performance practitioner. A framework to prepare for these challenges are a matter of life and death in this setting. **TOPIC:** Aerospace Medicine in its purest form is the management of both normal and abnormal human physiology in extreme environments. The polar environment creates specific demands on humans with both normal and abnormal physiology. In the US, the National Science Foundation has medical screening criteria to reduce risk. However, the primary mission for the U.S. Antarctica Program is to conduct scientific research and much of this is conducted at remote sites. Remote site researchers have training in survival in this environment, however, many have not practiced long-duration daily living in such a hostile setting. Pre-existing disease conditions can further exacerbate difficulties encountered by daily living. This panel will briefly highlight some of the diseases than can be caused or worsened in this remote area of the planet. Isolation, sleep deprivation, fatigue, hypothermia, and altitude sickness can contribute to the factors causing a mishap. The rescue, transportation, and aeromedical evacuation of a program participant involved in an accident at a remote site will serve as the backdrop for this discussion. This operation utilized communications, self-aid and buddy care, the "walking blood bank" concept, and the first-ever use of an Airbus as an aeromedical evacuation platform in Antarctica. Common concepts to planning for such an environment will be a central theme of this discussion. **APPLICATION:** The ability to plan for operations in this type of environment is essential to aerospace medicine and human performance practitioners. Antarctica is studied as an analog for long-duration space missions as well as utilized to train aerospace medicine physicians in support to launch and recovery operations of the Soyuz program.

Learning Objectives:

1. Participants will be able to list 5 key environmental factors affecting survival in a polar environment.
2. The audience will learn to recognize and state at least 3 signs of maladies associated with living in Antarctica.
3. The participants will be able to relate environment related factors associated with the accident discussed in the scenario.

Thursday, 05/09/2019 ***3:30 PM***
Miranda 5/7

[S-89] SLIDE: SPACE MEDICINE TECHNOLOGY & FUTURE OPS

Chair: Volker Damann

Co-Chair: Patrick J. McGinnis

3:30 PM

[481] PROBABILISTIC ASSESSMENT OF SEX-DEPENDENT MEDICAL RISK DURING SPACEFLIGHT

David Reyes[1], Kseniya Masterova[1], Eric Kerstman[1], Erik Antonsen[2]
[1]University of Texas Medical Branch, Galveston, TX, USA; [2]NASA Johnson Space Center, Houston, TX, USA

(Original Research)

INTRODUCTION: Crew sex differences may impact medical planning and crew performance by creating significantly different medical risk profiles during spaceflight. The contributions of sex-dependent conditions should be assessed and understood since proper medical planning will be essential as we continue to venture further into space for longer periods. In this study, we model the impact of sex-dependent medical conditions in spaceflight. **METHODS:** NASA's Integrated Medical Model (IMM, Service Request S-20170724-387) was used to perform probabilistic risk assessment to determine the impact of crew sex differences on mission medical outcomes. The IMM encompasses 100 conditions that have or may occur in spaceflight. Of these, 20 have sex-dependent outcomes in the model. Outcomes for all male, all female, and mixed sex crews were compared for a lunar sortie (42 days), International Space Station (ISS) mission (182 d.), and a Mars mission (913 d.). Crew Health Index (CHI), medical evacuation (EVAC), loss of crew life (LOCL), and influential medical conditions were reported. EVAC and LOCL were reported as probabilities (0 to 1). **RESULTS:** Sex-dependent differences are seen for rates of non-emergent EVAC during the 182 and 913-day missions, with females having higher probability of EVAC of 0.0388 vs. 0.0354 for the 182-day mission and 0.350 vs. 0.228 for the 913-day mission. These differences were primarily driven by higher incidence of partially treated Urinary Tract Infection. **DISCUSSION:** Partially treated urinary tract infection as a major driver indicates that the antibiotic used to treat this condition ran out during the 913-day mission period. This is an easily treated condition if appropriate resources are available. A major limitation of this work is that some conditions in the model that may have sex dependence are not currently input as sex-dependent conditions (e.g. Spaceflight Associated Neuroocular Syndrome). In addition, other conditions not included in the model may also have sex dependent impacts. However, this work shows that with adequate medical planning and supply, crew sex differences should not have a significant impact on mission medical outcomes.

Learning Objectives:

1. Participant will learn about the impact of sex-dependent medical outcomes in spaceflight.
2. Participant will understand the strengths and limitations of probabilistic modeling of medical outcomes in spaceflight.

3:45 PM

[482] THE EFFECT OF HEROIC MEDICAL CARE ON MISSION MEDICAL OUTCOMES

David Reyes[1], Eric Kerstman[1], Kris Lenhardt[2]
[1]University of Texas Medical Branch, Galveston, TX, USA; [2]Department of Emergency Medicine and the Center for Space Medicine, Baylor College of Medicine, Houston, TX, USA

(Original Research)

INTRODUCTION: A catastrophic illness or trauma requiring medical evacuation (EVAC) that occurs during a deep space mission will take days to reach definitive medical care (e.g., lunar orbit) or will be impossible (transit to Mars). Additionally, medical resources will be finite due to mass, volume, and resupply constraints. The impact of using a significant portion of available medical supplies to treat a catastrophic illness ('heroic measures') will impact the ability to provide for subsequent medical care and may decrease mission success. In this work, we model the impacts of treating a catastrophic medical event on subsequent mission medical outcomes. **METHODS:** We conducted a probabilistic risk assessment using NASA's Integrated Medical Model (IMM, Service Request S-20170724-388) to determine the impact of 'heroic measures' on subsequent mission medical outcomes. The model contains 100 medical conditions that have or may occur in spaceflight. A catastrophic medical event (urosepsis was selected a priori) requiring all relevant and available resources, was triggered in the model at 1, 135, 270, and 405 days into a 540-day simulated Mars mission. Crew Health Index (CHI), EVAC, loss of crew life (LOCL), and influential conditions were examined. **RESULTS:** CHI was not affected. The overall probability (0 – 1) of EVAC for the control (no catastrophic event) was 0.13, while the test cases had EVAC probabilities of 0.20, 0.19, 0.17, and 0.15 – at 1, 135, 270 and 405 days into the 540-day mission, respectively. A similar trend is noted for LOCL, although smaller in magnitude. Influential medical conditions in the test cases are dominated by partially treated conditions due to depletion of resources. This effect also diminishes the later in the mission the depleting event occurs. **DISCUSSION:** The desire to do everything possible to save a severely injured or ill astronaut could drive medical decision-making. However, the impact on the rest of the crews' health, and ultimate mission success, must be considered. These results show that there are minimal impacts on CHI after a large expenditure of medical resources due to a catastrophic event. Also, the increased risks of EVAC and LOCL are less pronounced the later in the mission the catastrophic event occurs. Therefore, the impacts of using heroic measures are less than might otherwise be anticipated. The quantification of these impacts may be useful for mission planning, as well as real-time mission decision support.

Learning Objectives:

1. The audience will understand the modeled impacts of "heroic" medical care on overall crew health and mission success.
2. The audience will learn about how models can be used to provide quantitative estimates of outcomes in the absence of definitive data.

4:00 PM
[483] OPTIMIZATION OF AN EXPLORATION MEDICAL KIT USING THE INTEGRATED MEDICAL MODEL

Eric Kerstman[1], John Arellano[2], Lynn Boley[3], David Reyes[1], Lynn Saile[3]
[1]University of Texas Medical Branch, Galveston, TX, USA; [2]MEI Technologies, Houston, TX, USA; [3]KBRwyle, Houston, TX, USA

(Original Research)

INTRODUCTION: As the National Aeronautics and Space Administration (NASA) plans for human exploration missions, the mass and volume constraints of new vehicles present challenges in designing medical kits for these missions. A lunar flyby hybrid free-return mission designated as Exploration Mission-2 (EM-2) is planned for 2023 using the new Orion vehicle. The Integrated Medical Model (IMM) is an evidence-based decision support tool used to assess mission risk due to in-flight medical events. The IMM was used to inform the preliminary design efforts of a medical kit for the EM-2 mission (IMM Service Request S-20180815-406). **METHODS:** The IMM generated two optimized 9 kg mass constrained medical kits, one with a volume constraint of 0.014 cubic meters and one with no volume constraint for an EM-2 mission of 21 days with 4 crewmembers. Since the IMM is baselined to the International Space Station vehicle and environment, it was modified to better reflect the Orion vehicle and environment. The IMM optimization routine was set to generate medical kits that maximized crew health within the specified mass and volume constraints. The primary outcome was Crew Health Index (CHI), a measure of crew health based on quality-adjusted time lost due to medical events and reported as 0 to 100%. The probability (0-1) of medical Evacuation (EVAC) and medical Loss of Crew Life (LOCL), required medical resources, and influential medical conditions were reported as well. **RESULTS:** Both optimized medical kits resulted in a mean CHI of 97.20%. The mean probability of EVAC was 0.0074 for the volume constrained medical kit and 0.0065 for the medical kit with no volume constraint. The mean probability of LOCL was 0.0005 for both the volume constrained medical kit and the medical kit with no volume constraint. The optimized medical kit with no volume constraint had a resultant volume of 0.024 cubic meters. **DISCUSSION:** The IMM generated an optimized medical kit for the EM-2 lunar flyby mission. The results demonstrate that it is feasible to design a medical kit within significant mass and volume constraints that can maintain crew health, while also maintaining a low probability of EVAC and LOCL. These results will be used by NASA to inform the preliminary design of a medical kit for the Orion EM-2 mission. Additional subject matter expertise and operational experience will be required to develop the definitive medical kit for this mission.

Learning Objective:

1. The audience will learn about the use of modeling to inform the design of medical kits for exploration spaceflight missions.

4:15 PM
[484] OPTIMIZING FUTURE EMERGENCY AND CRITICAL CARE CAPABILITIES DURING MEDICAL EVACUATION FROM LOW EARTH ORBIT

Craig Nowadly[1,2], Brandon Trapp[2], Stephen Robinson[3], John Richards[2]
[1]Travis Air Force Base, Sacramento, CA, USA; [2]University of California at Davis, Sacramento, CA, USA; [3]University of California at Davis, Davis, CA, USA

(Original Research)

INTRODUCTION: Provision of critical care and resuscitation abilities was not practical during early missions into space. Work has begun to design a "space ambulance" capable of dedicated medical evacuation from low Earth orbit (LEO) using the X-37B as a model. Given likely advancements in commercial spaceflight and increased human presence in LEO in the coming decades, consideration should be given to medical evacuation platforms capable of facilitating emergency and critical care. **METHODS:** PubMed, Web of Science, Google Scholar, NASA Technical Server, and Defense Technical Information Center were searched from inception to August 2018. Articles specifically addressing critical care and resuscitation during emergency medical evacuation from LEO were selected. Evidence was graded using Oxford CEBM. **RESULTS:** The search resulted in 109 articles included in the review with a total of 2,177 subjects. There were two Level I systematic reviews, 33 Level II prospective studies with 647 subjects, seven Level III retrospective studies with 1,455 subjects, and two Level IV case series with four subjects. There were two Level V case reports and 63 pertinent review articles. **DISCUSSION:** The ability to provide critical care and emergent resuscitation during transport is likely to be limited by mass, volume, cost, re-entry forces, and lack of specialized medical equipment. Military and civilian analogues for critical care medical evacuation highlight similar challenges to evacuation from low Earth orbit. By designing an optimized medical evacuation platform, such as a modified X-37B, we can identify limitations in current mission capability and medical knowledge. Such knowledge will allow the development of future design of capabilities capable of rapid and safe return to Earth for definitive care.

Learning Objectives:

1. The audience will learn about the history of medical evacuation capabilities from low Earth orbit.
2. The audience will learn about challenges faced during the delivery of emergency and critical care medicine during medical evacuation from from low Earth orbit.
3. The audience will learn about a proposed adaptation of the USAF X-37B into a "Space Ambulance" and how our understanding of this project will help shape future medical evacuation capabilities.

4:30 PM
[485] CURRENT INTRANASAL SCOPOLAMINE APPROACHES ARE NOT RAPID ENOUGH FOR OPERATIONAL USE

Aleksandra Stankovic[1], Jay C. Buckey[2]
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(Original Research)

INTRODUCTION: Motion sickness (MS) diminishes performance in altered motion environments (e.g. in naval, aviation, and space operations). Scopolamine (SCOP) suppresses motion sickness symptoms, but when administered orally must be given well before motion exposure to be effective. A rapid onset, non-injection mode of delivery is needed to provide an "as needed" or rescue therapy. Intranasal (IN) delivery of SCOP is attractive because it may be faster acting, could be effective when gastric motility is slowed, and may have pharmacokinetics that could minimize side effects. To assess IN SCOP's rate of absorption we analyzed pharmacokinetic data from a placebo-controlled, randomized, double blind, dose-ranging study of IN SCOP, and compared these pharmacokinetic outcomes against oral SCOP parameters in the published literature. **METHODS:** 8 healthy male and female adult volunteers received either low dose IN SCOP (0.2 mg), or high dose IN SCOP (0.4 mg). Subjects received each treatment dose once. Blood samples were collected before and after medication administration at various time points up to 6 hours post-treatment (pre-dose, 0.25, 0.5, 0.75, 1, 2, 3, 4, 6 hr post-dose). T_{max} (time to maximum drug concentration) was used as a marker of the rate of absorption. **RESULTS:** The mean time to reach peak plasma concentration (T_{max}) was not significantly different between high dose (M = 75.0 min, SD = 49.4 min) and low dose IN SCOP (M = 61.9 min, SD = 37.1 min). When compared to T_{max} of dose matched (0.4-0.5 mg) orally delivered SCOP from the published literature (N = 5, M = 46.9 min, SD = 42.1 min, Putcha et al., 1989; N = 14, M = 23.5 min, SD = 8.2 min, Ebert et al., 1998), IN delivery via gel formulation did not offer significant improvement of onset latency ($t(11) = 1.1$, $p = 0.32$, when compared with the Putcha et al.,1989 data), and in some cases performed significantly worse ($t(20) = 3.9$, $p < 0.001$, as compared with the Ebert et al., 1998 findings). Similar results were found for an aqueous IN solution (Geyer et al., 2017). **DISCUSSION:** Current IN SCOP formulations and administration methods do not offer a more rapid onset when compared with oral administration, and the variance in time to peak plasma concentration suggests a high degree of variability in delivery. While IN SCOP has potential as an alternate administration route for relieving MS symptoms, more work is needed to identify optimal intranasal formulation and dispensing methods.

Learning Objective:

1. Understand the limits of current knowledge of intranasal administration of scopolamine.

4:45 PM

[486] A WEB-BASED ENVIRONMENT TO CALCULATE THE MEDICAL MASS, POWER AND VOLUME OF EXPLORATION CLASS SPACE MISSIONS

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(Original Research)

INTRODUCTION: The ability to deliver an evidenced-based Medical Mass/Power/Volume (MPV) calculation for a Preliminary Design Review of any space mission has been a challenge. **METHODS:** Accordingly, a cloud-based relational database was created to development the requirements an Exploration Medical Care System (EMCS). The EMCS catalogs the resources needed to treat to resolution more than 300 medical conditions considered likely by several space agencies. Based on worst-case outcomes for each condition, the supplies needed were entered into the database. The MPV needed to provide primary and secondary medical prevention strategies for each condition was also included. The EMCS can therefore track the cumulative MPV required to maintain the heath and performance of all crewmembers. To bound the EMCS MPV, certain assumptions must be made, however they can also be dynamically changed (i.e. Only one crew member can be ill at one time). Crew training and competency maintenance required to mitigate each condition can also be tracked. **RESULTS:** The EMCS supports the creation of multiple mission versions (destination, levels of gravity, crew compliment, length of mission, medical conditions supported, levels of care, etc..) resulting in different MPV requirements. Due to the complexity of the data, a report generator was created to publish the MPV based on each condition and the total MPV for the mission. **DISCUSSION:** When missions are created or altered, these EMCS reports can be rapidly regenerated. For the next phase of the EMCS project, we anticipate the creation of a collaborative environment where multiple experts can use an evidence-based approach to derive event-sequence-diagrams (ESD) to map all possible outcomes of each condition besides the initial worst-case calculations. These ESD's will create more granularity to the MPV requirements and allow outcomes to be resolved differently (i.e., advanced levels of care versus palliation). To aid in the data management and collation of information, this web-based EMCS will allow experts to collaborate in the creation and assessment of medical literature required for each condition. The EMCS was developed using industry standards (Java, Spring Boot, etc.) to interact with the database structure. It is anticipated that the EMCS will facilitate trade studies which allow mission design teams to determine the impact of changing certain resources (i.e., removing a ventilator, adding palliative care).

Learning Objectives:

1. The audience will learn the concepts of "Entropy-Carrier Systems" in the design of complex systems.
2. The audience will learn the concepts of 'Trial of Therapy' before "Palliation" for exploration class missions.
3. The audience will learn the concepts of web-based collaborative environments to help coordinate the product from subject matter experts to control medical hazards for space travel beyond low Earth orbit.

FRIDAY, MAY 10, 2019

Friday, 05/10/2019 ***8:00 AM***
Red Rock Canyon Park

[S-90] WORKSHOP: INTRODUCTION TO DESERT AND EXTREME MEDICINE

Chair: Cheryl Lowry

Co-Chair: Brian Pinkston

WORKSHOP OVERVIEW: This is an introductory workshop focused on operational medicine and expedition support in an extreme (desert) environment. Extreme environments are increasingly used by NASA and other researchers as analogs to long-duration missions. AsMA members may either support or participate in research expeditions or adventure travel. In this workshop, participants will learn to assess hazards found in the desert environment. We will discuss treatment of common envenomation, endemic diseases and key elements of survival in desert austere environment. Participants will learn patient packaging and movement techniques incorporating improvised equipment and mechanical advantage raising and lowering systems. We will demonstrate strategies to maintain safety, prevent injuries and competently provide initial treatment for common injuries in this environment. Additionally, we will discuss assisting patients and expedition teams with travel planning including medical kit preparation, communication and emergency assistance planning. We will address the knowledge gap that exists in general medicine regarding desert and extreme environment activities. The workshop will culminate in a practice scenario applying workshop knowledge and skills.

Bus transportation to the site at Red Rock Canyon Park and lunch are included.