

**Sunday, May 10**  
**Asia 4**

**9:00 A.M.**

**10:00 A.M.**

## **[II.] WORKSHOP: AIRCREW FATIGUE: CAUSES, CONSEQUENCES, AND COUNTERMEASURES**

9:00 a.m.-3 p.m.

Fee: \$125, Advance registration only

5 AMA PRA Category 1 Credits™

**Co-Chair: John Caldwell**  
Yellow Springs, OH

**Co-Chair: Lynn Caldwell**  
Yellow Springs, OH

### **[002] AIRCREW FATIGUE: CAUSES, CONSEQUENCES, AND COUNTERMEASURES**

J. Caldwell<sup>1</sup> and L. Caldwell<sup>2</sup>

<sup>1</sup>Coastal Performance Consulting, Yellow Springs, OH; <sup>2</sup>Aeromedical Directorate, Naval Medical Research Unit Dayton, Yellow Springs, OH

**INTRODUCTION:** In modern aviation operations, aircrew fatigue is a serious but often unrecognized problem. The unpredictable work hours, long duty periods, circadian disruptions, and disturbed or restricted sleep that are commonly experienced by aviation personnel strain the body's adaptive capabilities. The result is that crewmembers often report for duty in a fatigued state. Because of this they make mistakes, respond more slowly, experience cognitive difficulties, and suffer mood disturbances that, taken together, often lead to performance problems and compromised safety. Aircrew fatigue can be effectively mitigated, but only if scientifically validated strategies are systematically applied. These include 1) the implementation of crew scheduling procedures that are based on up-to-date scientific information about the underpinnings of fatigue; 2) the implementation of scientifically-based in-flight counter-fatigue practices; 3) educating crew and crew schedulers on the importance of sleep and circadian rhythms in effective fatigue management; and 4) the utilization of effective strategies for optimizing off-duty sleep periods. Once comprehensive, scientifically-validated fatigue-risk mitigation processes are fully integrated into the aviation safety system, fatigue can be effectively managed, and safety and performance can be optimized. The proposed fatigue workshop will outline the importance of addressing fatigue from inadequate sleep as a danger in aviation, the basic physiological mechanisms underlying fatigue, and the most common causes of fatigue in air transport and other settings. In addition, the workshop will present ways to recognize fatigue in operational environments, provide information about the relative efficacy of various fatigue countermeasures, and present some basics of a good Fatigue Risk Management System (FRMS). This workshop is aimed at those with a basic understanding of the problem of fatigue in operational environments, and/or those who are anticipating new duty assignments in which they will bear some responsibility for the alertness management of aviators or other personnel. No prior education in fatigue management, sleep, or circadian rhythms is required.

#### **Learning Objectives:**

1. Identify the sources of fatigue in the operational community.

**Monday, May 11**  
**Northern Hemisphere Ballroom**

**8:00 A.M.**

## **OPENING CEREMONIES AND 61<sup>ST</sup> ANNUAL LOUIS H. BAUER LECTURE**

### **Advanced Medical Technologies and their Implications for Aerospace Medicine and Human Performance**

Melchor Antuñano, M.D., M.S.

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

**Monday, May 11**  
**Americas Seminar**

## **[III.] POSTER: SPACE: THE FINAL FRONTIER**

**Co-Chair: Michael Gallagher**  
Edmonton, Alberta, Canada

**Co-Chair: Anita Mantri**  
Bryan, TX

### **[003] BASIC SPEECH PERCEPTION DEFICITS DURING MICROGRAVITY SIMULATION AND CONTROLLED SLEEP LOSS**

C. Frank<sup>1</sup> and D. Molfese<sup>2</sup>

<sup>1</sup>Psychology, Butler University, Indianapolis, IN; <sup>2</sup>Center for Brain, Biology, and Behavior, University of Nebraska--Lincoln, Lincoln, NE

**INTRODUCTION:** The goals of this study were to assess the impact of microgravity on basic speech perception and to examine the consequences of controlled sleep loss on basic speech perception and the interaction, or cumulative effect, that sleep loss and microgravity produce when experienced together. Brain event-related potentials (ERPs) of 22 female and 23 male adults were recorded during an auditory phoneme distinction task both: (a) in an upright, sitting position and (b) in a head-down tilt (HDT) position used to simulate the effects of microgravity. After maintaining regular sleep patterns for Week 1, each participant was assigned to one of three sleep loss conditions for Week 2: (a) no sleep reduction, (b) 1-hour nightly sleep reduction or (c) 3-hour nightly sleep reduction. As expected, position had an overall effect, while sleep reduction differentially affected speech perception. No interactions between position and sleep were found, suggesting that sleep loss and head-down tilt act independently on the brain in a simulated microgravity environment.

#### **Learning Objectives:**

1. Assess the impact of microgravity on basic speech perception.

### **[004] DIABETES MELLITUS - A NOVEL ANALOGUE ENVIRONMENT TO ASSESS IMMUNE DYSFUNCTION IN MICROGRAVITY**

A.S. Ahmed

Center for Space Medicine, Baylor College of Medicine, Houston, TX

**INTRODUCTION:** Microgravity alters the normal physiology of cells and tissues seen on Earth; however, researching the mechanisms of these changes in outer space presents a challenge. Routine experimentation in space is limited by factors such as high cost, relatively short mission duration, and inadequate facilities. These limitations can be circumvented via analogue environments - artificial settings that simulate the desired effects of microgravity without the need to leave Earth. Analogue environments are not a novel concept and simulations mimicking specific effects of microgravity are in use, such as clinostats, rotary cell culture system bioreactors, hind limb unloading, and head-down tilt. However these modalities do not adequately address microgravity-induced immune dysfunction. Microgravity causes immunosuppression via effects on a variety of cells and signaling molecules - alteration of inflammatory cell function and tissue infiltration, changes in neutrophil phagocytic and oxidative responses, morphologic and functional changes in fibroblasts, blunting of monocyte and T-lymphocyte stimulation, decreased production of antibodies and cytokines by lymphoid cells, and decreased cellular response to growth factors such as PDGF, FGF, and EGF. These changes can lead to higher infection rates, worse prognosis after infection, and impaired wound healing following injury. A common condition that exerts similar deleterious effects on these cell populations and signaling molecules is diabetes mellitus. Hyperglycemic states result in diminished function and migration of immune cells such as neutrophils, monocytes, lymphocytes, and fibroblasts. It also alters signaling molecule and growth factor concentrations and cellular responses. Due to similarities in effects on immune cells and molecules, diabetes mellitus can serve as a novel analogue environment to test interventions and

countermeasures for microgravity-induced immune dysfunction. An extensive literature review showed a current lack of analogue modalities to study immune derangements in microgravity, and elucidated significant similarities in immune dysfunction between DM and microgravity.

#### Learning Objectives:

1. Diabetes mellitus can serve as an analogue environment to study immune cell and signaling molecule changes in microgravity.

#### [005] PREDICTED BONE LOSS RATE CHANGES FOR SPACEFLIGHT BASED ON TERRESTRIAL SKELETAL UNLOADING: A META-ANALYSIS

F. Bonato<sup>1,2</sup>, W.E. Thornton<sup>3</sup>, A. Bubka<sup>4</sup>, and D.E. Labropoulos<sup>2</sup>

<sup>1</sup>Aerospace Medicine and Human Performance, Montclair, NJ;

<sup>2</sup>Montclair State University, Montclair, NJ; <sup>3</sup>NASA (ret), Houston, TX;

<sup>4</sup>Saint Peter's University, Jersey City, NJ

**INTRODUCTION:** Research evaluating bone loss resulting from extended periods of microgravity commonly concludes that the rate of loss is 1-2%/month in the lower extremities. However, the true rate of loss over extended periods of time remains unclear. Although monitoring bone before, during and after spaceflight would be ideal in determining loss rate, such data are limited in availability and the use of countermeasures has not been consistent. However, analyzing bone loss that occurs in microgravity analogs can be valuable. Such analogs can include skeletal unloading during prolonged bed rest as well as the unloading that occurs for spinal cord injured (SCI) patients. **METHODS:** A meta-analysis of previous studies was performed, specifically focusing on tracking the percentage of bone (and calcium) lost across various lengths of time. Studies considered specifically addressed the pattern of loss given we were less concerned with the mechanisms involved for this study. **RESULTS:** There is evidence that suggests bone loss associated with skeletal unloading does not occur in a simple linear fashion. If 1-2% of original bone mass was lost each month no bone would be left after 50-100 months (without countermeasures). If 1-2% of existing bone mass was lost each month 50-75% of bone would be lost in 69 months. This pattern of loss is not linear and would never reach 100%. 1g studies suggest that such loss is exponential with a constant limit. Data from SCI patients also suggests that the rate of bone loss is not only nonlinear but decelerates with time and reaches a level at which no additional losses take place. **DISCUSSION:** Much remains unknown about the anatomic distribution (e.g. femoral neck geometry) of bone loss (lamellar, cancellous bone) and the biomechanical strength of the resulting bone (+/- countermeasures). However, based on our analyses, the commonly cited 1-2%/month bone loss rate is not correct. This may be the rate at which bone is initially lost. Bone loss during spaceflight may slow as a function of time and may be subject to a genetic floor effect.

#### Learning Objectives:

1. To examine more carefully the commonly cited 1-2% bone loss rate associated with spaceflight.

#### [006] THE HEART IN SPACE ENVIRONMENT

R. Iglesias

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**INTRODUCTION:** During spaceflight, cardiovascular system (CVS) has many important changes provoked by the absence of gravity (0G). These changes, substantially modify the normal cardiovascular clinical parameters as how they are measured on Earth. Therefore, when these parameters are evaluated by "terrestrial cardiology" criteria, as how they could indicate severe pathology, they would completely be normal at 0G and will follow the adaptation process to the 0G space environment. **METHODS:** General review was conducted over the accumulated experience gained in space medicine, particularly which is related to the anatomical and functional changes what the space environment conditions impress to the CVS. **RESULTS:** The most important cardiovascular modifications in space are the following: - Migration of fluids from the

inferior body's parts toward the upper regions. Facial edema, dilatation of face and neck veins; homogeneous pressure (arterial, venous, capillary) in the entire organism; elevation of the diaphragm and liver (5 cm); diminution of the heart's size (20%) and horizontalization of them; alteration of the thorax (it becomes shorter and wider); increase of intrapulmonary blood (average of 800 ml); homogeneous distribution of the circulation, ventilation in pulmonary pressure; diminution of the total blood volume (approximately one liter); diminution of pulse amplitude and collapse of the superficial veins in the lower limbs. All of these data are *abnormal* in a cardiology exam on Earth, but are *normal* in space and follow after an adaptive process. **DISCUSSION:** The normal clinical cardiovascular parameters in space, when evaluated by "terrestrial cardiology" criteria, would result in a significant indicative of severe pathology, but are normal in 0G and obey to a process of adaptation to the space environment.

#### Learning Objectives:

1. The normal cardiovascular examination data in space, is different from the examination on earth.

#### [007] MOTION SICKNESS IN ZERO-G PARABOLIC FLIGHTS

J.F. Golding<sup>1</sup>, A.C. Paillard<sup>2</sup>, and P. Denise<sup>3</sup>

<sup>1</sup>Psychology, University of Westminster, London, United Kingdom;

<sup>2</sup>Psychology, Newham Campus, Open University, London, United Kingdom;

<sup>3</sup>University of Caen, Caen, France

**INTRODUCTION:** Zero-G Parabolic flight reproduces the weightlessness of space for short periods of time. It has proved to be an invaluable research tool. However motion sickness can be a significant problem for some scientists. The aim was to assess the extent of this problem and to find possible predictors and modifying factors. **METHODS:** European Space Agency Parabolic Zero-G flights had a pattern in which 31 parabolas were performed in blocks during the middle portion of the flight. Each parabola consisted of 20s 0g sandwiched by 20s hypergravity periods of 1.5-1.8g. The survey covered n=246 person-flights (193 Males 53 Females), aged (M+/-SD) 36.0+/-11.3 years. An anonymous questionnaire included motion sickness rating (1=OK to 6=Vomiting), validated Motion Sickness Susceptibility Questionnaire (MSSQ), use of anti-motion sickness medication, prior Zero-G experience, anxiety level, and other characteristics. **RESULTS:** Participants were less susceptible than the general population with MSSQ percentile scores 27.4+/-28.0 versus norm of 50. Motion sickness was experienced by 33% and 12% vomited. Less motion sickness was predicted by older age, greater prior Zero-G flight experience, medication with oral scopolamine, lower MSSQ, less anxiety, but not by sex. The lack of effect for sex may have reflected the smaller number of women in the sample and perhaps self-selection to avoid Zero-G flights in the more motion sickness susceptible women. Sickness ratings in fliers pre-treated with scopolamine (1.81+/-1.58) were less than half those experienced by non-medicated fliers (2.93+/-2.16), and incidence of vomiting in fliers using scopolamine treatment was half to a third of that observed in non-medicated individuals. Possible confounding factors including age, sex, flight experience, MSSQ, could not account for this. **DISCUSSION:** Motion sickness presents a problem on parabolic flights. Fliers were intrinsically less motion sickness susceptible compared to the normal population. Doubtless very susceptible individuals avoid such a provocative environment if they can. Risk factors for motion sickness included younger age & higher MSSQ scores. Protective factors included prior Zero-G flight experience (probably reflecting habituation) & anti-motion sickness medication.

#### Learning Objectives:

1. The audience will gain a greater understanding of the problem of motion sickness in Zero-G Parabolic flight.

#### [008] MENSTRUAL CYCLE CONTROL IN FEMALE ASTRONAUTS AND THE ASSOCIATED RISK OF VENOUS THROMBOEMBOLISM

V. Jain<sup>1,3</sup> and V.E. Wotring<sup>2</sup>

<sup>1</sup>Barts Health Trust, London, United Kingdom; <sup>2</sup>Space Life Sciences, Universities Space Research Association, Houston, TX; <sup>3</sup>King's College London, London, United Kingdom

**INTRODUCTION:** Venous thromboembolism (VTE) is a common and serious condition affecting approximately 1-2 per 1000 people in the USA every year. There have been no documented case reports of VTE in female astronauts during spaceflight in the published literature. Some female astronauts use hormonal contraception to control their menstrual cycles and it is currently unknown how this affects their risk of VTE. Current terrestrial risk prediction models do not account for the spaceflight environment and the physiological changes associated with it. We therefore aim to estimate a specific risk score for female astronauts who are taking hormonal contraception for menstrual cycle control, to assess risks of VTE. A systematic review of the literature was conducted in order to identify and quantify known terrestrial risk factors for VTE. Studies involving analogues for the female astronaut population were also reviewed, for example, military personnel who use the oral contraceptive pill for menstrual suppression. Well known terrestrial risk factors, for example, obesity or smoking would not be applicable to our study population as these candidates would have been excluded during astronaut selection processes. Other risk factors for VTE include hormonal therapy, lower limb paralysis, physical inactivity, hyperhomocysteinemia, low methylfolate levels and minor injuries, all of which potentially apply to crew members. Lifetime Surveillance of Astronaut Health data will be assessed to identify which of these risk factors are applicable to our astronaut population. Using known terrestrial risk data, an overall estimated risk of VTE for female astronauts using menstrual cycle control methods will therefore be calculated. We predict this will be higher than the general population but not significantly higher requiring thromboprophylaxis. This study attempts to delineate what is assumed to be true of our astronaut population, for example, they are known to be a healthy fit cohort of individuals, and combine physiological impacts of space-flight (cephalic fluid shifts, lower limb inactivity) to understand specific risks associated with hormonal contraception.

#### Learning Objectives:

1. Review the etiology of venous thromboembolism.
2. Understand the specific risk factors for VTE for female astronauts using hormonal contraception.

#### [009] NEW DEVELOPMENTS TO PROMOTE CREW HEALTH AND SAFETY: "ACTIVE PERSONAL DOSIMETRY SYSTEM FOR HUMAN SPACEFLIGHT"

U.H. Straube<sup>1</sup> and T. Berger<sup>2</sup>

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<sup>2</sup>Institute of Aerospace Medicine, German Aerospace Center, Cologne, Germany

**INTRODUCTION:** Over the last decade human presence in space has increased significantly. Extended missions lasting half a year or more became "standard" scenarios and a one year missions will launch soon. Challenges to human health and wellbeing are though still significant, increasing with mission length and workload. Radiation in space remains one of the inevitable and dominating factors relevant to crew- health, -safety and mission success. **METHODS:** The European Crew Active Dosimetry development shall enable advanced personal dosimetry capabilities in real time. It provides a differentiated set of exposure data, supports risk assessment and dose management. Final goal is the verification of the system capabilities at highest standards enabling for operational use and medical monitoring in future. The system consists of several small portable Personal Active Dosimeters (MU = Mobile Unit's) as well as a rack mounted docking station called "Personal Storage Device (PSD)". The PSD provides data read-out data and advanced display capabilities as well as data storage and telemetry. The PSD contains a Tissue Equivalent Proportional Counter (TEPC) and an internal MU (iMU) for advanced analysis of the complex radiation environment in the space station and to ensure means of cross calibrations. **RESULTS:** This presentation will give an insight into the technical system and provide an overview of the project. **DISCUSSION:** The radiation environment that the space crews are exposed to differs significantly as compared to earth. Exposure in flight exceeds doses that are usually received by commercial pilots and ground based workers. Expanding 'medical'

demands are not a solely characteristics of upcoming mission scenarios. Challenges to efficiently utilize the fully operational science platform ISS are immense. Understanding, accepting and approaching those circumstances ESA-HSO did choose a particular pass of implementation this current development. Synergies of research, science and medical operations shall be exploited within the "European Crew Personal Active Dosimeter" project, a novel part of ESA Radiation Protection Initiative for astronauts.

#### Learning Objectives:

1. Recognize and relate the exposure to ionizing radiation within the professional environments of ground based-, airborne- and human spaceflight- activities.
2. Acknowledge how and why the radiation environment in space differs to what humans are exposed on earth.
3. Explain and contrast the specifics of active dosimetry for health monitoring in space.

#### [010] CAN COSMIC RADIATION AFFECT THE FETUS OF PREGNANT FLIGHT CREWS AT DOMESTIC FLIGHT IN TURKEY: A CUMULATIVE DOSE STUDY FROM TURKEY?

M. Ozturk<sup>1</sup>, M. Ulubay<sup>2</sup>, E. Karasahin<sup>2</sup>, U. Keskin<sup>2</sup>, and A. Aydin<sup>1</sup>

<sup>1</sup>Obstetric and Gynecology, Etimesgut Military Hospital, Ankara, Turkey; <sup>2</sup>Obstetric and Gynecology, Gülhane Military Medical Academy, Ankara, Turkey

**INTRODUCTION:** Potential adverse outcomes related to radiation exposure during pregnancy include teratogenicity, genetic damage, intrauterine death and increased risk of malignancy. National Council on Radiation Protection and Measurement recommends that exposure of the unborn child not exceed 0.5 millisieverts in any month once a pregnancy month (1) and five months exposure does not exceed 2 millisieverts. This article reviews cosmic radiation effects on the fetus of pregnant flight crews at domestic flights in Turkey. **METHODS:** The cosmic radiation exposure of pregnant crewmember who worked 120 hours a month between Istanbul (LTBA) and Batman (LTCJ) in Turkey twice time at the average altitude 30000 feet was evaluated. Exposures were estimated for cosmic ionizing radiation with galactic cosmic radiation calculator program of Federal Aviation Administration Office of Aerospace Medicine Civil Aerospace Medical Institute. This flight distance and altitude is not true. That flight has been considered as the longest and highest flight in Turkey and data was entered into the galactic cosmic radiation calculator program. **RESULTS:** If she worked 120 hours a month between Istanbul and Batman (the longest distance in Turkey with flight), the highest dose of cosmic radiation would be 0.24 millisievert in a one month. This doesn't exceed the recommended monthly limit of 0.5 millisievert. In 5 months her accumulated dose would be 1.2 millisievert which is not in excess of the recommended pregnancy limit of 2 millisieverts. **DISCUSSION:** Cosmic radiation exposure is not to be a factor that would limit domestic flying for a pregnant crewmember in Turkey. Reference: 1. National Council on Radiation Protection and Measurement Recommendations on Limits for Exposure to Ionizing Radiation. NRCP Report No:91 Bethesda MD.1987(sec 4.3.p 30)

#### Learning Objectives:

1. Cosmic radiation risk for pregnant flight crews at domestic flights in Turkey is described.

#### [011] JAXA HUMAN BEHAVIOR AND PERFORMANCE RESEARCH RELATED TO FATIGUE MANAGEMENT FOR SPACE EXPLORATION

T. Abe, G. Suzuki, S. Furukawa, and K. Ogata  
Japan Aerospace Exploration Agency, Tsukuba, Japan

**INTRODUCTION:** The space environment, which imposes multiple stressors due to the high workload, long-term isolation, non-24h day-night rhythm, multiple cultures, or high risk of living crisis



during space exploration, can seriously hinder astronauts' mental health and performance, resulting in consequences such as depressive symptoms, emotional instability, impaired sleep/wakefulness and human errors and accidents. In response, JAXA (the Japan Aerospace Exploration Agency) has started new research projects to evaluate the stress level and monitor vigilance (stress and vigilance projects, respectively). The stress project will involve us developing an overall method of assessing the stress level by integrating several stress markers, such as behavior and performance parameters, sleep/wakefulness parameters, sympathetic/parasympathetic responses, endocrine functions, immune responses, growth factors, and DNA methylation. In particular, our focus is to develop a means of measuring stress responses caused by long-term isolation using a long-term isolation and closing chamber. After this study, we will also investigate new methods to facilitate adaptation to long-term isolation. The vigilance project will involve us investigating a new and accurate marker to determine any decline in vigilance using multiple ocular metrics based on PERCLOS (percent of eyelid closure time) which has demonstrably been the most accurate means of assessing vigilance of multiple methods. After this project, we will develop a system to monitor vigilance and conduct feasibility studies for future space exploration. In addition, we are also considering scope to develop onboard self-tests for human behavior and performance (HBP) in spaceflight by integrating these newly developed measurements as well as others. Each system provides information about its level of adaptation to the space environment. Onboard self-tests for HBP will help optimize astronauts' health and performance, underpinning the success of space exploration missions.

#### Learning Objectives:

1. To understand the psychological/psychiatric problems predicted in future space exploration and how best to evaluate them.

#### [012] WEARABLE IMAGING AND DISPLAY SYSTEM FOR AEROSPACE MEDICINE

C.A. Mela, C. Patterson, and Y. Liu

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**INTRODUCTION:** Imaging technologies have been developed to help guide medical interventions at the point of care. Often times, these technologies rely on a separate, stand-alone display screen in order to show the image guidance. Such methods can be distracting and confusing, requiring the surgeon to manually correlate the on-screen images with the surgical landscape. To address this issue, we developed a miniature wearable imaging and display system for guiding medical interventions such as surgeries. **METHODS:** We have developed a light weight optical detector based on CMOS image sensor technology with adjustable lenses and near-infrared optical filters. The detector unit is affixed to a low-profile head-mounted display unit. We have characterized the detectors resolution, field-of-view, and fluorescent detection limits. In addition, we have implemented customized executable program that enable us to both control the device and capture images through a PC connection. We then demonstrated the capabilities of the system through simulated surgical interventions. **RESULTS:** The reflectance mode resolution of our detectors was determined to be in the sub-millimeter range (0.63mm at 40cm). In addition, we have found that the system can detect fluorescent emissions down to a 54nM concentration from a 40cm working distance. We have utilized our prototype system in conducting successful simulated image-guided surgeries. **DISCUSSION:** Our system automatically correlates the surgical landscape with fluorescent data in real time. This information is both recorded by our detector and displayed in the wearable display from the surgeons own line-of-sight, creating a highly intuitive viewing environment. In addition, the prototype system is low-profile and highly portable, which holds great potential for application in aerospace medicine.

#### Learning Objectives:

1. Demonstrate the construction, characterization and function of a light-weight, wearable imaging and display system applicable to the needs of aerospace medicine.

2. Show how our NASA-sponsored research is solving aerospace medicine problems in a new way.

#### [013] APPLICATION OF ULTRASOUND IMAGING TO DYNAMICALLY VISUALIZE INTERVERTEBRAL DISCS IN AVIATION AND MICROGRAVITY

R. Ramakrishnan

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**INTRODUCTION:** Injury to the cervical spine occurs at a rate of nearly 11,000 per year. The injury can occur in the acute setting or in a chronic condition and to a variety of structures including bony elements, ligaments, and nerve roots. Diagnosis and treatment of the condition is dependent on imaging and visualization of the internal anatomy. The purpose of this study was to analyze the efficacy of ultrasound imaging as an imaging modality to effectively visualize intervertebral discs in a dynamic setting. Damage to intervertebral discs is a large portion of all spine injuries and is of particular concern in microgravity and in long duration rotary wing flight. Back pain in astronauts is well documented in the literature as is neck pain in military helicopter pilots. MRI, CT, and plain film have traditionally been used to image the spine, but these have limited application in these field settings given size, power, and monetary constraints. Ultrasound fills this void and can be shown to be effective in visualizing the intervertebral discs with 81% sensitivity and 94% specificity for intervertebral disc pathology. Ultrasound has been used extensively as an aid for spinal therapeutics, including placement of epidural anesthesia, confirmation of bony landmark palpation, and localization of herniated nucleus pulposus. The data collected and reviewed also demonstrates that ultrasound is effective in visualizing changes to the discs during flexion/extension of the cervical region and during axial loading/unloading of the spine. This dynamic visualization is a unique advantage over other imaging techniques and offers the prospect of further research in flight.

#### Learning Objectives:

1. The efficacy of using ultrasound to visualize the intervertebral discs in the cervical spine has been demonstrated.

#### [014] EVALUATION OF A DE-IDENTIFICATION PROCESS FOR OCULAR IMAGING

M. LaPelusa<sup>2</sup>, S. Mason<sup>1</sup>, W. Taiym<sup>1</sup>, A. Sargsyan<sup>3</sup>, L. Lee<sup>4</sup>, M. Wear<sup>4</sup>, and M. Van Baalen<sup>5</sup>

<sup>1</sup>Epidemiology/LSAH, MEI Technologies, Houston, TX; <sup>2</sup>University of Illinois at Urbana-Champaign, Park Ridge, IL; <sup>3</sup>Wyle, Houston, TX;

<sup>4</sup>Epidemiology/LSAH, Wyle, Houston, TX; <sup>5</sup>Epidemiology/LSAH, NASA, Houston, TX

**INTRODUCTION:** Medical privacy of NASA astronauts requires an organized and comprehensive approach when data are being made available outside NASA systems. Magnetic Resonance Imaging (MRI) medical data is a recent source of interest to researchers concerned with the development of Visual Impairment due to Intracranial Pressure (VIIP) in the astronaut population. Each vision MRI scan of an astronaut includes 176 separate sagittal images that are saved as an "image series" for clinical use. In addition to the medical information these image sets provide, they also inherently contain a substantial amount of non-medical personally identifiable information (PII) such as name, date of birth, and date of exam. We have shown that an image set of this type can be rendered, using free software, to give an accurate representation of the patient's face. This currently restricts NASA from dispensing MRI data to researchers in a de-identified format. Automated software programs, such as the *Brain Extraction Tool*, are available to researchers who wish to de-identify MRI sagittal brain images by "erasing" identifying characteristics such as the nose and jaw on the image sets. However, this software is not useful to NASA for vision research because it removes the portion of the images around the eye orbits, which is the main area of interest to researchers studying the VIIP syndrome. **METHODS:** The Lifetime Surveillance of Astronaut Health program has resolved this issue by developing a protocol to de-identify MRI sagittal brain images using *Showcase Premier*, a DICOM (Digital Imaging and Communications in Medicine) software package. The software allows manual

editing of one image from a patient's image set to be automatically applied to the entire image series. This new approach would allow a new level of access to untapped medical imaging data relating to VIIP that can be utilized by researchers while protecting the privacy of the astronauts. In the next step toward finalizing this technique, NASA clinical radiology consultants will test the images to verify removal of all metadata and PII.

#### Learning Objectives:

1. To understand the risk of attribution associated with neuro-imaging, and to define a standard/method to keep this risk to a minimum.

#### [015] A SYSTEMATIC REVIEW OF MEDICAL EARLY WARNING SYSTEMS IN TERRESTRIAL AND MARS ANALOG ENVIRONMENTS TO IMPROVE THE M<sub>2</sub>ARS MODEL

R. Velho<sup>2,1</sup>, G. Grömer<sup>2</sup>, and T.J. Luger<sup>2,3</sup>

<sup>1</sup>Emergency Department, Heartlands Hospital and University of Warwick, Birmingham, United Kingdom; <sup>2</sup>Austrian Space Forum / Österreichisches Weltraum Forum (OeWF), Innsbruck, Austria;

<sup>3</sup>Department of Anesthesiology and Critical Care Medicine, Innsbruck Medical University, Innsbruck, Austria

**INTRODUCTION:** Medical Early Warning Systems (EWS) may increase astronaut medical autonomy for short and long duration missions. EWS rely on an aggregate score derived from a range of physiological parameters captured using biotelemetry. The final score is used to 'track' the physiological trend and 'trigger' the appropriate response according to pre-defined thresholds. EWS are utilized by terrestrial medical personnel to remotely assess the clinical status of patients; thus minimizing serious adverse events. The Medical Mars Analog astronaut aleRt System (M<sub>2</sub>ARS) is a modified EWS developed by the Austrian Space Forum (OeWF), using biotelemetry information collected by the AOUDEX suit during Mars analog missions. This study aimed to systematically review EWS models and improve the M<sub>2</sub>ARS for the AMADEE-2015 Mars analog mission. **METHODS:** A systematic review of terrestrial and aeromedical EWS was conducted using six online electronic databases. The Critical Appraisal Skills Programme checklist was used to evaluate identified studies in terms of validity, relevance and results.

**RESULTS:** The search identified 136 papers, of which 55 were relevant. Of these, 3 papers met the methodological standards. None of the studies were conducted in the Mars analog environment. Two cluster randomized controlled trials (RCTs) from Australia and the UK evaluated the benefit of a EWS that triggered a remote hospital response team. The Australian RCT found no statistical significance between control and intervention arms ( $p = 0.640$ ; adjusted OR 0.98; 95% CI 0.83 to 1.16). However, the UK RCT found that EWS reduced in-hospital patient mortality (adjusted OR 0.52; 95% CI 0.32 to 0.85). These RCTs were also evaluated by a Cochrane meta-analysis, which discussed the findings from a terrestrial perspective. **DISCUSSION:** It is challenging to derive specific improvements for the M<sub>2</sub>ARS model from terrestrial EWS models due to their heterogeneity. The Mars analog astronaut also has additional environmental limitations, such as the suit CO<sub>2</sub> levels, which need to be incorporated into the final EWS. Further research is required in the terrestrial and Mars analog environments to implement effective evidence based medical EWS for future space missions, including long-duration missions to Mars.

#### Learning Objectives:

1. Terrestrial and Mars analog medical Early Warning Systems (EWS) use a cumulative score from a range of physiological parameters captured using non-invasive biotelemetry.
2. Early Warning Systems (EWS) may provide an astronaut with autonomy over their health; vital for long duration Mars mission.
3. The M<sub>2</sub>ARS EWS model may contribute to improving terrestrial EWS systems and improving patient care, and vice versa.

#### [016] FEASIBILITY OF SURGICAL PERCUTANEOUS DRAIN USE IN THE MICROGRAVITY ENVIRONMENT

L. Brown<sup>1</sup>, H. Ho<sup>3</sup>, T.G. Smith<sup>2</sup>, J. Windsor<sup>1</sup>, and A. Phillips<sup>1</sup>

<sup>1</sup>University of Auckland, Auckland, New Zealand; <sup>2</sup>University of Oxford, Oxford, United Kingdom; <sup>3</sup>Auckland Bioengineering Institute, Auckland, New Zealand

**INTRODUCTION:** Percutaneous drains (PDs) have been described as the most important intervention available for stabilizing patients with intra-abdominal abscesses occurring during long-duration spaceflight. Percutaneous aspiration of intra-peritoneal fluid has been successfully performed in porcine experiments in microgravity. However, ongoing drainage of abscesses within the microgravity environment, beyond the initial aspiration, has not yet been investigated. With the advent of commercial spaceflight, transport of patients with PDs in-situ could occur. It is therefore important to understand within the microgravity environment the mechanism of fluid flow from an abscess by a PD in order to maximize drainage efficiency. The aim of this study was to analyze flow of fluid through a PD in a simulated microgravity environment. **METHODS:** A closed drainage system was set outside and within a water tank to simulate low gravity. The system had a cavity simulating intra-abdominal pressure, with a multipurpose PD (10.2Fr) inserted into the cavity and a collecting chamber measuring volume output over time. Water was used as standard fluid. Three suction levels were used from -334 to -517 Torr. Ansys fluid dynamics software was used to corroborate the experimental results and test simulated blood flow through the drain. **RESULTS:** Flow of fluid through a 10.2Fr PD in normogravity without suction was 42ml/min whereas in microgravity this was significantly reduced by 80% to 8ml/min. At -517 Torr it was 412ml/min reducing 40% to 270ml/min in the microgravity setting. Fluid flow velocity and volume output was reduced with increased viscosity of fluid (blood). The significantly reduced drainage under microgravity was predicted by computational modelling and this closely confirmed the findings from the experimental testing. **DISCUSSION:** The maintenance of abscess cavity drainage in a microgravity environment will require a constant suction vacuum to sustain adequate drainage rates. There is room for significant advancement in design concept of PD in microgravity.

#### Learning Objectives:

1. The use of percutaneous drains to maintain abscess drainage in a low gravity environment requires continuous suction.
2. The fluid flow of bodily fluids through a percutaneous drain in a low gravity environment is dramatically reduced compared with that at normogravity.

#### [017] CHALLENGES ENCOUNTERED USING OPHTHALMIC ANESTHETICS IN SPACE MEDICINE

T.M. Bayuse<sup>2,1</sup>, J. Law<sup>1</sup>, D. Alexander<sup>1</sup>, S. Moynihan<sup>1</sup>, C. LeBlanc<sup>3,1</sup>, K. Langford<sup>3,1</sup>, and L. Magalhaes<sup>3,1</sup>

<sup>1</sup>NASA Johnson Space Center, Houston, TX; <sup>2</sup>Wyle Integrated Science and Engineering, Houston, TX; <sup>3</sup>JES Tech, Houston, TX

**INTRODUCTION:** On orbit, ophthalmic anesthetics are used for tonometry and off-nominal corneal examinations. Proparacaine has been flown traditionally. However, the manufacturers recently changed the storage requirements from room temperature storage to refrigerated storage to preserve stability and prolong the shelf-life. Since refrigeration on orbit is not readily available and there were stability concerns about flying proparacaine unrefrigerated, tetracaine was selected as an alternative ophthalmic anesthetic in 2013. We will discuss the challenges encountered flying and using these anesthetics on the International Space Station. **METHODS:** The NASA Johnson Space Center Pharmacy Team researched the stability of the proparacaine under room temperature conditions. A comparison between proparacaine and tetracaine was provided to the operational flight surgeons, who approved tetracaine for use in microgravity. **RESULTS:** Tetracaine began flying in crewmembers' individual medical accessory kits before it was permanently incorporated into the standard medical kit. Tetracaine was used on five crewmembers as a topical anesthetic for tonometry testing during this timeframe. Two of the five crewmembers experienced corneal flushing and scleral injection, which interfered with interpretation of on-orbit surveillance testing results. Corneal flushing and scleral injection have not been noted with use of proparacaine. These findings required a switch back to proparacaine, necessitating a new process to be developed to supply the medication refrigerated. **DISCUSSION:** Storage requirements of medications in spaceflight are important factors to consider. In the absence of stability data, performance of the medication and/or the diagnostic testing may be affected. Selection of medications for future exploration missions will need

to consider storage. Stability studies will need to be conducted to ascertain the safety and effectiveness of medications if the necessary storage conditions will not be engineered into the spacecraft.

#### Learning Objectives:

1. Identify the challenges with flying and using ophthalmic anesthetics in spaceflight.

#### [018] PORTABLE ULTRASOUND USE FOR MEDICAL DECISION MAKING DURING NEAR-SPACE AND HIGH ALTITUDE MISSION OPERATIONS

L. Hiles<sup>1</sup>, D. Nusbaum<sup>1</sup>, D. Buckland<sup>2</sup>, C. Decker<sup>1</sup>, J.B. Clark<sup>1</sup>, A. Garbino<sup>1</sup>, and E. Antonsen<sup>1</sup>

<sup>1</sup>Baylor College of Medicine, Houston, TX; <sup>2</sup>George Washington University, Washington, DC

**INTRODUCTION:** High altitude and other extreme missions have the potential to lead to multiple types of disabling injuries in environments where definitive care is not easily accessible. Having a portable imaging modality, such as ultrasound, in the field is useful as a tool for clinical decision making when triaging patients in medical contingency scenarios. **METHODS:** For the purposes of crew recovery operations for the Paragon Stratospheric Exploration high altitude balloon flights, protocols were developed for integrating a handheld ultrasound machine into medical decision making, including describing the uses and limitations of this technology and developing algorithms for guiding its use in the field. **RESULTS:** The risk profile for a stratospheric balloon bailout and free fall mission includes increased risk of traumatic injury resulting from the fall and increased risk of ebullism, decompression sickness, arterial gas embolism, and pneumothorax from exposure at altitude. Both traumatic injuries and altitude exposure can be evaluated by ultrasound. Algorithms for utilizing ultrasound for triaging these injuries in the event of an off nominal situation were incorporated into this mission's medical contingency protocols for determining need for evacuation to a tertiary care or hyperbaric treatment facility. **DISCUSSION:** Handheld ultrasound has the potential to be a valuable tool for triaging injuries resulting from off nominal medical contingency scenarios during extreme environmental missions where tertiary medical care is not readily accessible.

#### Learning Objectives:

1. Handheld ultrasound has the potential to be a valuable tool for triaging injuries resulting from off nominal medical contingency scenarios during extreme environmental missions where tertiary medical care is not readily accessible.

**Monday, May 11**  
**S. Hemisphere 1**

**10:30 A.M.**

#### [IV.] PANEL: CONTROVERSIES IN AEROSPACE NEUROLOGY

**Chair: Roger Hesselbrock**  
*Wright-Patterson AFB, Ohio*

**PANEL OVERVIEW:** Aerospace neurology is a small but important subset of aerospace medicine. Neurologic diagnoses are among the top reasons for medical restriction from aviation and space-related duties. In many instances, little evidential data analogous to the aviator population exists, which makes recommendations to resume operational duties especially challenging. This panel will highlight the field of aerospace neurology, increase awareness of neurologic conditions and their operational impact, and stimulate collaborative discussion. Several timely neurologic topics with aeromedical implications will be presented. Clinical case material will be utilized to illustrate key concepts of evaluation and treatment of these selected neurologic conditions in the aviation and space populations. Ongoing collaboration and operational research will facilitate gathering cohort-specific data and ultimately advance aeromedical standards for neurologic conditions.

#### [019] COGNITIVE RESERVE HYPOTHESIS - POSSIBLE EXPLANATION FOR INTELLECTUAL RESILIENCY FOLLOWING A NEUROLOGICAL INSULT

G.E. Ford

*Aeromedical Consultation Service, WPAFB, Beavercreek, OH*

**INTRODUCTION:** Identifying residual intellectual and/or general cognitive deficits in pilots and air crew following moderate to severe neurological trauma or disease is difficult, due in part to, well above average premorbid intellectual functioning, education, and occupational strengths. The Cognitive Reserve (CR) Hypothesis has been advanced as a possible explanation for why many of these Air Force pilots and air crew do not evidence deficits on standardized cognitive testing when the member is seen for a return to fly waiver examination. In a number of cases the test performance actually improves. **METHODS:** Two neuropsychological cases will be presented that are characteristic of the majority of high functioning pilots and air crew evaluated by neuropsychology over the past three years at the ACS. **RESULTS:** A review of the neurological cases evaluated at the ACS over the past three years supported the above impressions. In comparing post-injury test scores (6 months to 5 years post-injury) to baseline testing, intellectual and cognitive scores remained stable and in a number of cases actually improved. **DISCUSSION:** According to the CR hypothesis, as a group, these members have residual capacity to compensate for deficits or the potential for more rapid and complete recovery for brain injury. This does not mean that the patient is protected from future decline in cognition or that the next mild insult will not exceed the cognitive reserve.

#### Learning Objectives:

1. To discuss the Cognitive Reserve Hypothesis as a possible explanation for the intellectual/cognitive resiliency of AF pilots and flight crew on intellectual/cognitive testing when examined for a RTF waiver 6 months to 5 years following a moderate to severe neurological insult.

#### [020] MULTIPLE SCLEROSIS: IMPLICATIONS IN AEROSPACE MEDICINE

M.J. Craner

*Nuffield Dept. of Neurosciences, University of Oxford, Oxford, United Kingdom*

**INTRODUCTION:** Multiple Sclerosis (MS) is a common neuro-inflammatory disorder in young adults characterized by demyelination and neurodegeneration. Considerable advances have been made in recent years that have translated into earlier diagnosis and an increasing array of therapeutic options. The aim of this presentation is to highlight the features of MS specific to risk, clinical features and management relevant to aerospace medicine. **Risk in MS:** Understanding risk of future events and progression is important in counseling both patient and advising on occupational issues. 'Radiologically isolated syndromes' have been associated with a 34% risk of a future event within 5 years. After the first clinical event baseline investigations with MRI (T2 lesions associated with 80% risk over 10 years) and CSF (9.0 OR) can further help define risk of future clinical episodes. Moreover, clinical features and co-morbidities associated with risk of disease progression will be highlighted. **Clinical features of MS:** Relapses can affect individuals within a variety of CNS regions impacting upon optic, sensory, motor and cognitive domains. MS can affect both white and grey matter with the later arguably contributory to cognitive dysfunction. Higher executive cognitive dysfunction is common but under-recognized in MS patients and yet can have a significant impact on both social and occupational functioning. Cognitive screening approaches will be discussed. **Management considerations in MS:** The therapeutic landscape and management approach to MS has changed rapidly in recent years. There is an increasing use of MRI to monitor and assess disease activity and guiding therapeutic management. The key disease modifying drugs and specific features relevant to aerospace medicine will briefly be highlighted. **Summary:** MS has significant implications to individuals, especially within an aerospace environment,



but with appropriate identification of risks, clinical vigilance and management the impact of MS can be mitigated.

#### Learning Objectives:

1. To understand the use of paraclinical investigations in determining risk of developing MS.
2. Recognize that cognitive dysfunction is common in MS and increase awareness of cognitive screening tools.

#### [021] DIAGNOSIS, INVESTIGATION, TREATMENT AND DISPOSITION IN AIRCREW WITH VARIOUS FORMS OF LEG PAIN

C.R. Skinner<sup>1</sup> and R.R. Hesselbrock<sup>2</sup>

<sup>1</sup>Neurology, Ottawa Hospital, Ottawa, ON, Canada; <sup>2</sup>Aerospace Medicine Consultation Division, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH

**INTRODUCTION:** As in the general population, active aircrew can present with a variety of lower limb pain including pain originating from lumbar spondylosis, muscle pain, various forms of neuropathic pain, and the restless legs syndrome. **METHODS:** This presentation consists of several short case vignettes to illustrate a diagnostic approach algorithm for the assessment of aircrew presenting with lower limb discomfort of various sorts including pain, paresthesias, stiffness and the feeling of need to move. **DISCUSSION:** The presentation will focus on specific treatments for specific disorders such as spondylosis, spasticity, neuropathic pain and restless legs and the impact of these treatments on aircrew fitness and waivers.

#### Learning Objectives:

1. To discuss the diagnosis and approach to investigation of various forms of leg pain including restless legs in aviators.
2. To discuss treatment options of various forms of leg pain including restless legs in aviators.
3. To discuss aircrew disposition in the various conditions which causes leg pain in aviators.

#### [022] SLEEP APNEA: CONTROVERSIES IN DIAGNOSIS AND MANAGEMENT

E. Boudreau

<sup>1</sup>Neurology, Oregon Health & Science University, Portland, OR;

<sup>2</sup>Mental Health and Clinical Neurosciences, VA Portland Health Care System, Portland, OR

**INTRODUCTION:** Obstructive sleep apnea is one of the most common and increasingly recognized sleep disorders in the general population affecting up to 10% of adults. Because it results in decreased sleep quality, sleep apnea has been linked with decrements in performance and decision-making, and has been implicated in a number of recent aerospace related incidents. Additionally, there is mounting evidence that sleep apnea contributes to the development of hypertension, stroke, diabetes, and other disorders which may negatively impact flight safety. However, considerable controversy exists regarding the impact of sleep apnea on aerospace operations, and the best way to approach diagnosis and treatment in this setting. During this talk, a series of cases illustrating approaches to the diagnosis and management of sleep apnea in the aerospace environment will be discussed, and where available, data supporting these approaches will be highlighted. The goal is to stimulate conversation regarding how best practices for the management of this condition in the aerospace environment can be advanced.

#### Learning Objectives:

1. To understand current controversies in the diagnosis and management of sleep apnea, and to appreciate the associated operational issues.

Monday, May 11  
S. Hemisphere 2

10:30 A.M.

#### [V.] PANEL: ANTHROPOMETRY ACROSS THE SERVICES: MEASUREMENT, IMAGING, MODELING, AND APPLICATIONS

Chair: GREGORY ZEHNER

Xenia, Ohio

**PANEL OVERVIEW:** This Panel will present focused overviews of the Anthropometric Programs in the US Navy, Army, and Air Force. The Overviews will highlight specific projects in Human Measurement and application of the data. Each Service will also present one additional paper highlighting a specific research effort. These are listed below: US Navy: Verification and Validation of Digital Human Model Performance for Military Pilots and Maintainers US Army: Visualizing the Body from the Outside-In: Recent Developments in External and Internal Digital Human Modeling US Air Force: Shape Modeling of the Cranium and Torso for Protective Equipment Design

#### [023] AN OVERVIEW OF THE USAF ANTHROPOMETRY PROGRAM

G.F. Zehner

Human Systems Integration, 711 Human Performance Wing, Wright-Patterson AFB, OH

**INTRODUCTION:** New and modified aircraft cockpits, workstations, and protective equipment must have representative anthropometric data in requirements documents and must have compliance with those requirements verified by accommodation test measurements. Assuring fit of our troops requires adequate baseline anthropometric databases, appropriate statistical methods for summarizing the data, modeling methods to assist in preliminary design work, and verification methods for testing accommodation in the final product. This overview of the USAF Anthropometry Program will present short descriptions of each of the components of a successful human centered design. Descriptions will be given of the 2011 Anthropometric Sizing Survey of aircrew, it's enhancement for female aircrew and all non-aircrew using a statistical matching approach, our experiences with commercially available digital human modeling packages, and several applications of the data to aircraft programs.

#### Learning Objectives:

1. Learning the basic process for assuring body size accommodation in equipment design.
2. Learn how the military population has changed size over the years.
3. Learn the shortcomings of commercially available Digital Human Models.

#### [024] U.S. NAVY OVERVIEW - AIRCRAFT SYSTEM ANTHROPOMETRIC ACCOMMODATION

L.L. Brattin<sup>2</sup>, L. Jones<sup>2</sup>, P. Teas<sup>2</sup>, C. Mattingly<sup>2</sup>, M. Warren<sup>2</sup>, and B.S. Shender<sup>1</sup>

<sup>1</sup>Human Systems, NAVAIR, Patuxent River, MD; <sup>2</sup>Human Systems, NAVAIR 4.6, Patuxent River, MD

**INTRODUCTION:** The NAVAIR 4.6 Advanced Design for Maintainer (ADAM) Aircrew Accommodation Lab is responsible for evaluating aircrew and maintainer physical accommodation for manned and unmanned aircraft systems. A primary function of the lab is to assess aircrew accommodation and create Anthropometric Restriction Codes (ARCs). ARCs reduce the number of aviator reassignments due to cockpit incompatibility, and are utilized to both maximize anthropometric accommodation and ensure aviator safety. ADAM is responsible for collecting individual anthropometric (body) measurements to quantify the sizes of test subjects, and to create anthropometric databases in support of aircraft Program Offices and the United States Naval Test Pilot School. The lab also provides support for other human physical interface related areas, such as strength and endurance. The

lab continues to expand its capability in the areas of aircraft scanning and digitization, CAD, digital human modeling, and Design for Maintainer. **DISCUSSION:** Over the years the USN Anthropometry Lab has identified a range of issues and needs pertaining to aircrew and maintainer anthropometric accommodation. Some of the challenges include poorly written program anthropometric requirements, ongoing improper use of anthropometric percentiles, a lack of understanding of the complexity of anthropometric accommodation (restraint systems, pilot flight equipment, posture, seat positioning, cushion compression, and the multivariate nature of accommodation all must be considered), a lack of current USN anthropometric databases, aircraft training pipeline issues, the need to consider joint populations, limitations and misuses of digital human modeling for evaluation of aircraft design, obtaining aircraft time for physical evaluations, obtaining CAD for digital evaluations, aircraft tolerance and configuration control with regard to anthropometric accommodation, difficulty in identifying endurance issues early in design, undervaluing the importance of maintainer accommodation, and late insertion of the accommodation team into acquisition programs. The overview will update current program support efforts, research projects, and collaboration efforts with other U.S. and international military services.

#### Learning Objectives:

1. Learn the challenges involved in assessing anthropometric accommodation.

#### [025] VISUALIZING THE BODY FROM THE OUTSIDE-IN: RECENT DEVELOPMENTS IN EXTERNAL AND INTERNAL DIGITAL HUMAN MODELING

B. Corner<sup>1</sup>, S.P. Paquette<sup>1</sup>, J.M. Carson<sup>1</sup>, P. Li<sup>1</sup>, C. Carneal<sup>2</sup>, and M. Reed<sup>3</sup>

<sup>1</sup>US Army Natick Soldier RDEC, Natick, MA; <sup>2</sup>Applied Physics Lab, Johns Hopkins, Laurel, MA; <sup>3</sup>UMTRI, Ann Arbor, MI

**INTRODUCTION:** The Army's last full anthropometric survey was conducted in 1988 (ANSUR). A small-scale survey in 2008 showed average male soldiers were eleven pounds heavier with no change in height relative to 1988 data. As a consequence, the Army and Marine Corps (MC) conducted anthropometric surveys (2010-2011). Survey method and results will be discussed. The last equipped soldier study was reported in 1999. Recently seated and standing equipped soldier studies were executed. Both studies utilized 3d scanning. Results, such as the homogenizing effect of gear, will be discussed. Recording unequipped soldier movements while running or walking is relatively simple in a laboratory with standard motion capture (mocap) systems. Collecting similar data is more challenging with equipped soldiers and outside the laboratory. Recent work employing inertial measurement units (IMUs) has enabled researchers to obtain equipped soldier movement data outside a mocap laboratory setting. Sample IMU output and processing will be presented. Three-dimensional surface scanning was part of Marine Corps and Army anthropometric surveys. 3d surface scan data is enhanced with bijective mapping of surface topology through template matching methods. Two methods will be described and their results illustrated with representative models. Other than the brain, modeling and warping internal organs is not established widely. The Army and its partners established a statistical lung model and derived allometry equations that tie lung form to external body dimensions. The work was expanded to include liver, kidneys, spleen, and bladder. A largely automated pipeline to extract multi-organ geometries from CT scans is underway. Thus far, manually segmenting the organs from a single raw CT scan takes about four hours. Preliminary implementation of the multi-organ segmentation pipeline suggests segmenting 180 CT scans on a small computer cluster will take about 12 hours. Organ model examples and an update on the pipeline will be provided.

#### Learning Objectives:

1. Understand developments in multiorgan CT segmentation to provide population-level statistical models.
2. Understand changes in body size and shape when soldier were current gear.

#### [026] ANTHROPOMETRIC CHANGE IN U.S. ARMY PILOTS: 1988-2012

C.C. Gordon, S.P. Paquette, and C.L. Blackwell

*Anthropology Team, U.S. Army Natick Soldier RD&E Center, Natick, MA*

**INTRODUCTION:** The cockpits of legacy Army Aircraft have traditionally limited the ranges of body sizes and proportions that can safely operate the aircraft. For this reason, pilots are usually measured and reported separately in Army anthropometric surveys. **METHODS:** 977 male pilots and 42 female pilots were measured during the U.S. Army ANSUR II Survey using standardized protocols to minimize observer error and maximize comparability to the 1988 ANSUR survey data. Demographic characteristics of ANSUR II pilots are compared against DMDC census data for Army pilots, and suitable subject weights calculated to match the age and race/ethnicity distributions. Finally, t-tests are used to compare the 1988 (n=447 males and n=8 females) and 2012 means of body dimensions important to cockpit design and sizing of personal protective equipment (PPE). **RESULTS:** U.S. Army male pilots measured in 2012 (n=977) are not significantly different in stature and sitting height than male pilots measured in 1988 (n=447). Male pilots in 2012 are, however, 8.3kg heavier on average (p<.0000), and their trunk circumferences are significantly larger than in 1988: Chest Circumference is 72.9 mm larger, Waist Circumference is 76.0 mm larger, and Buttock Circumference is 41.8 mm larger on average (P<.0000 for all three circumferences). There are no statistically significant differences between female pilots measured in 1988 (n=8) and 2012 (n=42), at least in part because those sample sizes are too small to provide the statistical power needed even when magnitudes of difference are relatively large. **DISCUSSION:** Body weight and trunk circumferences of U.S. Army pilots have increased substantially since the 1988 Army survey, indicating that cockpit clearances and sizing of PPE for today's Army pilots may need to be carefully re-evaluated.

#### Learning Objectives:

1. Analyze changes in the anthropometric distributions of U.S. Army pilots and infer changes in cockpit design and pilot Personal Protective Equipment (PPE) needed to accommodate contemporary Army pilots.

#### [027] VERIFICATION AND VALIDATION OF DIGITAL HUMAN MODEL PERFORMANCE FOR MILITARY PILOTS AND MAINTAINERS

B.S. Shender<sup>1</sup>, L.L. Brattin<sup>2</sup>, P. Teas<sup>2</sup>, L. Jones<sup>2</sup>, C. Mattingly<sup>2</sup>, and M. Warren<sup>2</sup>

<sup>1</sup>Human Systems, NAVAIR, Patuxent River, MD; <sup>2</sup>Human Systems, NAVAIR 4.6, Saint Leonard, MD

**INTRODUCTION:** Current U.S. Navy capabilities for evaluating aircrew accommodation and aircraft maintenance involve the use of human subjects and actual aircraft. To reduce program costs and development time, it is highly desired to develop a process for evaluating aircrew accommodation using aircraft computer aided design (CAD) or 3-D digital scans and Digital Human Modeling software as early in design as possible. **METHODS:** A project with a focus on verification and validation completed in FY14, and a three year follow on project began early in FY15. To date, a scanning capability has been established and training has been completed for Santos™ digital human model, Polyworks, Rhino, and Maya software applications. Several aircraft system assets have been scanned, to including a trainer aircraft, jet simulator, and UAV operator workstation. **RESULTS:** Improvements to Santos™ during this project include updates to the anthropometry module, addition of a restraint widget, a seat cushion compression study on helicopter and ejection seats, which will be used to further refine Santos™, and the addition of a NIOSH equation widget to allow lift and carry tasks to be evaluated within the software. Four digital avatars were developed from laser scans of two male and two female NAVAIR personnel for use with the Santos™ software. Anthropometric landmarks were digitized on these subjects during physical evaluations, and these data will be used to



compare posture and positioning of the actual human to the virtual human for these aircraft platforms as part of the validation effort. **DISCUSSION:** The project has identified a number of complexities that must be considered in order to utilize DHM to provide models that are representative of the actual human in the cockpit. Examples include body positioning, posture, static vs. dynamic environment, CAD configuration control, anthropometry, user interface, seat cushion compression, pilot clothing and equipment, and seat restraint systems. While some of these have been addressed under the umbrella of this project, there is still more to be done going forward. The project team has also already successfully supported several programs including a UAV program that resulted in important changes to layout design.

#### Learning Objectives:

1. Learn about the Santos DHM verification and validation effort.

#### [028] SHAPE MODELING OF THE CRANIUM AND TORSO FOR PROTECTIVE EQUIPMENT DESIGN

J.J. Whitestone<sup>4</sup>, J.A. Hudson<sup>1,4</sup>, C.R. Whitehead<sup>1,4</sup>, G.F. Zehner<sup>2</sup>, and B. Corner<sup>3</sup>

<sup>1</sup>Infoscitex, Dayton, OH; <sup>2</sup>ANTHRO, 711 HPW/HP, Xenia, OH; <sup>3</sup>US Army NSRDEC, Natick, MA; <sup>4</sup>Anthropometry Lab, 711 HPW/HPIF, Wright Patterson AFB, OH

**INTRODUCTION:** For this panel two current research examples, both employing 3D scan data, are offered: 1) a new method to extract cranial shape through the hair (which is combined with a face scan) to produce a complete 3D mesh of a head, and 2) a morphometric analysis employing Generalized Procrustes Analysis (GPA) and Principal Components Analysis (PCA) that offers 3D forms to represent the most relevant size and shape variation in 3D female anterior torso scans.

**METHODS:** At the request of a Marine Corp customer (Mr. Mark Richter, USMC/MERS, *Gruntworks*), the USAF Anthropometry Lab developed a head fixation rig and a method to collect 3D point data, through hair, that could be used to generate a geometric representation of the scalp. This work was driven by the inadequacy of current head scan data and the confounding effects of hair volume in the scan. The Morphometrics Laboratory at Florida State University was tasked to write software that combines the 3D scan data of the face with the scalp point data, resulting in a final 3D mesh head form. This technique produces much more accurate head mesh geometry as it relates to helmet fit. **DISCUSSION:** Several efforts are underway by the U.S. Army to redesign ballistic body armor to better fit male and female warfighters, thereby improving protection, maneuverability, and comfort. The goal of this current effort is to characterize meaningful size and shape variation in the anterior female torso to aid in the development of ballistic armor design forms. A geometric method employing both GPA and PCA was applied to 3D torso scans from the Joint Strike Fighter female subsample (JSF CAESAR, n= 722) of the CAESAR (Civilian American European Surface Anthropometry Resource) database. Analysis of the female anterior torso forms found differences along PC1 (Principal Component 1) to be largely in robustness, PC2 contrasted girth and torso height, and PC3 represented a ratio of girth in upper and lower torso. Thirteen anterior torso model shapes were mathematically defined on the first three Principal Component axes which could be offered to armor designers as design forms.

#### Learning Objectives:

1. Accuracy of 3D head scans is reduced by hair. A traditional contact probe can be used to sample the scalp, through the hair, and generate drastically improved representative scalp geometry when the head is kept still in a fixation rig.
2. Body armor design requires a thorough understanding of torso size and shape variation in the user population. A representative 3D torso database can be analyzed using traditional morphometric techniques to summarize the most important variation in size and shape.

**Monday, May 11**  
**S. Hemisphere 3**

**10:30 A.M.**

#### [VI.] PANEL: SHOWCASE: USAF 711TH HUMAN PERFORMANCE WING

**Chair: Kathryn Hughes**  
Dayton, OH

**PANEL OVERVIEW:** The mission of the 711th Human Performance Wing (711 HPW) is to advance human performance in air, space, and cyberspace through research, education, and consultation. The Wing, comprised of the USAF School of Aerospace Medicine (USAFSAM), Human Effectiveness Directorate and Human Systems Integration Directorate, supports the most critical Air Force resource – our operational military forces. The Wing's primary focus areas are aerospace medicine, human effectiveness science and technology, and human systems integration. The 711 HPW is the first human-centric warfare wing to consolidate research, education and consultation under a single organization. In conjunction with the Naval Medical Research Unit – Dayton and surrounding universities and medical institutions, the 711 HPW functions as a Joint Department of Defense Center of Excellence for human performance sustainment and readiness, optimization, and enhancement. This panel will highlight signature research and projects from the two Directorates and USAFSAM, emphasizing the collaborative capabilities and the wide impact of 711 HPW programs in support of the Air Force Mission.

#### [029] THE 711TH HUMAN PERFORMANCE WING: A WORLD LEADER FOR HUMAN PERFORMANCE

T. Jex

711 Human Performance Wing, Wright Patterson AFB, OH

**INTRODUCTION:** The purpose of this presentation will be to describe the Air Force Research Laboratory's 711th Human Performance Wing (711 HPW) and its exceptional capability to enhance airman performance and mission effectiveness. The United States Air Force (USAF) established the 711 HPW in March of 2008 by merging the Human Effectiveness Directorate, the United States Air Force School of Aerospace Medicine, and the Human Systems Integration Directorate. This synergy converges to support four primary mission areas: Airman Health & Performance, Force Protection, Education/Training and Airman-Machine Teaming. The 711 HPW's mission is to *advance human performance in air, space, and cyberspace through research, education, and consultation*. The 711 HPW is the first human-centric warfare wing, recognizing the Airman as "the" critical component of current and future Air Force systems, and that Airman performance is the differentiator in Air Force missions. Accordingly, the Wing's Vision is to be a *World Leader in Human Performance* and provide timely, innovative, and affordable solutions for the performance needs of the USAF. In conjunction with the Naval Medical Research Unit - Dayton and surrounding universities and medical institutions, the 711 HPW also functions as a Joint Department of Defense Center of Excellence for human performance sustainment and readiness, optimization, and enhancement. The 711 HPW employs 1,433 government workers, including 690 military and 743 civilian personnel, and is supported by approximately 550 contractors, who collectively represent a broad range of occupational specialties, including science and engineering, occupational health and safety, medical professions, technicians, educators, and business operations and support. The Wing annually executes a \$335 million portfolio.

#### Learning Objectives:

1. Learning objective: 1. Understand the 711th Human Performance Wing and its unique capabilities in human performance.

#### [030] PREDICTING READINESS IN MEDICAL AND DOD DOMAINS THROUGH THE APPLICATION OF A COGNITIVE MODEL

T.S. Jastrzemski<sup>1</sup>, M. Krusmark<sup>3</sup>, M.M. Walsh<sup>4</sup>, K.A. Gluck<sup>1</sup>, G. Gunzelmann<sup>1</sup>, D. Stefanidis<sup>2</sup>, M. Oermann<sup>5</sup>, S. Kardon-Edgren<sup>6</sup>, and J. Potts<sup>7</sup>

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AFRL, Wright-Patterson AFB, OH;<sup>4</sup>Tier1, AFRL, Wright-Patterson AFB, OH;<sup>5</sup>School of Nursing, Duke University, Durham, NC;<sup>6</sup>School of Nursing, Boise State University, Boise, ID;<sup>7</sup>Resuscitation Quality Programs, American Heart Association, Brussels, Belgium

**INTRODUCTION:** Training people to stable levels of high performance in specialized skills requires substantial investments in both time and capital. The research described here aims to shift the one-size-fits-all approach to a cognitively-principled, competency-based, individualized training and rehearsal approach using the Predictive Performance Equation (PPE). To achieve this goal, the current research highlights collaborative efforts to assess PPE's ability to track and predict skill acquisition/decay across two distinct medical skills -- laparoscopic surgery (LS) suturing performance and cardiopulmonary resuscitation (CPR) skills. These collaborations establish a foundation for future work in the fields of Air Force critical care nursing and aeromedical evacuation. **METHODS:** We have assessed PPE's ability to track individual medical student LS training histories ( $n = 18$ ) by calibrating individual learning and decay rates across a period of 2 weeks, and extrapolating individual learning trajectories to quantitatively predict skill retention at 1, 3, and 6 months. A similar methodology will be employed to assess skill acquisition and decay in CPR. Individuals will complete 4 training sessions spread out daily, weekly, monthly, or quarterly. Retention will be reassessed at either 3 or 6 month fixed intervals, or according to personalized PPE prescriptions. **RESULTS:** In the LS domain, PPE demonstrated an excellent ability to both track and predict performance for individual trainees (average RMSD = 29.06,  $R^2 = 0.92$ ), and demonstrated high predictive validity out to the 6 month test ( $R^2 = 0.94$ ). Data are forthcoming in the CPR study. However, simulations based on previously published data suggest significant payoffs for the cognitively principled approach: reducing both the training time needed to maintain performance above criterion, and the time at risk (performing below criterion). **DISCUSSION:** Use of a validated cognitive model to track and predict skill acquisition and retention with objective performance measures makes it possible to individualize training, ensuring performance criteria are achieved and sustained. We argue this approach could generate large payoffs in aerospace medical training resource management and patient safety.

#### Learning Objectives:

1. Grasp data requirements to utilize the cognitive modeling approach.
2. Understand the concept of the spacing effect and how it relates to skill acquisition and retention.
3. Gain an appreciation for the potential power this approach could hold for a multitude of domains and contexts relevant to aerospace medicine.

#### [031] BATTLEFIELD AIRMEN ADVANCED WEARABLE TECHNOLOGY DEVELOPMENT

G. Burnett and B.M. Tourtillott  
711th HPW, USAF, Wright-Patterson AFB, OH

**INTRODUCTION:** Critical to the mission success of the Air Force, Battlefield Airmen (BA) utilize advanced technologies and enhanced capabilities that distinguish them as world leaders in combat and humanitarian actions. The 711<sup>th</sup> Human Performance Wing, Human Effectiveness Directorate supports these elite Airmen through a human-centric advanced technology demonstration program known as 'BATMAN'. Similar to the comic action hero, the 711<sup>th</sup> HPW's BATMAN program investigates and develops state of the art wearable technologies and interfaces that enhance the BA's survivability, lethality, and mission effectiveness. While employing an operator-focused design approach, BATMAN is able to rapidly produce game-changing technology solutions that improve BA's capabilities and efficiencies in the strike, recon, and recovery missions; while ensuring operator acceptance regarding size, weight, and power (SWaP). BATMAN is focused on five major technology development thrusts: 1) Multimodal tactical communication systems; 2) Wearable equipment ergonomic form & fit; 3) Battlefield trauma equipment and interfaces; 4) Integrated power and data smart ensemble; and 5) Combat interfaces for mission rehearsal. Each of these five thrusts is assessed by BATMAN's technology development cycle, which includes:

Learning about operators, Interfacing concepts and designs, rapid prototyping and expert reviews, and field and laboratory testing. This panel discussion will highlight design and integration components of BATMAN's technology development cycle as well as showcase a recent point of injury tool technology development focused on adding capabilities to the medical kit of AF Pararescuemen (PJ). The Battlefield Airmen Trauma Distributed Observation Kit (BAT DOK) will illustrate various levels of integration while conforming to the needs of patient care on the battlefield. Moreover, BAT DOK is rapidly gaining interest in real-time team monitoring for human performance assessment, with future potential of providing early indicators for team leaders on the fatigue levels of individual operators.

#### Learning Objectives:

1. The importance of operator-centric advanced technology development and integration will be discussed.

#### [032] IMPROVING HUMAN PERFORMANCE OF U.S. AIR FORCE AE AND CCAT MEDICAL PROVIDERS

J. Serres, S. Dukes, and G. Maupin  
Department of Aeromedical Research, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH

**INTRODUCTION:** Aeromedical Evacuation (AE) and Critical Care Air Transport (CCAT) personnel are essential to the U.S. military's en route medical care system. These personnel provide medical care to patients during transit to definitive care facilities and often function in austere occupational environments. In-flight and operational conditions associated with these specialties may exasperate common stresses of providing ground-based medical care, thus optimizing human performance in these providers is crucial. **METHODS:** Numerous mixed-method studies have been conducted by the AE/CCAT research team at the U.S. Air Force School of Aerospace Medicine to investigate the physical, physiological, and psychological conditions in which these providers perform. **RESULTS:** Medical record reviews have identified both physical and psychological risk commonalities for subsets of these populations. Survey techniques have highlighted psychological risk factors. Field-based prospective data collection techniques have been used to investigate both physical and physiological risk factors for these populations. **DISCUSSION:** Study findings have been briefed to key stakeholders including major command and unit leadership to inform policy. Operational impacts to-date include changes in training curriculum and unit-specific interventions to improve the overall health and performance of these providers.

#### Learning Objectives:

1. Name three types of stressors encountered by AE and CCAT providers.
2. Identify one risk factor for AE/CCAT providers associated with each of the following areas: physical, physiological, and psychological.
3. Identify how AE and CCAT providers compare to the ground-based counterparts with respect to physical, physiological and psychological challenges.

#### [033] W/D

#### [034] AN OVERVIEW OF HP CONOPS AND THE HUMAN SYSTEMS INTEGRATION DIRECTORATE'S EFFORTS TO SUPPORT

M. Taranto  
711 HPW, Wright-Patterson AFB, OH

**INTRODUCTION:** The Human Systems Integration (HSI) Directorate's guidance from the AF/SG to establish the AFMS Human Performance Concept of Operations (HP CONOPS) program office is a forcing function for Human Performance innovation across the AFMS to support the AF/SG Vision, "...our supported population is the healthiest and highest performing segment of the U.S. by 2025." The new AFMS vision has provided a unique opportunity for the HSI Directorate to execute a Systems Engineering/Human Systems Integration approach to disciplined and human-centric systems and processes design across the AFMS. The result of this effort is HP CONOPS, a model to transform the delivery of

healthcare in the Air Force. This presentation will discuss how the three components of HP CONOPS - the Air Force Medical Home (AFMH), Human Performance Operations Center (HPOC) and Clinical Investigation Test and Evaluation System (CITES) - evolved through the deliberate exercise of the Systems Engineering/Human Systems Integration process. Acknowledging that organizational systems and populations alike are impressively resistant to change, the application of Air Power Doctrine and Col John Warden's Five-Ring Model to effectively target centers of gravity in a parallel is explored. This method is also discussed as a framework for intentionally drive towards positive human performance effects.

#### Learning Objectives:

1. Understand the Systems Engineering/Human Systems Integration Approach to HP CONOPS.

#### [035] W/D

#### [036] OPERATIONALLY BASED VISUAL ASSESSMENT LABORATORY (OBVA) OVERVIEW

S.C. Hadley

<sup>1</sup>U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH; <sup>2</sup>Dept of Surgery, USUHS School of Medicine, Bethesda, MD

**INTRODUCTION:** The Operationally Based Visual Assessment Laboratory (OBVA) was established by the USAF to validate vision standards and provide a platform for aircrew research. OBVA maximizes safety and efficiency in pilot and aircrew selection, utilization and retention. The objective of the OBVA are: To provide the aeromedical and operational communities understanding of the minimum vision requirements needed to perform operational tasks; To develop aeromedical vision standards and waiver criteria supported by operational task performance measures; To objectively evaluate vision correction, enhancement, and protective technologies; To develop vision performance models to predict operational performance based on clinical test results, and uncover strategies (training, engineering) to improve vision performance and possibly counter deficiencies. **DISCUSSION:** These objectives will be accomplished using high fidelity synthetic environments to evaluate the quantitative relationship between operational performance and vision screening test results. An overview video of the OBVA Laboratory will be shown.

#### Learning Objectives:

1. Describe the Operationally Based Visual Assessment Laboratory.
2. Explain the four different high fidelity synthetic environments in the OBVA lab.
3. Discuss OBVA research project.

Monday, May 11

S. Hemisphere 4

10:30 A.M.

#### [VII.] SLIDE: CARDIAC RISK ASSESSMENT

Chair: James DeVoll  
Washington, DC

10:30 a.m.

#### [037] CARDIOVASCULAR RISK FACTOR ASSESSMENT IN CANADIAN CIVILIAN AVIATION

H.I. Langille, M.L. Garand, and D. Raudzus

Civil Aviation Medicine, Transport Canada, Ottawa, ON, Canada

**INTRODUCTION:** Laboratory investigations such as lipid panels and fasting plasma glucose (FPG) are not a routine part of aviation medical examinations in Canada. Transport Canada has reviewed current clinical guidelines and has developed a framework for assessing cardiovascular risk in the aviator that involves requesting further data from selected aviators. This review looks at the outcomes of this risk stratification for a group of

aviators in a region of Canada. **METHODS:** The files of nondiabetic applicants aged 40 and over who had no known cardiovascular disease were reviewed for the presence of cardiovascular risk factors including smoking, hypertension, hyperlipidemia, obesity, family history of premature coronary artery disease, and increased waist circumference. Those with at least one risk factor other than age or gender were asked to provide a recent lipid profile as well as an FPG or Hemoglobin A1c (HbA1c). A Framingham risk score was calculated. Those applicants whose 10 year risk score was 20% or greater were asked to undergo an exercise stress test (EST). **RESULTS:** From 2012 until present 432 aviators were asked to supply a fasting lipid profile and FPG or HbA1c. Of these, 246 lipid profiles have been returned to date. 29 of these had a Framingham 10 year risk score of 20% or greater and were asked to provide ESTs. Of 20 ESTs reported to date, 7 have been positive. Two of those applicants had normal myocardial perfusion studies and were found fit, and 5 applicants were unfit. 23 applicants had a previously unknown impaired fasting glucose or prediabetes and 6 had frank diabetes. **DISCUSSION:** This review, while preliminary, is reassuring in that the majority of aviators appear to be low risk for cardiovascular events despite the presence of cardiovascular risk factors. However, there were 5 aviators identified who showed objective evidence of significant cardiovascular disease that may not have been detected had this secondary screening not been in place. Also, 29 applicants were identified with a dysglycemia which may put them at increased risk of cardiovascular events. It appears that there is value in enhanced screening of certain aviators. What indicators should trigger such screening is a matter for further study.

#### Learning Objectives:

1. To review which aviators may be at risk for incapacitation due to a cardiovascular event.
2. To review ways of detecting existing cardiovascular disease in asymptomatic aviators.
3. To review risk factors for cardiovascular disease.

10:45 a.m.

#### [038] EFFICACY OF CARDIOVASCULAR SCREENING IN ASYMPTOMATIC AIRCREW - THE USAF EXPERIENCE

E.D. Davenport, E. Palileo, W. Kruyer, and J.R. Strader  
Aeromedical Consultation Service, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH

**INTRODUCTION:** The efficacy of cardiac screening programs for aircrew is highly debated. In the past, United States Air Force (USAF) pilot training applicants underwent screening echocardiography. Many asymptomatic trained USAF aircrew also had noninvasive testing for coronary artery disease (CAD), performed for aeromedical indications. **METHODS:** The USAF School of Aerospace Medicine's Clinical Sciences Database contains over 1.2 million cardiac studies on over 283,000 aviators. We analyzed screening echocardiograms on pilot training applicants and noninvasive testing on asymptomatic trained aircrew to assess efficacy of these tests in formal screening programs. **RESULTS:** Between March 1994 and September 2006, there were 20,208 pilot applicant screening echocardiograms performed. The most common aeromedically disqualifying diagnoses were bicuspid aortic valve with mild or less aortic insufficiency (N=154, 0.76%), mitral valve prolapse with mild or less mitral regurgitation (N=51, 0.25%), and trileaflet aortic valve with mild aortic insufficiency (N=58, 0.29%) all of which were waivable for continued flight duties. A permanently disqualifying diagnosis was found in 9 cases (0.045%). Noninvasive tests performed in 903 asymptomatic trained aircrew included exercise treadmill testing, nuclear stress imaging and fluoroscopy for coronary calcification. Positive predictive values were 16%, 21%, and 29% respectively for significant CAD on coronary angiography. The annual event rate of death, MI, or revascularization was 0.5% for exercise and nuclear stress testing regardless of study outcome while calcium seen on fluoroscopy yielded a 1.1% annual event rate. **DISCUSSION:** The infrequency of positive findings in a large cohort of screening echocardiography and an asymptomatic cohort with nuclear stress imaging and cardiac fluoroscopy is discouraging. Screening echocardiography in general and stress testing non-stratified asymptomatic aircrew is not efficacious.



**Learning Objectives:**

1. Understand the positive predictive value of commonly used cardiovascular screening tests in asymptomatic aircrew.
2. Fully understand the risks and benefits to screening for coronary artery disease in the aviator population which will allow an informed decision by both the aeromedical examiner and aviator.
3. Discuss the importance of evidence based medicine with regard to Aerospace Cardiology and development of a data driven cardiovascular screening policy.

**11:00 a.m.****[039] CARDIOVASCULAR PATHOLOGY IN UK AIRCREW - AN AUDIT OF THE RAF CLINICAL AVIATION MEDICINE SERVICE (RAF CAMS)**E. Nicol<sup>1</sup>, A. Pavitt<sup>1</sup>, C. Pavitt<sup>3</sup>, and J. d'Arcy<sup>2</sup><sup>1</sup>Clinical Aviation Medicine Service (CAMS), RAF Centre of Aviation Medicine, Henlow, United Kingdom; <sup>2</sup>Royal Air Force, Henlow, United Kingdom; <sup>3</sup>Medicine, Chelsea and Westminster Hospital, London, United Kingdom

**INTRODUCTION:** Cardiovascular disease is the single commonest cause of loss of flying privileges in both military and civilian aviation. ECG screening generates a significant requirement for further investigations whilst a smaller, but significant number of aircrew present with cardiovascular symptoms requiring investigation and specialist management.

**METHODS:** A retrospective notes audit of all patients referred to the RAF CAMS was performed. Age, gender, specialty referral, trade, and occupational vs. clinical indication for referral were recorded. Additionally cardiovascular investigations performed and occupation restrictions both pre- and post- consultation were recorded. **RESULTS:** 1025 consultations were performed between 1 Sept 2011 and 31 Aug 2013. 705/1025 (68.8%) were for cardiovascular assessment. This was the commonest reason for referral across all age bands compared with other specialist groups ( $P < 0.0001$ ). 40% of cardiovascular patients were downgraded prior to referral and were more likely to be referred for occupational rather than clinical assessment (586/705 (83.1%)  $p < 0.002$ ). 98 aircrew aged  $> 60$  years underwent enhanced cardiovascular screening with an Exercise ECG (ETT). Over 1300 cardiovascular investigations were performed (ECG, ETT, echocardiogram, Holter, 24hr BP). Significant coronary, valvular, structural, electrophysiological and congenital heart disease was discovered in this cohort, however the majority of aircrew referred (442/705, 62.5%) were found to have no significant pathology and returned to unrestricted duty.

**DISCUSSION:** The use of screening ECG and referral to a specialist aviation cardiology service allows early and appropriate investigation, management and occupational disposition of military aircrew with cardiovascular abnormalities and disease. The ability to perform first-line on-site cardiovascular investigations results in the majority of aircrew returning to full duties following a single one-stop assessment. Cardiovascular abnormalities are prevalent in aircrew and close collaboration with occupation/family practitioners, as well as commanders, allows delivery of a timely and appropriate occupationally oriented specialist service.

**Learning Objectives:**

1. To understand the bespoke clinical aviation medicine service provided to UK military aircrew.
2. To understand the first-line and subsequent investigations and management of individuals referred with suspected or confirmed cardiovascular pathology.
3. To recognize the significant burden of cardiovascular disease in a population that is often deemed "fit and healthy" with low pre-test probability of disease.

**11:15 a.m.****[040] SPECIAL ECG DETECTION AND SYSTEMATIC ANALYSIS OF THE DEVELOPMENT OF ARRHYTHMIAS DURING HIGH POSITIVE G ACCELERATION IN THE LONG-ARM HUMAN CENTRIFUGE**A. Werner<sup>3,1</sup>, T.M. Seidel<sup>1</sup>, C. Wonhas<sup>2</sup>, R. Mörlin<sup>3</sup>, H.C. Gunga<sup>1</sup>, and A.R. Pries<sup>1</sup><sup>1</sup>Dept. for Physiology, Center of Space Medicine, Charité Universitätsmedizin Berlin, Berlin, Germany; <sup>2</sup>Section II 3 c Internal Medicine, German Air Force Center for Aerospace Medicine, Fürstenfeldbruck, Germany; <sup>3</sup>Branch I 1 Aviation Physiology Training Center, German Air Force Center for Aerospace Medicine, Königsbrück, Germany

**INTRODUCTION:** Pilots in high-performance aircrafts undergo high physical strain. Anatomically, the dislocation and elongation of the heart could increase the development of arrhythmias during high-G acceleration. From literature, arrhythmias during high +Gz-acceleration is described, but mostly analyzed in small numbers of subjects and their clinical relevance is not understood yet. **METHODS:** During high-G training in the German long-arm human centrifuge (laHC), a 1-channel ECG is recorded regularly. An increasing level of arrhythmias has been observed from 1993 to today. Two preliminary investigations (1993 to 1995 (P1),  $n = 360$ ; 1994 to 2001 (P2),  $n = 1320$ ) where compared to a period from 2006 to 2012 (P3). Male pilot-runs were evaluated retrospectively by analyzing the handwritten protocols. For characterization of the arrhythmias the clinically established LOWN classification was used. All runs on laHC were included and profiles up to  $9 + Gz$  with max. 16 ss plateau were analyzed. **RESULTS:** In P3 1922 healthy male pilots-centrifuge-runs,  $29.5 \pm 8.0$  years,  $180.7 \pm 5.4$  cm,  $79.5 \pm 8.0$  kg, BMI  $24.3 \pm 2.1$  kg/m<sup>2</sup>, were analyzed. Comparing with P1 and P2, we found an increase in the development of arrhythmias during simulated +Gz acceleration. Arrhythmia episodes increased quantitatively from  $\sim 0.3\%$  (P1) to  $14\%$  (P2) to  $20\%$  (P3). Qualitatively, we obtained formally higher arrhythmias up to non-sustained ventricular tachycardias (NSVT) which were not seen in P1/P2. In more than 98% of the cases, students denied symptoms that could be associated with episodes of arrhythmia.

**DISCUSSION:** Our data comparing P1, P2, and P3 showed an increase in arrhythmias quantitatively and qualitatively. However, the clinical impact is not perspicuous and particularly we are dealing with healthy subjects, not CHD-patients. Therefore, there is a need to evaluate a threshold and a potential clinical significance to estimate further meaningful diagnostics and consequences for high +Gz-accelerated pilots.

**Learning Objectives:**

1. High performance education on human long-arm centrifuge induces higher formal arrhythmia development, especially in young students.

**11:30 a.m.****[041] OUTCOMES OF ASYMPTOMATIC INCIDENTALLY FOUND WOLFF-PARKINSON-WHITE PATTERN ON ELECTROCARDIOGRAM**K.A. Rupp<sup>1</sup>, E.D. Davenport<sup>2</sup>, and J. Haynes<sup>2</sup><sup>1</sup>Residency in Aerospace Medicine, U.S. Air Force School of Aerospace Medicine (USAFSAM), Wright-Patterson AFB, OH; <sup>2</sup>Aerospace Medicine Consultation Division, USAFSAM, Wright-Patterson AFB, OH

**INTRODUCTION:** Many cases of Wolff-Parkinson-White (WPW) pattern have been found in asymptomatic individuals during routine electrocardiograms (ECGs). Few of these cases actually develop a dysrhythmia. There is an aeromedical concern regarding WPW pattern progression risks such as sudden cardiac death, sustained supraventricular tachycardia, or other dysrhythmia that may affect the safety of flight or aviator's health. The purpose of this study is to determine prevalence, outcomes, and possible contributing risk factors for aviators who have an ECG with WPW pattern. **METHODS:** All individuals found to have WPW in the USAFSAM ECG library database were included in the study. Medical records for the individuals were reviewed for outcomes data and risk factors analysis. Data collected include height, weight, blood pressure measurements, cholesterol results, exercise testing, cardiac testing, age at diagnosis, arrhythmias experienced, cardiac symptoms experienced, and tobacco and alcohol histories. **RESULTS:** There were 841 individuals found who had WPW pattern on at least one ECG. Data analysis is ongoing with results expected March 2015 in time for presentation in May 2015. Preliminary results do show an approximately 0.5% risk of arrhythmia and 0.13% annual risk of sudden cardiac death with no significant correlation between traditional cardiovascular risk factors or fitness data. **DISCUSSION:** This study provides insight into WPW pattern on ECG and aviator risk of arrhythmia or incapacitating events.

**Learning Objectives:**

1. Understand the relationships between risk factors and arrhythmias or incapacitating events in individuals with WPW pattern.

**11:45 a.m.****[042] RELATIONSHIP BETWEEN BICUSPID AORTIC VALVE AND CARDIOVASCULAR DISEASE**D.R. Pizzino<sup>1</sup> and E.D. Davenport<sup>2</sup><sup>1</sup>U.S. Air Force School of Aerospace Medicine, Wright Patterson AFB, OH; <sup>2</sup>Aeromedical Consultation Service, U.S. Air Force School of Aerospace Medicine, Wright Patterson AFB, OH

**INTRODUCTION:** Current medical literature suggests that people with a bicuspid aortic valve (BAV) have an increased risk of hemodynamically significant valvular disease, valve replacement, and possibly increased risk of other major adverse cardiovascular events (MACE) to include death, stroke, myocardial infarction, and revascularization. This study examines the likelihood and rate of progression to valvular disease, associated risk factors, and outcomes to include valve surgery and other MACE among aviators. **METHODS:** In this retrospective study, 260 aviators with BAV were identified by the U.S. Air Force Aeromedical Consult Service. These subjects included those disqualified and those who received aeromedical waivers to continue flying duties and were enrolled in a BAV study group at the time of identification. There were no inclusion criteria other than presence of BAV. The BAV database contained subjects starting from the year 1967 through the present. The electronic medical records of these aviators were examined for presence of any valvular regurgitation/stenosis or replacement and/or MACE. **RESULTS:** Data analysis is ongoing with results expected March 2015 in time for presentation in May 2015. Preliminary results do show a possible correlation between certain cardiovascular risk factors and worsening regurgitation/stenosis in aviators with BAV, but no increased risk of MACE. **DISCUSSION:** Determining a relationship with BAV, valve disease progression, and MACE could alter the U.S. Air Force pilot selection process, airframe assignment, and decisions to grant flying waivers.

**Learning Objectives:**

1. Discuss the relationship of BAV on development of MACE or cardiac valvular disease.
2. Identify other associated risk factors affecting the progression of BAV to cardiovascular disease.
3. Discuss the aeromedical risks of aviators with BAV.

**Monday, May 11**  
**S. Hemisphere 5****10:30 A.M.****[VIII.] PANEL: CURRENT AND FUTURE CHALLENGES FACING AEROMEDICAL COMMUNITIES****Chair: Chris Foster**

NAS Patuxent River, MD

**PANEL OVERVIEW:** The field of aerospace medicine continues to address traditional challenges ranging from topics such as aircrew health to fatigue to human system integration; however, our continued success as practitioners relies on our ability to address not only these challenges, but also to plan for and prepare to address emerging aeromedical issues. This panel will include presentations from leaders in each of the Navy's uniformed aeromedical communities: Flight Surgeons, Aerospace and Operational Physiologists, Aerospace Experimental Psychologists, Aerospace Optometrists, and Aerospace Clinical Psychologists. Embedded within line communities and deployed to support the warfighter, these communities have unique insight into the current and future aeromedical challenges facing the Navy. Each presenter will detail the specific challenges they are addressing today and provide their perspective on the challenges that we have to be prepared to address in the future.

**[043] CURRENT AND FUTURE CHALLENGES FACING AEROMEDICAL COMMUNITIES**

K. Toone

U.S. Navy, Pensacola, FL

**INTRODUCTION:** Navy Aerospace Medicine providers range from junior Flight Surgeons with a minimum of completion of a clinical internship and six months of training at the Naval Aerospace Medical Institute to senior physicians with board certification in Aerospace Medicine and decades of experience. This wide variation requires ready access to current issues and standards ensuring the youngest of providers have the tools required to make sound medical decisions and the most senior providers remain current with access to evidence based practice guidelines. **METHODS:** We provide aeromedical care to Sailors and Marines in brick and mortar medical treatment facilities as well as at sea and in tents near the front lines. These personnel are typically healthy, but medical issues that arise in any of these locations can pose significant risk to the safety of flight. These medical issues may arise from fatigue at the front lines, systems integration issues at experimental commands or natural disease processes at any location. **RESULTS:** The biggest challenges to our community at this time are maintaining a robust training pipeline, updating medical standards and ensuring that those standards are easily accessible from any location. Due to the high risk of errors in this medical field, selecting high functioning physicians is a priority. Remaining current in medical knowledge is difficult in any field, but the diversity of Aerospace Medicine provides for a need to follow technology, policy and medical research equally. If the policy is current and based off of the latest medical research and technology, it will not matter unless there is an adequate delivery system of this information to the "fleet." **DISCUSSION:** In addition to the current challenges we face in Naval Aerospace Medicine, we need to be ready for future challenges. As the ACGME requirements for residency become more restrictive, the Navy method of training junior Flight Surgeons will soon become a thing of the past and we need to ensure that we are ready to transition to a new paradigm. This new paradigm also exists for the transition to unmanned systems. With the successful launch of unmanned vehicles from sea and land, the need to continue to redefine flight personnel is paramount.

**Learning Objectives:**

1. Familiarization with Naval Aeromedical Specialists.
2. Familiarization with current challenges facing Naval Aeromedical Specialists.

**[044] CURRENT AND FUTURE CHALLENGES IN AEROSPACE AND OPERATIONAL PHYSIOLOGY**R. Bates<sup>1</sup> and L. Kindling<sup>2</sup><sup>1</sup>BUMED, Falls Church, VA; <sup>2</sup>Headquarters Marine Corps, Washington, DC

**INTRODUCTION:** The Naval Aerospace and Operational Physiology (NAOP) community supports the Navy's warfighters through education, training, aeromedical and human performance support, acquisitions and research, development, test and evaluation. NAOPs prepare all prospective and designated aviators, aircrew and other fliers for the physiological challenges of flight and survival. NAOPs are subject matter experts in human factors and physiological threats related to flight and operational environments, physiological elements which enhance mission performance, mitigation factors that prevent mishaps, procedures for surviving mishaps and hostilities, application of aircrew and personal protective systems and procedures for emergency egress and rescue. The following initiatives are a sample of current efforts and areas of concentration: 1. Improved physiological and survival training - Relevant and safe hypoxia training - Development of improved sensory physiology/spatial disorientation and situational awareness training - Dietary supplement and energy drink/compound education 2. Improved human performance - Neck and back pain prevention - Fatigue mitigation strategies through predictive model development 3. Flight and ground force equipment procurement and sustainment programs - Aircrew survival vests and components - Ground force load/carriage assessments - Hearing protection as flight equipment.

**Learning Objectives:**

1. Understand the mission, capabilities, and priorities of the Aerospace and Operational Physiology (AOP) community.

**[045] CURRENT AND FUTURE CHALLENGES IN AEROSPACE EXPERIMENTAL PSYCHOLOGY**J. Patrey<sup>1</sup> and C. Foster<sup>2</sup><sup>1</sup>4.6 Human Systems, NAVAIR, Patuxent River, MD; <sup>2</sup>4.6, NAWCAD, NAS Patuxent River, MD

**INTRODUCTION:** The Naval Aerospace Experimental Psychology (AEP) Community responds to emerging challenges within and beyond the boundaries of Naval Aviation to support the Navy, Marine Corps, and DoD through research, applied work, and program management bringing to bear our expertise in human systems integration, human performance, human engineering, aviation selection and assessment, training and simulation, and aviation safety. Today AEPs support key focus areas of the Naval Aviation Enterprise (NAE) including survivability, human machine interface, system acquisition, and selection and training. The AEP community envisions a future in which these priorities will remain, but evolve to include new approaches and the requirement for new capabilities. First, there will be increased need for unmanned systems, which will require addressing issues ranging from operator selection and training to human machine interface and common control system to manpower, fatigue, and stress management. Second, given increased cost of fleet platforms and the complexity of training requirements, there will be increased reliance and capability demands for live, virtual, constructive (LVC) training. Third, the importance of network centric warfare will continue to evolve to include the integration of data across the battlespace, timely analysis, and secure sharing to deployed assets. Fourth, the increased prevalence of data rich environments will necessitate greater emphasis on brain based technologies to realize improvements in human performance (e.g., monitoring cognitive state). This presentation will highlight the important role that AEPs will play in delivering these critical capabilities for the Joint force, the NAE, and Naval Medicine.

**Learning Objectives:**

1. Understand the role of the Aerospace Experimental Psychology community and how changes to mission and technology are likely to influence future capability requirements.

**[046] UNITED STATES NAVAL AEROSPACE OPTOMETRY**K.J. McGowan<sup>2</sup>, H. Gao<sup>1</sup>, and K.J. Whitwell<sup>3</sup><sup>1</sup>Ophthalmology, Naval Medical Center San Diego, San Diego, CA;<sup>2</sup>U.S. Army Public Health Command, Aberdeen, MD; <sup>3</sup>Naval Aerospace Medical Institute, Pensacola, FL

**INTRODUCTION:** The U.S. Naval Aerospace Optometry (AsO) Community supports the Naval Aviation Enterprise through dynamic vision care, research, and training. AsOs are highly specialized vision experts who offer expertise in military vision standards, aviation personnel selection and assessment, aeromedical training, aviation safety, human visual performance and visual systems integration. **DISCUSSION:** To meet the challenges of modern naval aviation, AsOs encompass a few key focus areas in Navy medicine: 1) The advent of enhanced color displays, such as in F-35, demands the utilization of more sensitive color vision screening tests. New computerized color vision tests have been tested and evaluated to extend and improve upon current capabilities. Fielding of these more reliable and sensitive tests will improve operational performance and enhance safety. 2) Navy refractive eye surgery provides critical visual advantages to the U.S. Warfighter via world-class surgical treatments and vision research; however, long-term outcomes need to be systematically evaluated and newer surgical technologies/procedures require additional validation for military personnel. 3) Given the increased incidence of lethal or non-lethal laser exposure incidents in aviation and maritime operations, there is a critical need for a night time cockpit/instrumental compatible laser eye protection countermeasures to mitigate these laser threats. 4) Spatial disorientation remains the number one Aeromedical causal factor in Class

A mishaps. Motion-based mitigation strategies are needed. 5) Unmanned aerial systems (UAS) require investigation in performance-based vision standards for UAS operators and address issues such as stress, fatigue and visual performance degradation. And, 6) AsOs investigate and assess U.S. Navy vision readiness and develop operational vision requirement for deployed personnel.

**Learning Objectives:**

1. Understand what important roles Naval Aerospace Optometry play in supporting U.S. Naval Aviation Enterprise, Navy Medicine, and the Joint force.

**[047] CURRENT AND FUTURE CHALLENGES IN AEROSPACE CLINICAL PSYCHOLOGY**

A. Saitzyk

Psychiatry, NAMI, Pensacola, FL

**BACKGROUND:** Aerospace Clinical Psychology (ACP) is an emerging community. To date, we have largely operated from Naval Aerospace Medical Institute (NAMI). Functionally, ACPs provide three major services: (1) train Flight Surgeons to recognize and provide immediate intervention regarding psychiatric issues for aviation personnel (of note, NAMI Psychiatry delivers the majority of the student Flight Surgeon curriculum - 28 hours didactics, 12 hours hands-on workshops), (2) support Flight Surgeons via on-going consultation and comprehensive assessment regarding psychiatric physical qualification and aeronautical adaptability, and (3) guide Squadron Commanders with respect to human factors and aeromedical issues. In the future we want to be more directly embedded within communities we serve (e.g., on board U.S. Navy Aircraft Carriers, within Marine Air Wings) to better support the Fleet. **METHODS:** Discuss current and future challenges, prioritize issues, and develop courses of action to best support the Fleet. **CURRENT CHALLENGES:** Present training at NAMI prepares multiple physician and allied-health aviation specialists to support our forces, but there is no ACP-specific curriculum. Instead, we include courses from the Flight Surgeon and Aerospace Experimental Psychology "tracks" and supplement with a NAMI Psychiatry rotation. There is considerable appeal to modify the training so that individuals are best prepared to directly support the Fleet similar to other mental health specialists (e.g., those embedded with Marine ground forces - OSCAR program, Navy SEAL community, submarine forces). Providers will then become more sufficiently acquainted with the aviation community, and have greater credibility and authority. **FUTURE CHALLENGES:** Our top three future challenges are: (1) grow the ACP community, (2) obtain billets (there is already much interest within the Marine Air Wings for ACPs who can deploy with squadrons. Additional billets on the carriers, by CONUS region, overseas, or within Naval Air Forces commands should be carefully considered), and (3) draw upon ACP expertise to inform standards within the UAS operator community.

**Learning Objectives:**

1. Discuss current services provided by ACPs and identify challenges in these arenas.
2. Generate ways to best address future challenges to meet the needs of those in Naval Aviation and UAS communities.

**Monday, May 11****S. Hemisphere E3****10:30 A.M.****[IX.] PANEL: AEROSPACE MEDICINE REVIEW BOARD #1: FLIGHT ENVIRONMENT****Co-chair: Justin Woodson**

Bethesda, MD

**Co-chair: Charles Clinton**

Yorktown, VA



**PANEL OVERVIEW:** The Aerospace Medicine Board Review series will review core topics in Aerospace Medicine and is designed to prepare Aerospace Medicine specialists for the ABPM re-certification exam. Topics are presented in three sessions each year by specialists in the field and adhere to the ABPM Study Guide outline which will be covered in its entirety over the course of three consecutive years. Combined with the annual RAM Bowl and Aerospace Medicine Grand Rounds sessions, these board review sessions will address the preventive medicine core and the four core knowledge areas of Aerospace Medicine: Flight Environment, Clinical Aviation Medicine, Operational Aerospace Medicine, and Management & Administration. This panel will cover essential elements of the SPATIAL ORIENTATION & THEORY OF FLIGHT in two parts: 1) Spatial Orientation and Aviation Vision (physiology, cues, illusions). 2) Theory of flight.

**Monday, May 11**  
**S. Hemisphere E4**

**10:30 A.M.**

## **[X.] PANEL: AEROMEDICAL EVACUATION TRAINING FLIES INTO THE FUTURE**

**Chair: Marla DeJong**  
*Bethesda, MD*

**PANEL OVERVIEW:** With the downsizing of inpatient medical treatment facilities within the Air Force, there is growing concern about the declining inpatient experience of nurses and medical technicians who enter aeromedical evacuation (AE) training programs. The lack of experience coupled with the high acuity of wounded warriors transported from Iraq and Afghanistan has many AE leaders concerned about the potential impact on patient safety and outcomes. With the drawdown of operations in Afghanistan, AE leaders are also concerned about sustaining the clinical competence of Flight Nurses (FN) and Aeromedical Evacuation Technicians (AET). This panel will bring together results from recent studies regarding the clinical experience and learning styles of FN and AET students, and hybrid education methods used to teach trauma skills to FNs, AETs, and Critical Care Air Transport (CCAT) team members. Panel members will provide insight into the current state of AE training and propose innovative approaches to better prepare future FNs and AETs. Panel members will describe: the clinical experience of AE students the clinical education needs of AE students the learning styles of AE students and the application of hybrid education methods to teach trauma skills to AE crew and CCAT team members. Findings from these studies confirmed assumptions regarding the clinical preparation of students who enroll in the United States Air Force School of Aerospace Medicine FN and AET courses. Further, the results laid the foundation for education initiatives to address confirmed gaps, and may soon change policy regarding eligibility for the courses and course prerequisites. Innovative approaches to training are warranted as we move into an uncertain anti-access/area denial environment. During the current fiscally austere environment, a sound assessment of the current situation is needed before time and resources are expended to change any education initiatives or policies.

### **[048] CLINICAL EXPERIENCE OF FLIGHT NURSE AND AEROMEDICAL EVACUATION STUDENTS**

M.J. DeJong, S. Dukes, K.M. Dufour, and D.L. Mortimer  
*Wright-Patterson AFB, OH*

**INTRODUCTION:** It is critical that nurses and technicians demonstrate clinical expertise on the ground before they can be expected to proficiently care for 30-50 combat casualties at 35,000 feet in a cargo aircraft, under the stresses of flight for 8-12 hours with a 5- to 7-member crew. Whereas new active duty Flight Nurses (FN) and Aeromedical Evacuation Technicians (AET) may have limited military inpatient experience, some Air Force Reserve Command (AFRC) and Air National Guard (ANG) members have acquired extensive clinical experience at civilian hospitals and healthcare agencies. The impression, nonetheless, is a steadily declining trend in the experience level of nurses and medical technicians. Further, no mechanism exists to capture the clinical experience of incoming students. The purpose of the study was to describe the clinical

experience of students entering the U.S. Air Force School of Aerospace Medicine FN and AET courses. **METHODS:** Active duty Air Force, AFRC, and ANG students who attended the FN or AET course were invited to complete a questionnaire on clinical experience. Students completed the survey on day one of the FN or AET course outside of class hours. **RESULTS:** A total of 198 FNs and AETs completed the survey. Respondents reported  $5.3 \pm 5.2$  years total experience, and  $28.7 \pm 28.1$  months clinical experience. The majority reported managing nasogastric tubes, chest drainage units, and wound vacs; administering blood, using portable suction, and managing patients with a burn injury or neurological disorder once every 2 weeks or less. More than 25% reported varying degrees of discomfort using infusion pumps, wound vacs, and chest drainage units, administering blood, and managing patients with shock, burns, or neurological disorders. **DISCUSSION:** Future aeromedical evacuation (AE) crewmembers are relatively inexperienced, and many work in outpatient settings. Their discomfort using equipment and caring for typical types of AE patients is concerning.

#### **Learning Objectives:**

1. Discuss concerns regarding clinical experience of AF Flight Nurses and Aeromedical Evacuation Technicians.
2. Identify clinical care training priorities for AE crewmembers.
3. Identify at least one research gap pertaining to the clinical experience of AF Flight Nurses and Aeromedical Evacuation Technicians.

### **[049] GAP ANALYSIS OF CLINICAL EDUCATIONAL NEEDS OF AE STUDENTS**

S. Dukes, M.J. DeJong, K.M. Dufour, and D.L. Mortimer  
*Wright-Patterson AFB, OH*

**INTRODUCTION:** There is a steadily declining trend in the experience level of nurses and medical technicians who arrive at the U.S. Air Force School of Aerospace Medicine (USAFSAM) to take the Flight Nurse (FN) or Aeromedical Evacuation Technician (AET) course, which is expected to only worsen as the military draws down operations in Afghanistan. Yet, it is critical nurses and technicians demonstrate clinical expertise on the ground before they can be expected to proficiently care for 30-50 combat casualties at 35,000 feet in the back of a cargo aircraft, under the stresses of flight for 8-12 hours with a 5-7 member crew. The purpose of this study was to identify the clinical educational needs of students entering USAFSAM's FN and AET courses. **METHODS:** A gap analysis assessment was conducted to identify clinical learning needs of incoming students based on AE crewmember tasks identified in an Occupational Survey Review. Students rated their confidence level in performing each clinical task identified and AE subject matter experts (SMEs) identified the importance of each clinical task on the survey. A gap analysis was conducted to identify the gap between the importance of being able to perform a particular task and the confidence of the students in performing the task. This method utilized the SMEs' perspective of what is important, and the students' confidence level in doing so to determine the overall educational needs. AE and methodology SMEs were used to assess content validity of the gap analysis. **RESULTS:** A total of 198 students completed the confidence rating of the AE tasks and 12 AE SMEs evaluated the importance of each task. Further details of the gap analysis will be available at the time of presentation. **DISCUSSION:** These findings will lay the foundation for education initiatives to address confirmed gaps within AE.

#### **Learning Objectives:**

1. Describe a gap analysis and how it is conducted.
2. Identify the primary clinical learning needs found in this study.
3. Discuss how the findings from this study may impact educational initiatives.

### **[050] THE USE OF A HYBRID EDUCATIONAL METHOD FOR TRAUMA TRAINING AMONG U.S. AIR FORCE NURSES**

K.M. Dufour<sup>1</sup> and T.S. Jastrzembski<sup>2</sup>

<sup>1</sup>Wright-Patterson AFB, OH; <sup>2</sup>711th Human Performance Wing/Cognitive Models & Agents, AFRL, Centerville, OH

**INTRODUCTION:** Trauma assessment is a core skill for all United States military nurses. With the recent withdrawal of troops from Iraq and the imminent withdrawal from Afghanistan, there are serious concerns about how Air Force (AF) nurses can maintain high-level trauma skills without the frequent exposure and opportunities in which to perform them. The purpose of this evidence-based practice (EBP) project is to implement a trauma training program that combines didactics and simulation to sustain trauma skills among AF nurses. **RESULTS:** A pilot is underway to assess the feasibility of full-scale implementation in a medical treatment facility and potentially throughout all of the AF Medical Service, to include aeromedical evacuation. A modified trauma evaluation tool based on Holcomb et al.'s study (2002) was developed to assess pre-/post-trauma assessments in conjunction with a trauma assessment lecture. Data points will be entered into the Predictive Performance Equation (PPE) which incorporates experimental, cognitive, and mathematical psychology to predict performance to determine appropriate training spacing over time to minimize skill/knowledge decay (Jastrzemski, Portrey, Schrieber, & Gluck, 2013). Preliminary data will be available at time of presentation. **DISCUSSION:** Simulation provides participants the opportunity to replicate scenarios using a realistic, yet non-threatening environment to achieve a desired outcome. Didactic education is a common way to deliver the theory that is integrated with the practice of simulation to stimulate and enhance knowledge, clinical skills, and critical thinking. Using the PPE concept, the appropriate "dose" of training is determined using objective, proficiency-based measures rather than calendar-driven periods to maximize skill/knowledge retention. An individualized training program using a hybrid education method for aeromedical crewmembers at the squadron level may mitigate the effects of budgetary restraints and decreased trauma exposure on maintaining proficiency, quality care, and patient outcomes.

#### Learning Objectives:

1. Identify the challenges for AF nurses to sustain trauma skills.
2. Discuss how the combination of didactics and simulation can affect knowledge and skill retention.
3. Describe how training can be tailored to individuals using the Predictive Performance Equation to attain the right "dose" to minimize trauma knowledge/skill decay.

#### [051] IDENTIFICATION OF FLIGHT NURSE AND AE TECHNICIAN LEARNING STYLES USING VARK

D.L. Mortimer, S. Dukes, M.J. DeJong, and K.M. Dufour  
Wright-Patterson AFB, OH

**INTRODUCTION:** The standard in the education and training community has evolved from lecture to multimodal non-traditional teaching strategies that align with adult learning principles and are mindful that students learn through a variety of means. Frequently, instructors use learning styles inventory (LSI) tools to assess student's learning preferences. Learning style refers to the ways learners most efficiently and effectively perceive, process, store, and recall what they attempt to learn. In this way, instructors can provide individualize teaching strategies based on learning style preferences. The purpose of this study is to identify the learning styles of aeromedical evacuation students. **METHODS:** Students at the United States Air Force School of Aerospace Medicine (USAFSAM) Flight Nurse (FN) and Aeromedical Evacuation Technician (AET) training courses were invited to complete the VARK (visual, aural, read/write, kinesthetic) LSI on the first day of class, January through June, 2014. The VARK LSI is a 16 question tool designed to identify individual learning style preferences. Participation in the study was anonymous. Data were aggregated. **RESULTS:** A total of 198 students completed the VARK LSI. The majority of FNs and AETs (n = 97/198; 49%) endorsed Kinesthetic (n = 53/198; 27%) and multi-modal Type One (n = 44/198; 22%) learning styles. Type One learners are those who express two, three, or four almost-equal learning style preferences, which are applied singularly depending on the situation. **DISCUSSION:** These findings suggest that the majority FN and AET students are Kinesthetic and Type One multi-modal learners. Blending a variety of teaching strategies while incorporating learning style specific modalities will resonate well with all learners. Instructors can apply the learning styles

strategies to optimize students' educational experiences and promote learning outcomes with the ultimate goal of improving patient care and patient outcomes.

#### Learning Objectives:

1. Describe the VARK Learning Style Inventory tool.
2. Discuss the application of the VARK Learning Style Inventory to the FN/AET Courses.
3. Explain the Type I learning style.

#### [052] THE USE OF SIMULATION EDUCATION METHODS FOR TRAUMA TRAINING AMONG U.S. AIR FORCE NURSES

T.L. Millwater  
USAFSAM, Wright-Patterson AFB, OH

**INTRODUCTION:** Simulation consists of a wide spectrum of methods ranging from low fidelity manikins, part-task trainers, and standardized patients to high-tech virtual reality screen-based trainers (Cherry & Ali, 2008). Use of simulation is that of a technique and not a technology to strengthen real experiences with guided experiences, which are often immersive to evoke or replicate real world occurrences (Gaba, 2004). Authentic learning occurs if simulation is constructed appropriately (Bland, Topping, & Wood, 2011). The purpose of this presentation is to provide an overview for simulation utilization in meeting education and training objectives. **METHODS:** As with all training modalities, simulation has advantages and disadvantages. Advantages include: protection of patients, learner-centered teaching, creation of high risk/low volume training experiences, events may be tailored to meet the learning styles and time needs of participants, and visualization of consequences of wrongful actions. Disadvantages include: equipment and space expenses, maintenance requirements, and limitation of capabilities (Ziv, Small, & Wolpe, 2000). **DISCUSSION:** In order for simulation to be effective, consideration of training objectives and educational outcomes is paramount. To reach these conclusions, education and training opportunities should be based on concepts, conditions, or circumstances which cannot otherwise be obtained through clinical practice. Effective simulation-based education must have a foundation in understanding attributes of each method available (Ziv, Small, & Wolpe, 2000). Simulation opportunities should be non-threatening and non-judgmental which allows participants to make mistakes, learn from them, and encourage continuous deliberate practice. Educational objectives must drive which type of simulation will best meet the needs of participants while accomplishing the learning outcomes (Kohn & Corrigan, 1999). To improve patient safety, comprehensive training for healthcare professionals is paramount. Simulation may provide the techniques required to accomplish this goal.

#### Learning Objectives:

1. Describe advantages of simulation as an educational technique.
2. Discuss how simulation may augment learning processes for participants.
3. Discuss types of events simulation training should emulate for optimum educational opportunities.

Monday, May 11  
S. Hemisphere 1

2:00 P.M.

#### [XI.] PANEL: FATIGUE: CHALLENGES, COUNTERMEASURES, AND RISK MANAGEMENT STRATEGIES

Sponsored by the AsMA Associate Fellows Group

Co-Chair: Steven Gaydos  
Middle Wallop, Hampshire, United Kingdom

Co-Chair: Philippe Souvestre  
Vancouver, British Columbia, Canada

**PANEL OVERVIEW:** Napoleon is quoted as saying "The first quality of a soldier is constancy in enduring fatigue and hardship." Fatigue has indeed remained an enduring constant throughout military history and is now a seemingly ubiquitous problem among our fast-paced society posing authentic occupational health and safety challenges. Within the purview of aviation human factors, fatigue is an extant threat to safe, efficient operations. It has been implicated in numerous, tragically consequential accidents. It is a complex and challenging problem with multiple factors at play including inadequate sleep, circadian dysrhythmia, high workload, extended duty periods, psychosocial factors, environmental factors, inter-individual variability and others. As the scientific community continues to expand the working base of knowledge, aircrew, safety officers and supervisors must remain au courant to leverage evidence-based, cooperative, and integrated policies, operating procedures, and mitigating strategies. Panel presentations will address fatigue risk management within the context of systems and strategies for space, military and commercial aviation, address some of the misguided notions and entrenched misconceptions, and provide updates on recent developments for mitigation and countermeasures.

### [053] SLEEP IS FOR SISSIES

J. Caldwell

*Coastal Performance Consulting, Yellow Springs, OH*

**INTRODUCTION:** Most adults require 7-9 hours of sleep per day in order to perform optimally, but Americans rarely achieve this goal. Instead, sleep restriction is rampant throughout society, and the result is diminished cognitive functioning, reduced athletic performance, poor health, and compromised safety. Given that science clearly supports the need for adequate restful sleep, why are we as a society so insistently clinging to sleep deprivation? **METHODS:** A review of the literature related to this issue was conducted. **RESULTS:** Cultural factors are most likely responsible for the view that sleeplessness is a desirable, macho characteristic. Many of America's most famous heroes and entrepreneurs have eschewed sleep in favor of long work hours and demanding schedules. Examples include Thomas Edison, Charles Lindbergh, Dale Carnegie, and Donald Trump—all of whom touted their fatigue resilience, resistance to sleep, and inexhaustible drive for competitive success. As role models for Americans everywhere, their influence still can be seen throughout society. Since numerous scientific studies run counter to the macho culture of sleep deprivation, the time has come to jettison the myths of the past and accept nature's demand for adequate daily recuperation. **DISCUSSION:** We must put an end to the cultural ideal that threatens health, productivity, and safety. Through regulation, education, and appropriate sleep augmentation, we can improve performance and quality of life.

#### Learning Objectives:

1. Appreciate the impact of cultural factors on perceptions of fatigue-management programs.

### [054] FATIGUE IN AVIATION: NTSB FINDINGS AND SAFETY RECOMMENDATIONS

J.H. Marcus and M.R. Rosekind

*National Transportation Safety Board, Washington, DC*

**INTRODUCTION:** The National Transportation Safety Board (NTSB) investigates every civil aviation accident in the U.S. then issues findings and recommendations to prevent their recurrence. In this study, major NTSB investigations between 2001 and 2012 were reviewed for findings of fatigue and all NTSB fatigue-related recommendations were categorized. **METHODS:** The prevalence of fatigue in major NTSB accident investigations between 2001 and 2012 was analyzed. All NTSB fatigue-related safety recommendations were reviewed and assigned into one of seven different subject categories. The organizations receiving the recommendation and status were also reviewed. **RESULTS:** Of the 61 major aviation accident investigations during the study period, fatigue was identified in 14 (23%). The first NTSB fatigue recommendation was issued in 1972; since then 51 aviation fatigue recommendations have been issued. The recommendations were divided into the following subject categories: (1) scheduling policies and practices; (2) education/raising awareness; (3) organizational strategies; (4) medical issues; (5) vehicle and environmental; (6) research and evaluation; and (7) fatigue management plans. Scheduling policies and practices accounted for 55% of the recommendations while education/raise

awareness and medical issues each represented 13.7%. The Federal Aviation Administration received 86% of the recommendations with 8% issued to individual operators, and 4% to associations. **DISCUSSION:** While significant efforts have focused on reducing fatigue risks in aviation, the NTSB continues to identify fatigue issues in about 20% of all major aviation accidents investigated. Scheduling policies and practices were the subject of more than half of the recommendations issued. For more than 40 years, the NTSB has been issuing fatigue recommendations and accident investigation techniques and procedures have been developed and refined. This has allowed for a better understanding of the presence and role fatigue plays in accidents, and the actions needed to minimize the associated safety risks.

#### Learning Objectives:

1. The prevalence of fatigue as an issue in civil aviation.
2. The categories of actions needed to reduce the safety risks posed by fatigue.

### [055] FATIGUE MANAGEMENT: IDENTIFYING FUTURE UK MILITARY AVIATION REQUIREMENTS

K.A. Robertson

*Aircrew Systems, QinetiQ, Farnborough, United Kingdom*

**INTRODUCTION:** Within the UK military, there are a number of different policies relating to the management of fatigue and more recently guidance on the introduction of fatigue risk management systems has been published. To understand how these policies and guidance are currently being implemented and managed, a survey and workshop were completed. The aim was to identify areas of good practice and to highlight where additional guidance or further knowledge could be provided to help manage fatigue. **METHODS:** The survey was distributed to scheduling personnel within the RAF, Army and Navy. Individuals were invited to provide information about the day-to-day management of duty schedules, any tools used to estimate the impact of duty schedules on fatigue, details of fatigue reporting systems, any specific issues that individuals considered contributed to fatigue and the requirement for further guidance on fatigue management. Information from the survey was used to inform a subsequent workshop of key personnel involved in fatigue management. **RESULTS:** Overall, awareness of fatigue management is growing across the UK military. The majority of survey respondents (67%) stated that fatigue was well managed on a day-to-day basis and that they were encouraged to report any fatigue-related concerns. Nearly half (48%) of all the factors cited as contributing to fatigue were associated with the organization of duty schedules. Just under a quarter of respondents (24%) stated that they required additional information to help with the management of fatigue. These comments fell into two main areas, guidance material (e.g. platform specific advice as well as more general fatigue management advice) and fatigue management tools (guidance on and access to tools). **DISCUSSION:** Information from the survey and workshop indicated that there is a wide variation across UK military organizations in understanding of fatigue-related risks and in the implementation of fatigue risk management strategies.

#### Learning Objectives:

1. Awareness of factors contributing to fatigue in military aviation.
2. Awareness of fatigue management strategies and future requirements.

### [056] THE EVOLUTION OF FATIGUE RISK MANAGEMENT IN THE UK JOINT HELICOPTER COMMAND

A. Bushby<sup>1</sup>, I. Curry<sup>1</sup>, and S. Gaydos<sup>2</sup>

<sup>1</sup>Aviation Medicine, MOD, Stockbridge, United Kingdom; <sup>2</sup>U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL

**INTRODUCTION:** This presentation will seek to outline the steps that led to the formation of a formalized fatigue policy within the UK Joint Helicopter Command (JHC), the practical difficulties of implementation, the outcome measures that were applied and the conclusions drawn on effectiveness. For the last twelve years rotary wing (RW) formations from the JHC have been involved in operations in Southwest Asia; both conflicts have been particularly 'helicopter hungry' as RW aviation has allowed operational capability in non-permissive environments with difficult terrain. The high workload demands and often hostile working



and living conditions placed considerable strain on air and ground crews and maintainers (three worlds). An aviation medicine assessment was made when it became clear that the impact of fatigue among the three worlds was approaching a nadir whereby it would be likely to cause mishaps, indeed in retrospect it was found to have been implicated in minor mishaps almost from the inception of the campaigns. A comprehensive fatigue risk management strategy was put in place with a novel peer to peer assessment system. The successes and limitations of this strategy will be discussed along with the difficulty of providing objective toolsets for the complex world of operational RW aviation.

#### Learning Objectives:

1. To recognize the insidious nature of fatigue and the organizational difficulty in countering it in the deployed environment.

#### [057] FATIGUE IN U.S. ASTRONAUTS ONBOARD THE INTERNATIONAL SPACE STATION: ENVIRONMENTAL FACTORS, OPERATIONAL IMPACTS, AND IMPLEMENTATION OF COUNTERMEASURES

R.A. Scheuring<sup>1,2</sup>, R.C. Moomaw<sup>1</sup>, and S.L. Johnston<sup>1</sup>

<sup>1</sup>Space Medicine, NASA-JSC, Houston, TX; <sup>2</sup>Biodynamics Research Division, USAARL, Ft. Rucker, AL

**INTRODUCTION:** Since 2000, U.S. astronauts have been supporting missions up to a six month duration on the International Space Station (ISS). Crewmembers have experienced fatigue for reasons similar to military deployments. Astronauts experience psychological stressors such as heavy workloads, extended duty periods, circadian misalignment, inadequate/ineffective sleep, and loss of the environmental cues of a gravity environment. Complicating the psychological stressors are environmental factors; distracting background noise, unexpected and variable mission schedules, unfavorable thermal control, elevated CO<sub>2</sub> levels, and an unusual sleep environment with schedules that impinge on pre-sleep periods. Physiological contributors to poor sleep and fatigue include a cephalad fluid shift and back pain. Restful sleep is further challenged due to a lack of gravity-related proprioceptive cues and need for restraints. The term "space fog" has been used by astronauts to describe a phenomenon of forgetfulness, slowed reaction time and transient confusion while trying to complete tasks. There is a distinct temporal correlation with arrival on the Space Station and the onset of slowed cognitive skills and a spontaneous resolution that may take up to 6 weeks. The Genesis of this phenomenon may be chronic fatigue secondary to transitioning from a planar environment to a 360° microgravity perspective. Recently, countermeasures to improve sleep duration and quality in astronauts on the ISS have been instituted with moderate degrees of success as measured by self-reaction time (psychomotor vigilance task testing), actigraphy, and subjective reports. Judicious use of stimulants and hypnotics, light therapy, controlled sleep periods and sleep shifting and reducing ambient CO<sub>2</sub> levels are a few of the most promising countermeasures being used in space to improve sleep and reduce fatigue.

#### Learning Objectives:

1. The audience will identify physiological and environmental risk factors for inadequate and ineffective sleep contributing to fatigue in U.S. Astronauts on board the International Space Station and the effective countermeasures used to improve performance.

#### [058] AVIATION FATIGUE COUNTERMEASURES: THE OLD AND THE NEW

L. Caldwell

Aeromedical Directorate, Naval Medical Research Unit Dayton, Yellow Springs, OH

**INTRODUCTION:** Decades of research and operational experience have validated traditional approaches currently in use to manage aircrew fatigue stemming from unpredictable work hours, long duty periods, circadian disruptions, and disturbed or restricted sleep. However, our evolving understanding of the nature of fatigue along with recent advances in technology has created new possibilities for the future of fatigue management in aviation. Interventions such as light manipulation for improved alertness in the workplace, the enhancement of slow-wave sleep

to bolster the beneficial effects of short sleep periods or power naps, and the use of brain stimulation to enhance operator vigilance will be discussed within the context of existing counter-fatigue techniques. Many of these avenues promise hope for enhanced performance during otherwise compromised times when crew sleepiness negatively impacts the safety and effectiveness of a mission. Additional research will determine whether these ideas can be integrated into a safety system so that fatigue can be more effectively managed and safety and performance can be optimized.

#### Learning Objectives:

1. Be aware of potential new fatigue countermeasure options which may be useful in the operational environment following scientific validation.

Monday, May 11

S. Hemisphere 2

2:00 P.M.

#### [XII.] PANEL: MEDICAL OPERATIONS FOR A STRATOSPHERIC FREE FALL TEST PROGRAM: LESSONS LEARNED FROM PARAGON'S STRATEX PROGRAM

Chair: Derek Nusbaum

Houston, TX

**PANEL OVERVIEW:** The Paragon Stratospheric Exploration (StratEx) Project was a high altitude balloon flight test program that culminated in a freefall from 135,800 feet, thereby breaking the record for the highest freefall to date. Crew recovery and medical contingency operations required an innovative approach due to the unique nature of the event, the pressure suit design, and the equipment used for each of the flights. This panel will describe medical experiences had and lessons learned throughout the duration of this test program, including development of a novel drogue system for mitigation of acceleration injuries related to severe spins, evaluation of the current state of the art for physiologic monitoring in extreme environments, development of procedures for emergency medical care in a pressure suited patient, design of chase and recovery operations, and the implementation of portable ultrasound into medical decision making algorithms for use in the field. These experiences can be used as a framework for future space, near-space, and other extreme environmental missions.

#### [059] CREW RECOVERY OPERATIONS FOR A STRATOSPHERIC BALLOON JUMP

E. Antonsen<sup>1</sup>, D. Nusbaum<sup>1</sup>, A. Garbino<sup>1</sup>, A. Menon<sup>3</sup>, S. Watkins<sup>2</sup>, and J.B. Clark<sup>1</sup>

<sup>1</sup>Baylor College of Medicine, Houston, TX; <sup>2</sup>Preventive Medicine & Community Health, UTMB, League City, TX; <sup>3</sup>NASA Johnson Space Center, Clear Lake, TX

**INTRODUCTION:** Due to the unique nature of the Stratospheric Exploration (StratEx) Project, organization of the crew recovery operations, as well as the design of emergency medical care procedures, required an innovative approach to ensure effective management of any potential medical emergency scenarios. **METHODS:** New medical protocols were developed for this project, which included chase team recovery algorithms, selection of medical team members, integration and training with the Pressure Suit Assembly team, medical equipment selection, selection of on-site medical capabilities, and goals for "time-to-care" in the event of a medical contingency during flight. **RESULTS:** Unlike prior stratospheric balloon bailout jumps, there was no capsule for the ascent stage of the StratEx flights. The parachutist donned a custom spacesuit similar to an EMU with life support system worn on the anterior aspect of the suit and a parachute worn on the posterior aspect. The complex and bulky nature of this suit impacted crew recovery operations in two main ways. First, specialized protocols were developed in order to conduct emergency medical procedures like Advanced Cardiac Life Support and Advanced Trauma Life Support within the suit. Second, crew recovery teams were created that integrated suit specialists

with medical team members in order to rapidly extract the pilot from the suit for more definitive medical care. **DISCUSSION:** Because of the novel methods used during the StratEx program, especially with regards to pressure suit design, novel approaches had to be developed in order to effectively manage a medical contingency scenario should it have occurred during flight.

#### Learning Objectives:

1. Because of the novel methods used during the StratEx program, especially with regards to pressure suit design, novel approaches had to be developed in order to effectively manage a medical contingency scenario should it have occurred during flight.

#### [060] MEDICAL INFORMED CONSENT FOR HIGH ALTITUDE JUMPS: A PROOF OF CONCEPT

M. Carminati

University of Houston Law Center, Pearland, TX

**INTRODUCTION:** The Commercial Space Launch Act requires commercial human spaceflight operators to obtain informed consent from spaceflight participants prior to flying them on orbital and suborbital trajectories. The informed consent process broadly requires an individual to be informed of the "risks" of their particular flight profile. Federal law does not specifically discuss or mention the medical and physiological risks of such endeavors. Yet, the author posits that these risks need to be specifically addressed in a process akin to a "medical informed consent" which also mirrors the federal informed consent process. This comprehensive informed consent will therefore require the cooperation of physicians familiar with aerospace medical risks, operations, and an attorney familiar with the same issues, who together—as a team—can craft an adequate informed consent document for the spaceflight participant. During the course of the Stratex jump, the author and her medical colleagues, crafted such a document for the Stratex jumper. **RESULTS:** The author used a combination of her team's medical and aerospace capabilities, her own familiarity and knowledge of liability waivers, and her particular expertise in the informed consent and Commercial Space Launch Act legislation to craft a substantive, particularized informed consent document. **DISCUSSION:** The author will discuss the various considerations that went into developing an informed consent document that can be applied to suborbital and orbital flights by spaceflight participants and federal laws. The author will also discuss the importance of understanding which state law applies to ensure adequate protection under states' particular tort and contractual waiver laws.

#### Learning Objectives:

1. To understand the process by which a medical team works with the legal team to create a medically sound, legally solid, informed consent form for physiological and medical risks of activities such as high altitude jumps, suborbital flights, and orbital flights.
2. To understand the challenges and opportunities created by the various state laws, with particular examples of such state laws, and their integration into the federal informed consent framework.
3. To understand the significance of an informed consent process at the federal level, how it differs from the medical informed consent process, and how the two can be integrated for maximum information to the spaceflight participant.

#### [061] MEDICAL MANAGEMENT OF A SPACE-SUITED PATIENT IN EMERGENCY CONTINGENCY SCENARIOS

D. Nusbaum<sup>1</sup>, A. Garbino<sup>1</sup>, E. Antonsen<sup>1</sup>, D. Buckland<sup>2</sup>, and J.B. Clark<sup>1</sup>

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**INTRODUCTION:** The Paragon Stratospheric Exploration (StratEx) test program was designed without a capsule, but rather a robust pressure suit assembly for the ascent stage of flight. This newly designed pressure suit provided multiple challenges that had to be overcome in order to care for the pilot in the event of a medical emergency. **METHODS:** New emergency medical procedures, including modifications to Advanced Cardiac Life Support (ACLS) and Advanced Trauma Life Support (ATLS) protocols, were

developed to ensure appropriate medical care in the setting of a bulky, complex pressure suit. **RESULTS:** The StratEx pressure suit has a hard upper torso, which in conjunction with the parachute and life support assembly, created a significant barrier to extraction from the suit in the event of a medical contingency. For this reason, the Medical Support Team was integrated with the Pressure Suit Assembly Team for purposes of training in suit removal, defining a priori contingency leadership on-site during chase operations in the event of an off nominal landing scenario, creating a color-coding system to quickly communicate various nominal and off nominal landing and extraction scenarios, developing novel methods for the implementation of ACLS and ATLS in a suited patient, and practicing extraction drills with suit mock-ups in order to ensure appropriate coordination of team efforts in the event of a medical contingency. **DISCUSSION:** Novel methods, with regards to medical procedures and integration with the suit team, were required for the StratEx test program because of the design of the new pressure suit system, which limited access to the pilot in the event of a medical emergency situation.

#### Learning Objectives:

1. Novel methods, with regards to medical procedures and integration with the suit team, were required for the StratEx test program because of the design of the new pressure suit system, which limited access to the pilot in the event of a medical emergency situation.

#### [062] EFFECTS OF A HIGH-BACK DROGUE PARACHUTE ON PILOT ACCELERATIONS DURING STRATOSPHERIC FREE FALL

A. Garbino<sup>1</sup>, D. Nusbaum<sup>1</sup>, E. Antonsen<sup>1</sup>, D. Buckland<sup>2</sup>, J.B. Clark<sup>1</sup>, and J. Leidich<sup>3</sup>

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**INTRODUCTION:** A typical, center back tandem standard drogue parachute can help with stabilization during stratospheric free fall, but can still leave the jumper at risk of flat spins and injury from negative Gz exposure at the head. Here, we develop and test a novel drogue system with high back attachment for prevention of debilitating spins during high altitude free fall. **METHODS:** Mathematical analysis was performed to evaluate the effect of various drogue attachment points on acceleration forces at the level of the head during freefall. This modeling was then corroborated by data collected during wind tunnel testing, airplane jumps, and high altitude dummy drops. Finally, a high back drogue system, developed from the aforementioned testing, was implemented in a high altitude free fall test program. **RESULTS:** Testing demonstrated a shoulder or high back-attached drogue reduces the G loading at the level of the head by placing the head closer to the flat spin axis. In addition, a high attachment point places the spin axis out of alignment with any of the principle axes of inertia, introducing instability into and thus disrupting any developing spin. When used in manned stratospheric jumps, this system proved to be stable and easily controllable with little or no unintended spinning. **DISCUSSION:** A drogue parachute oriented with a shoulder or high back attachment point can protect against the detrimental effects of negative Gz exposure from a flat spin during high altitude free fall. This technique was implemented with success in a recent stratospheric free fall test program.

#### Learning Objectives:

1. A drogue parachute oriented with a shoulder or high back attachment point can protect against the detrimental effects of negative Gz exposure from a flat spin during high altitude free fall.

#### [063] W/D

#### [064] PHYSIOLOGIC MONITORING DURING EXTREME ENVIRONMENTAL PROGRAMS: UTILITY, LIMITATIONS, AND LESSONS LEARNED

A. Garbino<sup>1</sup>, D. Nusbaum<sup>1</sup>, E. Antonsen<sup>1</sup>, D. Buckland<sup>2</sup>, and J.B. Clark<sup>1</sup>

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**INTRODUCTION:** With the growing market for commercial space, near-space and other extreme environmental activities, a variety of physiologic monitoring systems are being used to monitor the health of participants. Here, we discuss the common features and limitations of currently available technology and requirements for future systems. **METHODS:** Experiences from two stratospheric free fall test programs (the Red Bull Stratos program and the Paragon Stratospheric Exploration [StratEx] program) were used to evaluate the current state of the art of and provide recommendations for improvements to physiologic monitoring systems for extreme environmental projects. **RESULTS:** Though commercially available physiologic monitoring systems do exist, they are limited in a number of areas. First, these systems are only able to monitor a limited number of physiologic and environmental parameters. Second, the parameters monitored are often done so in a limited fashion (eg. acceleration measured with linear accelerometers only, limited EKG leads). Third, the data collected is associated with a large degree of noise, especially related to movement. Fourth, the associated software packages lack the ability to manage large quantities of data produced by prolonged missions and to visualize them in a meaningful way to aid clinicians in medical decision-making. Finally, the hardware in these systems is insufficiently robust to appropriately tolerate extreme environments, especially with regards to appropriate length of battery life. **DISCUSSION:** A gap exists between currently available, commercial physiologic monitoring systems and features requested by the aerospace community. New systems are needed to make such devices optimal for monitoring the health of people as they participate in extreme environmental projects such as commercial space and near-space activities, and requested features may need to be modified to match currently available or near-term technologies.

#### Learning Objectives:

1. A gap exists between currently available, commercial physiologic monitoring systems and features requested by the aerospace community.

#### [065] PILOT CHALLENGES DURING THE PARAGON STRATOSPHERIC EXPLORATION BALLOON JUMP MISSION

D. Buckland<sup>1</sup>, E. Antonsen<sup>2</sup>, A. Garbino<sup>2</sup>, D. Nusbaum<sup>2</sup>, and J.B. Clark<sup>2</sup>

<sup>1</sup>George Washington University, Washington, DC; <sup>2</sup>Baylor College of Medicine, Houston, TX

**INTRODUCTION:** As more individuals engage in commercial space, near-space and other extreme environmental activities, it is important to ensure that experiences and lessons learned are preserved so that the science of exploration continues to move forward. **METHODS:** Alan Eustace, pilot for the Paragon Stratospheric Exploration [StratEx] program, gives his account of the challenges involved with sponsoring and participating in a stratospheric balloon bailout and free fall test program. **RESULTS:** There were multiple challenges for the pilot during this stratospheric test program. These challenges included the cold temperatures that the pilot was exposed to in the thermal chambers and at altitude, the extreme fatigue from being suspended in the suit for multiple hours at a time, disorientation from oscillation of the suit during free fall, and difficulties with removing aspects of the suit, including the helmet, once down on the ground, especially in the context of extreme fatigue. Most of these challenges were discovered during the testing phase of this project and were combated with a combination of suit design, pilot conditioning, and tricks discovered by the pilot throughout the test program. **DISCUSSION:** There were many lessons learned by the pilot throughout his participation in the StratEx program. It is important that these lessons be shared and preserved so that future missions can learn from and take advantage of these experiences.

#### Learning Objectives:

1. There were many lessons learned by the pilot throughout his participation in the StratEx program. It is important that these lessons be shared and preserved so that future missions can learn from and take advantage of these experiences.

Monday, May 11  
S. Hemisphere 3

2:00 P.M.

#### [XIII.] PANEL: VISION OF THE FUTURE: WHERE DO WE GO, AND HOW DO WE GET THERE?

*Sponsored by the Society of U.S. Air Force Flight Surgeons*

**Chair: Lt Gen (Dr.) Thomas Travis**  
*The Pentagon, Washington, DC*

**PANEL OVERVIEW:** Air superiority, now across three domains, remains the mission of the USAF. Changing threats, new technology, lessons learned, and resource constraints demanded innovative Airmen to execute the mission of the Air Force in 1947. The Air Force of our past was guided by an innovative spirit: the USAF must constantly evolve to meet modern needs. This same demand still exists; if we are static, we lose. As mission requirements change, the medical needs of both individual Airmen and warfighter sub-populations change as well. We need to change our focus as medics from the delivery of healthcare to helping ensure a healthy population, enhancing human performance to execute their mission: that is what we mean from the shift from Healthcare to Health. At both the organizational and base level, the Air Force has begun to test and adopt a new, more efficient approach to Air Force medicine to align with present and emerging medical and operational demands. This panel will discuss the vision of a broad-based Human Performance Concept of Operations, and describe strategies that move from this vision to the tactical execution at the base level. It will consider the framework from the headquarters designed to foster innovation, the support with subject matter experts, both military and civilian, and the importance of a base level laboratory to test innovative concepts to validate prior to fielding. Finally it will introduce the concept of leading change from industry leaders, providing a glimpse of what may be in store for the Aeromedical Enterprise of the future.

#### [066] THE AIR FORCE MEDICAL HOME AS A HUMAN PERFORMANCE DELIVERY SYSTEM

C. Baker

*AFMOA, USAF, Lackland AFB, TX*

**INTRODUCTION:** The Air Force Medical Service's (AFMS') unique purpose or its "value proposition" to the USAF is to provide Airmen (and other Service members who are in the AFMS' supported population) to their commanders who are medically able to perform their duties whether deployed or in garrison. Ensuring that Service members are able to perform better than our adversaries provides a competitive advantage that may equal or exceed technological advantages. When envisioned in this way, human performance is a capability that can be directly supported by the AFMS, and medical support to the mission becomes a capability not just a commodity providing a healthcare benefit. Optimal human performance is a shared responsibility and requires engaged commanders, mission support partners, Service members and their families. The Air Force Medical Home (AFMH) is the USAF's health and human performance delivery system. The AFMH builds on PCMH teaming, relies on a central repository of evidence-based intervention sets specifically designed to mitigate sub-population health and performance risks, and is structured so that every AFMH benefits from the experience of all others. The AFMH is conceived using Human Systems Integration principles and engages human system engineers. The AFMH relies on efficiencies generated by designating one team - the Base Operational Medicine Cell to perform all Service member health assessment, profiling, disability examination, and occupational medical surveillance activities. Segregating these activities allows all care teams to participate in Mission-Essential Tasks/Activities for Line Support (METALS). METALS are intervention sets designed to mitigate operational risks and include mission familiarization activities for all medics involved in the care of Service members. The AFMH focuses on human performance not only for Service members but also for all of the AFMS' supported population. Healthy and well-performing family members directly support Service members; activities that improve health and performance of all high-performing medics.



**Learning Objectives:**

1. To describe how the Air Force Medical Home supports human performance.

**[067] THE BASE OPERATIONAL MEDICINE CELL: DESIGNING FOR TEAM PERFORMANCE**

C.P. Tvaryanas

711 HPW, USAF, Wright-Patterson AFB, OH

**INTRODUCTION:** Development of the Base Operational Medicine Cell (BOMC) model emerged from a systems analysis of current Flight and Operational Medicine Clinic (FOMC) workflows. Workflows are how FOMCs generate capability and execute their mission to support local air base operations—they are value-generators. Workflows are also where Human Systems Integration (HSI) occurs within the FOMC, with the outcome of healthcare team performance. The FOMC is best envisioned as a system comprised of multiple workflows. The clinic provides the environment (in terms of facilities, personnel, health IT, policies, etc.) in which those workflows are embedded and resourced. Because individual workflows compete for limited resources, the FOMC is an inherently complex system to manage. A front-end analysis (FEA) was accomplished of the FOMC for the purpose of understanding the clinic staff (i.e., the users), their needs in accomplishing the clinic's mission, and the demands of the work situation. The primary methods of the FEA included workflow analysis, process mapping, and process redesign. Each workflow was analyzed to identify points of waste (i.e., inefficiency or decreased effectiveness). Types of waste were categorized based on lean production principles as used by Toyota business systems and codified in "Lean Thinking." Since many of the categories of waste were repeated across workflows and appeared to be driven by common problems, the DoD Human Factors Analysis and Classification System (HFACS) was leveraged to conduct a root cause analysis. Per the HFACS paradigm, observed waste in the workflows was considered an active failure and the related latent failures at the preconditions, supervisory, and organizational levels were subsequently identified. These latent failures were then addressed in a systematic redesign of the workflows leading to the proposed BOMC model. Redesign was guided by focusing on the application of HSI to the FOMC and adopting the aviation "systems culture." This presentation will discuss applications of HSI principals, evidence-based medicine, and best practices from both military and civilian models to the BOMC test center in support of the Surgeon General's HP CONOPS vision.

**Learning Objectives:**

1. To understand exams and standards functions as a type of occupational medicine system.
2. To understand the application of HSI within a clinical system at the level of workflows.
3. To understand attributes of the aviation "systems culture" as applied to a clinic.

**[068] REIMAGINING AIR FORCE MEDICINE WITH A HUMAN PERFORMANCE FOCUS: PRELIMINARY RESULTS FROM THE BASE OPERATIONAL MEDICINE CELL TEST SITE**

P. Nelson, L. Roberts, M. Steiner, and C.C. Uptegraft

81 MDG, USAF, Keesler AFB, MS

**INTRODUCTION:** The Base Operational Medicine Cell (BOMC) is the linchpin component of the Air Force Medical Home (AFMH). Keesler AFB is the test site designed to formally evaluate ideas and concepts in support of the Human Performance CONOPS including the SG's vision: "Our supported population is the healthiest and highest performing segment of the U.S. by 2025". It was charted to report thru the Air Force Medical Operations Agency (AFMOA) directly to the office of the Surgeon General and is supported by both local commanders and military and civilian subject matter expertise thru the 711 Human Performance Wing. Included in the test structure were intuitive design processes and principles of human systems engineering to support and enhance the performance of the medical operator and decision

maker. The BOMC was charged with deconstruction of care delivery to Airmen to better understand value streams, study what works and what doesn't, and understand why. The outcomes from the BOMC test, including concepts, qualitative observations and quantitative data, will be considered for incorporation into the AFMH. Using the test cell construct, BOMC-developed ideas may be directly exported and implemented, refined for further testing, or used to generate future requirements through the planning, budgeting, and resourcing process. This will allow data-driven decision making and prioritization of resources. This panel discussion will present preliminary findings from the BOMC test cell, including measures of accuracy, effectiveness and efficiency. Additionally, the author will present observations from the BOMC that will impact successful implementation of the AFMH and development of the multi-disciplinary cadre of professional staff necessary to achieve the AFMS vision described in the Human Performance CONOPS. It will finally present observations for improving the performance of the test cell concept moving forward.

**Learning Objectives:**

1. To understand the concepts learned and challenges faced with the BOMC test site.
2. To understand how the BOMC test site supports HPCONOPS and the AFMH.

**[069] FROM FLIGHT AND OPERATIONAL MEDICINE TO THE BASE OPERATIONAL MEDICINE CELL**

L. Berry

HAF, USAF, Pentagon, DC

**INTRODUCTION:** The Air Force Surgeon General initiated a Flight and Operational Medicine (FOM) Integrated Process Team (IPT) to address non-standardized work currently completed in the USAF FOM Clinics in February 2014. The FOM IPT was formed with stakeholders and SMEs throughout the USAF and utilized Defense Health Agency Business Process Management Team. The FOM IPT established workflows with use-case descriptions within a patient centered medical home FOM Clinic and a specialty FOM Examinations and Standards Clinic focused on occupational workflows; later called Base Operational Medicine Cell-Phase 1 (BOMC1). Three beta-test sites were launched; Seymour Johnson, Joint Base McGuire-Dix-Lakehurst, & Ramstein. The purpose of the beta-test sites were three fold. 1) Test how to change from current state to a two clinic system with standard workflows. 2) Test the standardized products; updating to meet the clinic requirements. 3) Test the feedback loop to capture local process improvements. While launching test sites, leadership was the most valuable requirement for success. The second identified area for success was hiring a Medical Standards Management Element civilian with previous experience in USAF Medical Standards application. The third was consistent local training for the technicians with the appropriate expertise. Finally, opportunities for growth from BOMC1 to build to meet the future Air Force Medical Home model were identified to the local Squadron and Group Leadership to consider in the near future. While establishing the standard approach to FOM operations has been accomplished and executed at beta-test sites, the limit to full execution will be basic leadership capabilities and training of FOM and Medical Standards Skills. With the initiation of the new Aerospace Medicine Technician path in 2014, this will continue to improve into the future while learning from these initiatives. The ultimate goal is to be able to support the future of the Air Force Medical Home.

**Learning Objectives:**

1. To identify a method to standardize Aerospace Medicine execution of examination and standards.
2. To identify critical capabilities identified in the USAF FOM IPT to appropriately execute a standardized approach to tasks completed.

**[070] CHANGING THE CULTURE, LESSONS FROM MILITARY AND CIVILIAN PERSPECTIVES**

L. Steinkraus

Mayo Clinic, Rochester, MN

**INTRODUCTION:** Driving organizational change effectively is always challenging. Most larger organizations resist change due to perceived or real costs, whether financial, personal, or cultural. Highly structured and process oriented groups such as the military require significant energy and persistence when changes to established procedures are initiated, particularly when "outside" groups are involved as change agents. This panel will present reflections and data on re-engineering the return to work processes at Keesler AFB using a combined military-civilian team. **METHODS:** As part of the Base Operational Medical Cell (BOMC) re-engineering efforts, an outside consultant group was brought in to assist military team members. Oversight was provided locally by the BOMC team leader as well as the BOMC oversight group. **RESULTS:** The discussion will focus on three areas: the initial contracting process and identified pain points; the AS-IS process defining existing occupational support structure and processes; and the TO-BE development story - which revealed organizational gaps and pain points slowing or preventing progress toward stated goals. The panel will expand upon the challenges faced in this setting as part of the necessary growth/change model in any re-engineering effort of this scope. **DISCUSSION:** Understanding that change is required is insufficient to drive effective solutions. Organizations must understand that true re-engineering can be messy and painful. Serious change management often requires use of external change agents to avoid in-bred solution sets which provide little added value. This panel will discuss concrete examples of how an aggressive civilian-military team fared in prosecuting changes within a complex and at times, hostile, operational medical structure.

#### Learning Objectives:

1. Understand and be able to discuss basic features of a business re-engineering program.
2. Understand and be able to discuss at least three common barriers to change within a military medical organization.
3. Be able to discuss at least two effective communication methods in change management.

**Monday, May 11**  
**S. Hemisphere 4**

**2:00 P.M.**

### [XIV.] SLIDE: MEDICAL CONSIDERATIONS IN AVIATION MISHAPS

**Co-Chair: Eduard Ricaurte**  
Edmond, OK

**Co-Chair: Charles DeJohn**  
Oklahoma City, OK

**2:00 p.m.**

#### [071] DRUG USE TRENDS IN FATAL ACCIDENT PILOTS: NTSB ANALYSIS OF TOXICOLOGY TEST AND ACCIDENT INVESTIGATION FINDINGS, 1990-2012

L.S. Groff and M. McKay  
National Transportation Safety Board, Washington, DC

**INTRODUCTION:** This study addressed a growing aviation safety concern by examining trends in the prevalence of drugs identified by toxicology testing of fatally injured accident pilots between 1990 and 2012. **METHODS:** The Federal Aviation Administration (FAA) routinely conducts extensive post-accident toxicology testing on fatally injured pilots. FAA toxicology test results were matched to National Transportation Safety Board (NTSB) aviation accident database records. Toxicology test results were categorized by drug type and potential for impairment. Due to the complexities of interpreting the source of ethanol identified postmortem, toxicology results for ethanol were not analyzed in this study. **RESULTS:** The study population consisted of 6,677 fatally injured accident pilots,

involved in 6,597 accidents with NTSB accident investigation data and FAA toxicology test results. Study results showed increasing trends in accident pilot drug use, including potentially impairing drugs, drugs used to treat potentially impairing conditions, controlled substances, and illicit drugs. The proportion of study pilots with positive toxicology results for one or more potentially impairing drug increased from 11% in 1990-1997 to 23% in 2008-2012. There was also an increasing trend in the number of drugs identified per pilot. The most common potentially impairing drug was the sedating antihistamine diphenhydramine, found in more than 7% of study pilots from 2008-2012. Although findings of illicit drugs were uncommon, positive findings for marijuana increased from 1.6% in 1990-1997 to 3% in 2008-2012. Pilots with an expired or no medical certificate were significantly more likely than those with at least a third-class medical to have positive toxicology findings of potentially impairing drugs, drugs used to treat potentially impairing conditions, and controlled substances. Positive toxicology findings were also associated with increased pilot age. Pilot demographic and medical certification data suggest that drug use trends will continue to increase. **DISCUSSION:** Increasing evidence of use of a variety of drugs by fatally injured pilots suggests an increasing hazard to flight safety; further research is warranted to better understand the safety effects of such drug use.

#### Learning Objectives:

1. Recognize the increasing trend in positive toxicology findings among fatal aviation accident pilots.
2. Identify the potentially impairing drugs most commonly found in toxicology tests of aviation accidents pilots.
3. Assess the need for additional research regarding pilot drug use and accident risk.

**2:15 p.m.**

#### [072] THE DEVELOPMENT AND AN INTER-RATER RELIABILITY ANALYSIS OF DOD HFACS, VERSION 7.0

R. King

<sup>1</sup>CAMI, FAA, Oklahoma City, OK; <sup>2</sup>Headquarters, Air Force Safety Center, U.S. Air Force, Kirtland AFB, NM

**INTRODUCTION:** The United States (U.S.) Army, Navy, and Air Force worked together to improve the inter-rater reliability of the Department of Defense Human Factors Analysis and Classification Systems (DoD HFACS). DoD HFACS is derived from the system developed by Wiegmann and Shappell (2003), based on the work of Reason (1990), that broadly considers Organization Influences, Supervision, Preconditions, and Acts. DoD HFACS further analyzes mishaps and hazards to a more granular level - arriving at specific "nanocodes" such as "Inadequate Real-Time Risk Assessment" (AE201) under "Judgment & Decision-Making Errors" (Acts) and "Controls and Switches are Inadequate" (PE204) under "Technological Environment" (Preconditions). **METHODS:** The steps involved in the recent effort included determining which of the 147 "nanocodes" were rarely or never used and collapsing nanocodes and rewriting definitions to arrive at a reduced total of 109 nanocodes. A chart allows for the ready translation of old codes into new codes to permit continued analysis of data already collected. Next, the DoD HFACS Working Group created a stepwise checklist to systematically guide investigators through consideration of nanocodes, using 18 yes/no questions to direct investigators to areas of inquiry. Student investigators enrolled in courses at the Headquarters of the Air Force Safety Center as well as the School of Aerospace Medicine continually tested checklists and generated empirical results to gauge inter-rater reliability as well as offering constructive criticism to hone checklist questions. **RESULTS:** While inter-rater reliability results are encouraging (a Fleiss' Kappa of .847 at the 18-question level), additional work is necessary to realize the goal of an optimally reliable human factors taxonomy. **DISCUSSION:** This presentation will explore the complete DoD HFACS version 7.0 taxonomy as well as the checklist that was created and tested with groups of mishap investigation students. Suggestions for future efforts, to include validation studies and possible use with domestic and international civilian organizations, are offered.

**Learning Objectives:**

1. Participants will learn the changes made to HFACS and understand the rationale underlying these changes.
2. Participants will appreciate the value of increased inter-rater reliability in a human error taxonomy.
3. Participants will understand the trade off of increased granularity against the increased training required to effectively use a human error taxonomy.

**2:30 p.m.****[073] RISK ASSESSMENT IN THE U.S. PILOT POPULATION FROM 1983-2005: DIABETES PREVALENCE AND FLIGHT SAFETY**P. Rogers, S.J. Veronneau, and E.M. Forster  
FAA-CAMI, Oklahoma City, OK

**INTRODUCTION:** A Scientific Information System developed at the Civil Aerospace Medical Institute (CAMI) has assisted in several studies of the U.S. civil pilot population. The Numerical Sciences Research Team at CAMI used this unique data construct to examine the aeromedical and aviation safety aspects of diabetes. The team studied the prevalence of diabetes from 1983 through 2005 and its associated risk factor, obesity along with issues associated with medical certification for aviators with diabetes and their effects on the U.S. civil pilot population. **METHODS:** The Scientific Information System is a longitudinal dataset of the entire U.S. civil pilot population, spanning the years 1983 through 2005. This study examined the parallel trends of body mass index (BMI) and numbers of aviators with diabetes over a 23-year time frame. The information was stratified by gender and age groups. A count-based regression model was used to quantify risk from diabetic airmen and other population factors of interest. **RESULTS:** The number of airmen with diabetes in the U.S. active population of airmen has risen from 2,768 in 1983 to 10,806 in 2005. The increasing proportion of reported diabetes within the U.S. civil pilot population escalated to 1.6% and 0.5% for men and women, respectively, by 2005. Increasing median BMI and median weight were found to be on the rise from the early 1990s through 2005. There was evidence that aviators with reported diabetes controlled by hypoglycemic medication (FAA code 937) or diet alone (FAA code 935) were at greater risk than aviators without these conditions for having an aircraft accident (28% and 18% respectively). Examining the accident reports for airmen with diabetes controlled by insulin (FAA code 936) did not reveal any evidence that the diabetes condition affected accident occurrence. **DISCUSSION:** The contribution of these two diabetes conditions in aviation accidents was not a causal one but rather serves as a marker for airmen with multiple comorbid chronic conditions. Each of these conditions was not individually medically disqualifying, but their combination with diabetes elevated safety risk.

**Learning Objectives:**

1. The objective is to describe and quantify the effects of the various conditions of diabetes on flight safety within the U.S. civil pilot population.

**2:45 p.m.****[074] COMPARISON OF POST-MORTEM TOXICOLOGICAL HAZARDS FINDINGS OF FEDERAL AVIATION ADMINISTRATION MEDICALLY CERTIFIED THIRD-CLASS AND SELF-CERTIFIED PILOTS, CY 2011 THROUGH APRIL 2014**E.M. Ricaurte<sup>1</sup>, C.A. DeJohn<sup>1</sup>, W.D. Mills<sup>1</sup>, D. Porras<sup>4</sup>, and M.C. Laverde<sup>1</sup><sup>1</sup>FAA-CAMI, Oklahoma City, OK; <sup>2</sup>Aerospace Medicine, National University Of Colombia, Bogotá, Colombia

**INTRODUCTION:** In 2004, the U.S. Federal Aviation Administration created the sport pilot/light sport aircraft (SP/LSA) rule. Under this rule, a person using a valid medical certificate or a valid U.S. driver's license is eligible to exercise SP privileges in a LSA. The purpose of this project was to compare hazards to flight safety identified from toxicology reports in fatally injured pilots who possessed a valid FAA issued 3<sup>rd</sup>-class medical

certificate to fatally injured sport pilots who were not required to possess a medical certificate. **METHODS:** Data for fatally injured U.S. pilots, including hazards identified on FAA medical certification records and toxicology results, were obtained from the FAA's Medical Analysis Tracking (MANTRA) database from 1/1/2011 to 4/30/2014. **RESULTS:** Toxicology was performed on 435 of 471 pilots (92%), including 61 SP (14%) and 374 (86%) 3<sup>rd</sup>-class medically certified pilots. Toxicology results were positive in 357 (82%) pilots, including 58 (13%) SP and 299 (69%) 3<sup>rd</sup>-class pilots. Fifty-eight SP pilots (95%) of 61 were reported positive for any drug or substance, compared to 299 (80%) of 374 3<sup>rd</sup>-class pilots, with statistically significant difference in proportions ( $p < 0.002$ ). No significant difference was found in the proportions of toxicological hazards between the SP and 3<sup>rd</sup>-class pilots, 6/42 (14%) and 29/222 (13%) respectively. The most common class of medications reported on both groups was cardiovascular (19%). When comparing cardiovascular medications found in SP versus 3<sup>rd</sup>-class pilots, a statistically significant difference in proportions was found: 22/61 (36%) and 62/374 (16%), respectively ( $p < 0.001$ ). **DISCUSSION:** Although a significantly greater proportion of positive toxicological results was found in SPs, no significant difference in toxicological hazards was found between 3<sup>rd</sup>-class and SP. Treated cardiovascular conditions were found to be more prevalent in self-certified compared, to the 3<sup>rd</sup>-class pilots ( $p < 0.001$ ).

**Learning Objectives:**

1. To determine the prevalence of toxicological hazards in sport pilots and third class medically certified pilots who died in aircraft accidents.
2. To compare the proportion of toxicological hazard related to scanned medications/drugs between sport pilots and third medically certified class pilots.

**3:00 p.m.****[075] COMPARISON OF HAZARDS TO FLIGHT SAFETY IDENTIFIED BY AUTOPSY IN U.S. PILOTS WITH AND WITHOUT FAA MEDICAL CERTIFICATES**W.D. Mills<sup>1</sup>, C.A. DeJohn<sup>1</sup>, E.M. Ricaurte<sup>1</sup>, and D. Porras<sup>2</sup><sup>1</sup>FAA-CAMI, Oklahoma City, OK; <sup>2</sup>National University of Colombia, Bogota, Colombia

**INTRODUCTION:** In 2004, the U.S. expanded flying privileges for some pilots based on their possession of a driver's license rather than an FAA medical certificate. Unfortunately, 10 years later, direct comparison of accident risk for these pilots with medically certified pilots is not possible because of lack of flight time data and overall counts for the uncertified pilots. The goal of this study was to compare a surrogate measure of hazards to flight safety based on autopsy findings in medically certified and uncertified pilots. **METHODS:** The FAA's Medical Analysis Tracking (MANTRA) Program maintains a registry of U.S. pilots fatally injured in aircraft accidents and includes autopsy results for most cases. Data were extracted for 1084 individuals involved in fatal accidents from 1/1/2011 to 4/30/2014. After exclusions, subjects included 68 pilots flying legally without a medical certificate and 403 legal pilots with a 3<sup>rd</sup>-class medical certificate. **RESULTS:** Moderate to severe hazards identified by autopsy were found in 25% of medically certified pilots and 60% of uncertified pilots. This difference was statistically significant with  $p < 0.001$ . The uncertified pilots were significantly older (63 yo) than the certified pilots (56 yo), and the age-adjusted odds ratio was 4.0 (95% CI 2.0 to 7.9.) A comparison of the proportion of moderate vs. severe disease in pilots for whom a cardiac hazard was identified in these groups was conducted. No statistically significant difference was found. **DISCUSSION:** This study's surrogate measure of potential medical hazards to flight safety found a higher proportion of autopsy hazards in medically uncertified pilots compared to certified pilots but cannot be directly related to accident risk. However, this study does suggest that medical certification is advantageous in all flight operations where the pilot's risk of adverse medical events must be minimized.

**Learning Objectives:**

1. To appreciate the use of a measure of risk derived from autopsy findings in medically certified and uncertified pilots as a surrogate for actual accident risk.



3:15 p.m.

**[076] ASSESSMENT OF WEATHER RELATED INCIDENTS IN THE HELICOPTER EMERGENCY MEDICAL INDUSTRY**

J.K. Cruit and A. Boquet

*Human Factors, Embry-Riddle Aeronautical University, Daytona Beach, FL*

**INTRODUCTION:** The helicopter emergency medical service industry (HEMS) continually demonstrates a poor safety record. The literature reveals that human error and weather-related events are both primary causes of HEMS accidents. The steady increase in HEMS accidents has fostered research on causative factors of the industry's consistently poor safety record. Increasing our understanding of these HEMS accidents demands a more detailed inspection of these causes. The current study utilized a questionnaire to gather qualitative and quantitative data regarding pilot decision-making surrounding weather-related, near-miss incidents. **METHODS:** 171 participants completed a 52-item questionnaire that asked HEMS professionals about the weather-related incidents that they had encountered during previous missions. The questionnaire addressed key issues such as: demographic and aircraft information (e.g., type, equipment used), how, when, and where weather information is obtained, and dispatch procedures. Open response questions asked participants to describe up to three scenarios/narratives in which they encountered an incident due to problematic weather conditions. **RESULTS:** The analysis revealed an experienced pilot sample with 83% holding both commercial and instrument ratings. Overall flight time for participants was 6,366 hours. Responses indicated that 49% of the reporting organizations are independently based, while 51% are hospital-based. 81 weather related scenarios/narratives were reported. A card sort was used to further categorize the weather incidents. The card sort analysis identified the top five incident-related categories as: *pressure to fly* (20%), *lack of weather equipment* (14%), *dark conditions* (10%), *terrain* (10%), and *lack of preparation* (9%). The remaining categories included *workload*, *operational processes* and *not applicable*. **DISCUSSION:** The information obtained from the questionnaire provides insights into near-miss accidents and possible risks that need to be addressed. The results may guide industry officials in developing accurate weather information products while ultimately increasing certainty in crew decision-making and reducing human error during a time-critical flight.

**Learning Objectives:**

1. The audience will gain familiarity with current decision-making trends during weather-related incidents in the helicopter emergency medical industry.
2. The audience will gain familiarity with the card sort methods of data analysis.

Monday, May 11

S. Hemisphere 5

2:00 P.M.

**[XV.] SLIDE: PSYCHOLOGICAL FACTORS IN SELECTION AND PERFORMANCE**

Co-Chair: M. Kathryn Bleckley

*Oklahoma City, OK*

Co-Chair: Carol Manning

*Oklahoma City, OK*

2:00 p.m.

**[077] BUNDESWEHR AIRCREW SELECTION - ADVANCES IN SIMULATOR-BASED ASSESSMENT OF FLIGHT-SPECIFIC APTITUDES**

K. Meierfrankenfeld, W. Gress, and B. Vorbach

*German Air Force Center for Aerospace Medicine, Fuerstenfeldbruck, Germany*

**INTRODUCTION:** The presentation will introduce the Bundeswehr's simulator-based screening for future aircrew members (fixed-wing). Special emphasis will be placed on inherent and unique characteristics: The Bundeswehr's third and last stage of aircrew selection (Phase III) simulates a typical flying training scenario within a one week timeframe. In 1998 Phase III replaced the former GAF Flying Screening Program. The presentation will outline methodological peculiarities and outcomes of this approach to personnel selection.

**METHODS:** The Bundeswehr's screening for aircrew members is a simulator-based job sample test. It is conducted interdisciplinarily: Aviation psychologists, former GAF fighter pilots or navigators and a Military Training Staff Officer judge the applicants' performance and trainability in a typical flying training scenario. Phase III is highly standardized: All four simulator missions are objectively the same for each and every applicant. Ratings of the applicant's performance are standardized by using behaviorally based rating scales and objective data provided by the simulator. Pass/ fail decisions and the final overall grading (which is important for employment decisions) also rely on empirically based profiles. **RESULTS:** Since 2008 more than 1600 applicants for fixed-wing aircraft have been tested. Of those, 175 applicants (10.7%) were recommended to become jet pilots, 342 (20.8%) to become transport aircraft pilots, 90 (5.5%) to become weapon system operators/ navigators, and 609 applicants (37.1%) failed. Inter-rater-reliability in Phase III is high (above 0.90). Long term evaluation data are used to calculate validity of Phase III decisions. Attrition rates during flying training are a main criterion for Phase III success. Attrition rates in basic and advanced flight training due to flying deficiencies are low, they lie between 5% und 10%. **DISCUSSION:** Bundeswehr's simulator-based screening has proven to be an objective, reliable and valid method of personnel selection.

**Learning Objectives:**

1. Get to know peculiarities of the Bundeswehr's simulator-based screening for future aircrew members (fixed-wing).

2:15 p.m.

**[078] THE DEVELOPMENT OF AN ACTIVE LISTENING TEST FOR FEDERAL AVIATION ADMINISTRATION AIR TRAFFIC CONTROL SPECIALISTS**

M. Bleckley, D. Broach, and C.L. Wilkinson

*FAA-CAMI, Oklahoma City, OK*

**INTRODUCTION:** Active listening is a critical skill in air traffic control. Active listening as defined by Nickels, et al. (1995), is "the ability to hear and comprehend spoken information. This ability requires an individual to recognize/pick out pertinent auditory information" (p.68). For air traffic control specialists (ATCSs), this must be accomplished in a noisy environment where many voices are speaking at once. Additionally, it is frequently necessary that active listening be accomplished while performing other tasks, such as scanning the control environment or entering data. We have developed a possible assessment of active listening that that may prove useful in predicting training success in ATCSs. We will discuss the development of the test and results of a calibration study. **METHODS:** Stimuli were developed from the Harvard Sentences (Egan, 1948). First, comprehension questions with appropriate distractors were developed for most sentences. Recordings of 7 females and 7 males reading the sentences were made. We developed a program to deliver the auditory stimuli at 7 virtual locations along with a visual tracking task. The software also delivers and scores the comprehension questions at the end of each trial. **RESULTS:** Data collected from FAA Air Traffic Academy students (N=436) were analyzed. Performance on the comprehension test was poor (mean proportion correct = .32) suggesting that the initial configuration of the test is too difficult. **DISCUSSION:** If we are successful, this test will increase our understanding of the skills needed to be a successful ATCS.

**Learning Objectives:**

1. Multimedia Test Development.
2. KSAOs for Air Traffic Control Specialists.
3. item difficulty calibration.

2:30 p.m.

**[079] PSYCHOLOGICAL PREDICTORS OF AIR TRAFFIC CONTROL TRAINING OUTCOMES**W. Thompson<sup>1</sup>, W. Chappelle<sup>2</sup>, and T. Goodman<sup>1</sup><sup>1</sup>Neurostat Analytical Solutions, LLC, San Antonio, TX;<sup>2</sup>Neuropsychiatry, U.S. Air Force School of Aerospace Medicine, Wright Patterson AFB, OH

**INTRODUCTION:** The present study examined the utility of cognitive and non-cognitive psychological testing to predict training success in 1,003 air traffic controller (ATC) trainees. The results of predictive modeling indicate that personality testing, as measured by the Emotional Quotient Inventory (EQ-i), may be utilized to increase predictive validity when used with measures of cognitive aptitude (Armed Services Vocational Battery - ASVAB). The results of predictive modeling reveal cognitive aptitude is necessary, but not sufficient for identifying suitability of trainees. And that the assessment of personality traits is especially important to improving selection processes.

**METHODS:** Participants included 1,003 training candidates who received pre-entry testing with the ASVAB and pre-training Emotional Quotient Inventory (EQ-i) testing upon entry into Basic Military Training. Candidate scores were subsequently matched on training outcomes (success vs. failure in initial course of ATC training). Statistical analyses using logistic regression were used to determine predictors of success from the initial course of ATC training. Subsequent analysis of incremental validity of the addition of the EQ-i to the ASVAB for predicting success from the initial course of ATC training was analyzed. **RESULTS:** The results of statistical analyses revealed cognitive testing (using the ASVAB) provided 8.3% of the predictive validity to the selection model. However, the results of the study revealed personality testing (using the EQ-i) contributed an additional 9.0% to predictive validity. Under the current protocol (ASVAB only) 51% of candidates pass training, however, the inclusion of the EQ-i resulted in the prediction of 61% of candidates passing for an incremental increase of 10%. **DISCUSSION:** Air traffic controllers are in a high-demand, high-risk occupation in which selection processes and aeromedical screening processes across civilian and military agencies will greatly benefit from research identifying areas of psychological functioning predictive of performance and training outcomes.

**Learning Objectives:**

1. Recognize the cognitive attributes and personality traits critical to successful performance during Initial Course of Air Traffic Controller Training that are necessary for adaptation to the high stress, high demand operational environment.
2. To recognize how an understanding of the 'profile for success' can assist training cadre in provided mentorship opportunities to candidates throughout training.
3. To recognize how identifying this 'profile for success' while improving production can also be used as a valuable tool for aeromedical providers during the lifecycle of the Air Traffic Controllers career.

2:45 p.m.

**[080] TIME-TO-EVENT SURVIVAL ANALYSIS USING DAY OF TRAINING ELIMINATION AND NEUROLOGICAL ASSESSMENTS TO PREDICT ELIMINATION IN USAF PARARESCUE TRAINING**W. Thompson<sup>2</sup>, W. Chappelle<sup>1</sup>, and T. Goodman<sup>2</sup><sup>1</sup>Neuropsychiatry, USAFSAM, Wright Patterson AFB, OH; <sup>2</sup>Neurostat Analytical Solutions, LLC, San Antonio, TX

**INTRODUCTION:** Time-to-event analysis has the unique ability to extend simple logistic regression to a deeper level of discrimination by using 'time' as a covariate in the analysis. Such analyses allows for greater understanding of where and when failure occurs in the training pipeline of USAF Combat Pararescue (PJ) training candidates. While normally reserved for medical longitudinal studies, time-to-event analyses, using neuropsychological assessment scores, were used to determine predictors of pass/fail training outcomes during first two courses of initial entry into PJ training. The study was designed to improve aeromedical screening procedures that would reduce

excessive training attrition (86-90%). **METHODS:** Data collected from 2011- 2014 from USAF Pararescue training candidates were analyzed (n = 107 graduates and n = 665 failures). Pre-training cognitive (Armed Services Vocational Aptitude Battery) and non-cognitive (NEO PI-III) testing was obtained on each candidate and merged with pass/fail training outcomes. Life Tables Hazard analysis and Stepwise Hierarchical Cox Regression were used to establish predictors and time-to-event probability cut points for discrimination. Time-to-event analyses results were compared with traditional regression methodologies. **RESULTS:** Two cognitive aptitudes and nine personality traits were identified as predictors of training outcomes and the utility of time-to-event analyses provided increased capability in identifying candidates at risk for failure at each day of training. Findings result in greater accuracy in identifying pass/fail outcomes for each candidate using time-to-event survival analyses when compared to traditional methodologies.

**DISCUSSION:** The use of time-to-event methodology resulted in an increased utility of neuropsychological functioning that is critical to assessing suitability and risk for failure at key points in training. The results of survival analyses identified percentile cut point scores for predicting candidate risk for failing training. The results of the study may be used to improve and modernize aeromedical screening and selection of candidates who are suited for the demands of training for this special duty career field.

**Learning Objectives:**

1. By using time as a covariate in predicting success and failure in Pararescue training more accurate cut scores for adaptation can be determined.
2. Day of training failure rates for Pararescue trainees, in conjunction with Neuropsychological assessments, can assist leadership in better understanding strengths and weakness of both candidates and training processes. This knowledge can extend to the development of better selection criteria for entry into training.
3. Using non-traditional statistical methodologies can contribute greater levels of discrimination in identifying those candidates with greater capacity for success than failure in Pararescue training.

3:00 p.m.

**[081] FACTORS ASSOCIATED WITH NAVAL AVIATORS DELAYING EJECTION**

J.E. Miles

USAF, Beavercreek, OH

**INTRODUCTION:** The purpose of this investigation was to identify factors associated with naval aviators delaying ejection during inflight emergencies. **METHODS:** Data was extracted by reviewing United States Naval Safety Center data detailing mishaps which resulted in the destruction of ejection seat-equipped aircraft between 1993 and 2013. Univariate analysis and multivariate logistic regression were used to explore the association between delayed ejection and multiple potential risk factors. **RESULTS:** 534 crewmembers were involved in mishaps which resulted in the destruction of ejection seat-equipped aircraft between 1993 and 2013. 99 (18.5%) of these crewmembers were identified as having delayed ejection during these mishaps. Analyses revealed increased odds of delay only in mishaps that resulted from aircrew human factors (OR=2.53, p=0.003). Aircrew age, rank, and crew position were not significantly associated with the timing of ejection. Aircraft type, number of crewmembers, and mishap location were likewise unrelated to the timing of ejection. **DISCUSSION:** The results of this study support previous findings that delayed ejection is an ongoing problem and that the most important factor associated with a delay in ejection is a human factors cause of the initiating inflight emergency. Delayed ejection has been linked to death and serious injury during aviation mishaps. In order to minimize such adverse outcomes, continuing efforts must be made towards addressing the aircrew human factors that underlie many of these mishaps.

**Learning Objectives:**

1. Identify and discuss factors associated with naval aviators delaying ejection.

**Monday, May 11**  
**S. Hemisphere E3**

**2:00 P.M.**

## **[XVI.] PANEL: HOW DO WE STRENGTHEN THE PREVENTIVE HEALTH ASPECTS OF AVIATION MEDICAL EXAMINATIONS?**

*Sponsored by the AsMA Air Transport Medicine Committee*

**Chair: Kevin Herbert**

*Daventry, Northamptonshire, United Kingdom*

**PANEL OVERVIEW:** The panel will consider the factors which make it desirable to add value to the current aeromedical examination process, in particular the benefits to flight safety of incorporating a preventive health approach. The role of international and national regulatory authorities will be reviewed. The feasibility of such a change will be discussed, and examples will illustrate a partnership approach between pilot/controller and the AMA or medical assessor. The skill set and training needs for the AME, and practical aspects of such a change will be discussed. The application of such principles in an airline environment, and military setting, and the role of medical assessment as an integral part of a Safety Management System will be considered.

### **[082] PREVENTIVE MEDICINE AND AEROMEDICAL ASSESSMENT. THE VIEW OF THE EUROPEAN SOCIETY OF AEROSPACE MEDICINE (ESAM)**

K.C. Herbert

*European Society of Aerospace Medicine, Daventry, United Kingdom*

**INTRODUCTION:** Aviation medical examination and assessment has made a significant contribution to flight safety for many decades. Historically it has had the primary aim of avoiding accidents caused by acute medical incapacitation, through the use of generic tools of illness investigation and management which are familiar to all clinicians. These tools are proving to be of limited value in detecting subtle incapacitation, or impairment of performance. There can be little doubt that the world of commercial air travel has changed dramatically in recent years. Advances in Medical and other technologies, better treatments, a relentless rise in passenger hours flown and the increased risk legal challenge to regulatory decisions, are amongst a number of factors which call into question the validity of an assessment process based upon 'one size fits all' regulations. In addition to these factors in the commercial world, the value of medical assessments as a contribution to flight safety in General Aviation is being called into question, with proposals to abolish them completely in some countries. The presentation will review these and other factors, referring to the ESAM 'Fly Safe, Fly Well' project and the lessons learned from the fourth European Conference of Aerospace Medicine, to consider how to add value to the current medical assessment process, shift the focus from incapacitation risk, to a more balanced approach using preventive medicine to facilitate good health, wellness and optimum performance, and integrate aeromedical decision making into an overall Safety Management System.

#### **Learning Objectives:**

1. To understand the desirability of integrating a preventive medicine approach into aeromedical assessment.
2. To clarify the contribution that a preventive medicine approach could make to flight safety.
3. To question whether the current approach to aeromedical assessment is fit for purpose in the future aviation environment.

### **[083] PREVENTIVE MEDICINE AND AEROMEDICAL ASSESSMENT: ICAO VIEW**

A. Evans

*Aviation Medicine Section, International Civil Aviation Organization, Montreal, QC, Canada*

**INTRODUCTION:** The regulatory periodic medical examination (PME) aims to identify and restrict or remove from operations those applicants who are considered to have an increased aeromedical risk of incapacitation

beyond limits set by the State (Licensing Authority). However, the PME does not reliably identify those at increased risk and an additional strategy to reduce aeromedical risk may be to prevent the development of disease in the pilot (or air traffic controller) population. **METHODS:** At an International Civil Aviation Organization (ICAO) Session held during May 2014 at the Aerospace Medical Association (AsMA) Scientific Meeting in San Diego, the potential for introducing preventive medicine/health maintenance into the PME was discussed. Sufficient support for the concept was obtained to consider the matter further and an ICAO Medical Provisions Study Group was established, which met during October 2014. A proposal was developed to put to the ICAO Air Navigation Commission which, if approved would potentially result in a change to ICAO Annex 1 - *Personnel Licensing*. **RESULTS:** There is general support for health maintenance advice to be provided by the Licensing Authority of a State. However, not all Authorities are ready to include this as part of the PME - for such States, other methods may be effective. **DISCUSSION:** Although ICAO has not yet formally extended the State's Safety (Management) Programme to Annex 1 - *Personnel Licensing* (which include the medical aspects of fitness to operate), it seems clear that health maintenance could be regarded as an integral part of such an initiative. If agreed by ICAO member States, preventive medicine/health maintenance could become part of a Licensing Authority's strategy for reducing aeromedical risk to flight safety.

#### **Learning Objectives:**

1. Understand ICAO's view on the introduction of health maintenance advice as part of a Licensing Authority's strategy for reducing aeromedical flight safety risk.

### **[084] PREVENTION AND AEROMEDICAL EXAMINATIONS: WHERE DO WE GO FROM HERE?**

A.S. Wagstaff

*Institute of Aviation Medicine, Jar, Norway*

**INTRODUCTION:** Aviation medical examinations of pilots are performed in the interest of flight safety. Yet, the evidence of such examinations on any outcome related to flight safety is lacking. Discussions around regulations governing medical examinations for pilots have started to bring up the question of the validity of such examinations, and the value of such examinations is put into question. **METHODS:** A literature search was performed in order to get an overview of scientific data regarding aircrew health and mortality, the effect of periodic medical examinations for aviators, and the effect of prevention on health risks relevant to aircrew. **RESULTS:** The standardized mortality rate for pilots is low for most diseases. However, the occupational accident risk is high, with large variations according to the type of flying the aircrew are involved in. Current aeromedical examinations focus primarily on finding early signs of disease, but standard clinical methods have a low sensitivity for such early diagnosis, especially since the incidence of most diseases is low in the aircrew population. Population studies of screening for disease have failed to show improved health outcomes, unless screening activities focus on particular health risks relevant to the population in question. **DISCUSSION:** There is a room for improvement in medical examinations of aircrew. A clearer focus on risk-based individual prevention and screening would be in line with current safety management thinking in aviation. Since 80 % of accident causes are from human factors, many aspects of aircrew's health issues may be addressed in a more preventive approach relevant to aircrews' risk factors and may have a more long-term perspective. Longitudinal AME follow-up may be used to address and advise on fatigue, stress and other increasing problem areas in aviation as well as e.g. cardiovascular conditions in older pilots. In order to achieve this, increased trust between AME and aircrew may be necessary. This can be facilitated by a clearer focus on keeping the aircrew flying in the long term and making more transparent decision-making processes involving aircrew themselves to a greater extent.

#### **Learning Objectives:**

1. To improve the understanding of the possibilities and limitations of the periodic medical examination of aircrew, and possible developments in the future.



# **[085] PREVENTIVE MEDICINE AND AEROMEDICAL ASSESSMENT - THE APPROACH OF AN AIRLINE MEDICAL DEPARTMENT**

T.R. Stevenson

Health Services, Virgin Atlantic Airways Ltd, Crawley, United Kingdom

**INTRODUCTION:** The case for including Preventive medicine in the annual medical examination has been made by a number of aviation practitioners and specifically by the author in previous presentations. The benefits of that approach have been expressed as, better health for the individual, better performance by the pilot, increased efficiency for the company, and improved safety for all. It is the author's opinion that "A healthy Pilot is a safer pilot". This presentation will endeavor to demonstrate how this might be applied in a commercial aviation setting, and to look at the "tools" that an aviation examiner could use during their precious and powerful annual aeromedical consultation and assessment.

## **Learning Objectives:**

1. To highlight how good health could be seen as a positive indicator of performance and that by demonstrating that, to highlight how poor health and wellbeing might therefore have an adverse effect on performance and safety.
2. To consider how this approach could be seen as an important contributor to a safety management system.
3. To consider how best to convey "the message" during one's own consultation and to promote this approach among colleagues and how to measure its effectiveness.

**Monday, May 11**  
**S. Hemisphere E4**

**2:00 P.M.**

# **[XVII.] PANEL: CURRENT AND FUTURE CARDIOLOGIC CONCERNS IN AEROMEDICAL FITNESS**

*Sponsored by the French Society of Aerospace Medicine*

**Co-chair: Sebastien Bisconte**

*Villanave d'Ornon Cedex, France*

**Co-chair: Olivier Manen**

*Clamart, France*

**PANEL OVERVIEW:** This year, the French panel will present a variety of cardiology topics which have an impact on fitness for flight. In the first part of the session, experts will discuss management of daily questions in aeronautical fitness. To begin, the first author will present a long clinical follow up of aircrew members with a complete left branch block and will discuss how these data may influence future aeromedical decisions. Next, the second issue will expose the difficult question of the prognosis behind premature ventricular beats especially in fighter pilots through an interesting case report and a retrospective study about effects of flying deconditioning. We will propose to continue this panel with a focus on long QT syndrome: these changes under aeronautical constraints like hypoxia and the best way to detect this abnormality in clinical practice. Then, we will present a case report regarding left ventricular non compaction and difficulties to adapt the fitness decision at all stages of this disease evolution. The second part of the session will focus on cardiovascular risk factors. The next author will complement the session by presenting an epidemiological study concerning physical activities and its professional impact for aircrew members. For the last presentation, we will discuss about the ethical problems rise by the acceptance of insulin therapy for light aircraft pilot by EASA. As usual, this panel will present the process used in the French military and civilian aeromedical centers and will offer an opportunity to share working practices in an international congress.

# **[086] LEFT BUNDLE BRANCH BLOCK AMONG FRENCH AIRCREW MEMBERS: FOLLOW-UP AND FITNESS**

J. Monin<sup>1</sup>, S. Bisconte<sup>2</sup>, A. Hornez<sup>1</sup>, D. Dubourdieu<sup>1</sup>, O. Manen<sup>1</sup>, J. Deroche<sup>1</sup>, P. Bertran<sup>1</sup>, and E. Perrier<sup>1</sup>

<sup>1</sup>Aeromedical Center, Percy Hospital, Paris, France; <sup>2</sup>Aeromedical Center; Robert Picqué Hospital, Villenave d'Ornon Cedex, France

**INTRODUCTION:** According to the medical literature, the discovery of a complete left bundle branch block (LBBB) often leads to a diagnosis of cardiovascular disease. For both military and civilian aircrew members (AM), the fitness assessment must be considered by the licensing authority if a LBBB is discovered. For civilian AM, a 3-year-period of stability is asked for initial applicants or for revalidation to have a fit assessment without a multi pilot limitation. **METHODS:** In this study, the clinical and follow-up status was evaluated in all AM with a LBBB, among a population of 49,418 AM examined for fitness assessment at the Aeromedical Expertise Centre of Clamart from 09/22/2000 to 09/22/2010. For our study, all ECG with a diagnosis of LBBB were extracted by the TraceMasterECGVue® software, and then reviewed by a senior physician. **RESULTS:** Our population was composed of 32 AM with LBBB [ma : 42yo+/- 7.3 (range 27-56yo), 77.1% males, mean follow period : 12.9yo+/-7.3]. All LBBB were discovered thanks to the realization of a systematic ECG at each visit, for asymptomatic subjects. 53.13% of the population had at least one cardio-vascular risk factor. The initial evaluation included an echocardiography, a 24-hour ambulatory ECG and an exercise ECG. 29 subjects (91%) needed further evaluation: 50% with a coronarography, 25% with a myocardial scintigraphy and 16% with a coronary tomography. A cardiovascular disease associated with LBBB was found for 28% of the population: at the initial evaluation for 12.5%, during the follow-up for 15.5% (after 6.5+/-3.5 years). **DISCUSSION:** We found less cardiovascular disease than the general population (28% vs 75%), and principally less coronary artery diseases (1 subject in our study). As these diseases are found during the initial evaluation or after 6.5 years of follow-up, the 3-year period of stability asked by the regulation does not seem appropriate.

## **Learning Objectives:**

1. Illustrate the need of a specific follow up for AM with LBBB.

# **[087] ARE YOU AT EASE WITH PREMATURE VENTRICULAR BEATS IN FIGHTER PILOTS?**

O. Manen<sup>2</sup>, S. Bisconte<sup>1</sup>, R. Souplet<sup>2</sup>, J. Monin<sup>2</sup>, A. Hornez<sup>2</sup>, J. Deroche<sup>2</sup>, and E. Perrier<sup>2</sup>

<sup>1</sup>Aeromedical Center; Robert Picqué Hospital, Villenave d'Ornon Cedex, France; <sup>2</sup>Aeromedical Center, Percy Military Hospital, Clamart, France

**INTRODUCTION:** Premature ventricular beats (PVB) with left bundle branch block (LBBB) morphology lead to difficult aeromedical decisions for fighter pilots (FP) because of the effects of +Gz on arrhythmogenesis and the frequent abnormalities found in modern cardiology imaging. France has adopted a strict policy in comparison to other nations in case of PVB < 10,000/24h, with regular discussions about a way to change this attitude. The aim of the presentation is to analyze if the French decision-making process is justified considering three kinds of arguments. **METHODS:** -A retrospective study carried out in Percy Military Hospital (Department of Cardiology and Aviation Medicine) about the effect of flying deconditioning on the evolution of complex PVB in 12 FP (mean age 33 yr old) followed from 2000 to 2011. -A literature study of the past few years about PVB and arrhythmogenic right ventricular cardiomyopathy (ARVC). -A recent case report of a FP with a final diagnosis of ARVC during the follow-up of PVB. **RESULTS:** -During the study period, no cardiopathy was discovered but a sequela of myocarditis in one FP and aspecific abnormalities on cardiac imaging in 50%. In case of a significant change in flying activities, it was observed a disappearance of PVB in 33% and persistence in 56%. Without a deconditioning, PVB disappeared in 17%, remain stable in 33% and got worse in 50%. -It is not admitted that the last Task Force criteria for the diagnosis of ARVC are more specific and sensitive. The prognosis of ARVC is severe, but MRI abnormalities suggestive of ARVC without a definite diagnosis should also be considered. -A 48-yo FP followed during 4 years for « benign » PVB (echocardiography, 24h-ECG, exercise test, late potentials), presented with a non-sustained ventricular tachycardia that

led to a diagnosis of ARVC. **DISCUSSION:** Considering the risk in fast jets, the difficulty to rule out a localized ARVC, the prognostic role of the abnormalities observed on MRI, the perfect initial check-up and regular follow-up for FP with PVB is still a challenge in 2015. The assessment must lead to a case-by-case decision, particularly for the question of a second pilot on board.

#### Learning Objectives:

1. To understand the difficulty to assess the risk of severe arrhythmia in case of premature ventricular beats in a fighter pilot.
2. To know how is posed the diagnosis of arrhythmogenic right ventricular cardiomyopathy.

#### [088] LONG QT IN AEROMEDICAL PRACTICE: PROPOSAL TO FACILITATE ITS DETECTION

O. Manen<sup>2</sup>, S. Bisconte<sup>2</sup>, J. Monin<sup>1</sup>, A. Hornez<sup>3</sup>, D. Dubourdieu<sup>3</sup>, S. Nguyen<sup>2</sup>, and E. Perrier<sup>3</sup>

<sup>1</sup>Aeromedical Center, Percy Hospital, Paris, France; <sup>2</sup>Aeromedical expertise, French Health Service, Clamart, France; <sup>3</sup>Percy Hospital, Clamart, France

**INTRODUCTION:** A prolonged corrected QT interval (QTc) is associated with an independent increased risk of sudden cardiac death, feared in aviation medicine. Apart from long QT syndrome, several acquired factors may prolong the QTc (drugs, electrolytic disorder...) including exposure to hypoxia. For these two reasons, it's imperative to detect a long QT during aeromedical practice. Bazett's QT corrected formula is still the most popular but isn't the best tool to detect long QT. Other QTc formulae like Fridericia, Framingham and Hodges can be also used. Aims of this study are to compare commonly used QT correction formulae in air crew member and discuss the best way to detect long QT in aeromedical practice. **METHODS:** The inclusion population consisted of military and civilian AM periodically examined for fitness assessment in the French main aeromedical center (CPMPN) with a standard 12-lead ECG in each examination. ECG were computerized, analyzed by one physician and then stored in a data base. QT duration and heart rate were extracted from the data base using appropriate software. A part of these ECGs was reviewed by a flight surgeon to test the computerized extraction. **RESULTS:** From 01/01/1996 to 09/30/2010, 69,186 AM [72% male, mean age (ma) 31.3±11 yr old] were examined and 222,867 ECG were stored. We used this database to compare the distribution of QTc on different formulae and to select a population presenting a QTc > 440 ms. All these results allowed us to propose a technique to facilitate the detection of long QT in aeromedical practice using the most efficient corrected formulae before a manual correction by a flight surgeon. **DISCUSSION:** Automatic analysis of QT duration is an interesting tool to detect long QT but can't replace the experience of flight surgeons.

#### Learning Objectives:

1. Discover the impact of hypoxia on QT duration.
2. Learn the appropriate technique to measure QT.
3. Learn the different formulae that can be used to correct QT.

#### [089] LEFT VENTRICULAR NONCOMPACTION IN TWO FLIGHT ATTENDANTS: AEROMEDICAL ISSUES

P. Pichereau and J. Paris

Aeromedical Center, Air France, Paris Charles de Gaulle Airport, France

**INTRODUCTION:** Left ventricular noncompaction (LVNC) is a little known myocardial pathology exceptionally encountered among flight crew: problems about fitness to fly arise necessarily and an implantable defibrillator could be part of the therapy. **FIRST CASE PRESENTATION:** A 35-year-old man, presented a complete left bundle branch block, absent in the previous ones. Unfitness is declared. Transthoracic echocardiography showed a light dilation of the left ventricle, with global hypokinesia. Infero-lateral and apical trabeculations are observed. The ejection fraction is reduced (37 %). The cardiac MRI confirmed the diagnosis. Coronary arteries are normal on CT-angiography. Under treatment (beta-blocker and ACE-inhibitor), the ejection fraction is increased (50 %). The follow-up is quarterly, and a 3-month fitness is declared. **SECOND CASE PRESENTATION:**

A 37-year-old woman, of African descent, presented T negative waves in the left derivations of a systematic EKG, absent in the previous ones. Echocardiography showed a normal ejection fraction and EKG stress test was negative. She was declared fit to fly. Two years later, she experienced three episodes of loss of consciousness. After the second one, she had a complete workup in a cardiology department. Echocardiography showed a slight dilation of the left ventricle, a severe and global hypokinesia and apical trabeculations. The ejection fraction was measured at 30 %. The diagnosis of LVNC was set up with MRI. Equipped with a long duration Holter device, she presented a third syncope during which a ventricular tachycardia occurred. A defibrillator was then implanted and a definitive unfitness was decided. **CONCLUSION:** The LVNC is a potentially severe myocardial pathology. Fitness or unfitness could occur depending on the clinical context, the ejection fraction or the European regulations (cabin crew member with an automatic implantable defibrillating system should be assessed as unfit).

#### Learning Objectives:

1. Knowledge of a little known cardiomyopathy and its aeromedical implications.

#### [090] SPORTS AND PHYSICAL ACTIVITIES AMONG FRENCH AIRCREW MEMBERS: A PROSPECTIVE EPIDEMIOLOGICAL SURVEY

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**INTRODUCTION:** Aircrew members (AM) are exposed to specific constraints (postural, environmental, jet lag or night work). We realized an epidemiological investigation about sport among French AM to evaluate the professional impact of regular physical activity. **METHODS:** A Physical Activity Questionnaire developed under the SphinxIQ® software was submitted anonymously to all military and civilian AM examined for fitness assessment at the Aeromedical Expertise Centre of Clamart from 03/01/2014 to 07/31/2014. Statistical analysis was performed with the Sigma plot® software. **RESULTS:** 1810 AM responded to this study [ma : 39.8 ± 9.7 years, 79.3% male, 35.2% military (77.7% from Airforce), 64.8% civilian (62.3% pilot, 37.7% cabin crew)]. Average BMI was 24.10 ± 3.07kg/m<sup>2</sup> and 15.4% of subjects were current smokers, which is less than general population (BMI=25.4 ± 4kg/m<sup>2</sup> and 27% of smokers, p<0.001). In the past 12 months, 94.2% of the population reported having engaged in physical activity, but less than once per week for 26.5%. Factors significantly associated with a high practice of sports are: military AM, males, and non smoking persons (p < 0.01). Running is the main activity (62.5%), followed by cycling (36%). Team sports are less represented (14%). Over 90% of subjects do sports outside working hours, and in the military population, only 19.6% use the dedicated time slots. During holidays, 35.3% of our population increases their physical activities, and 48.3% of them do sports in a particular environment (mountain, water). According to 88.9% of AM, sports improve tolerance to professional constraints, facilitating sleep (78.1%) and improving tolerance to stressful situations (72.2%). Professional unavailability related to sport injuries is more frequent among military AM (p<0.01) especially fighter pilots (p=0.05), with high practice of sports (p<0.01) and doing sports in a particular environment during the holidays (p<0.01).

#### Learning Objectives:

1. Evaluate the professional impact of regular physical activity among aircrew members.

#### [091] THE ACCEPTANCE OF INSULIN TREATMENT IN COCKPITS: A NON-ETHICAL DECISION FOR THE HEART OF DIABETICS.

O. Manen<sup>2</sup>, A. Hornez<sup>2</sup>, S. Bisconte<sup>1</sup>, J. Monin<sup>2</sup>, P. Bertran<sup>2</sup>, and E. Perrier<sup>2</sup>

<sup>1</sup>Aeromedical Center; Robert Picqué Hospital, Villenave d'Ornon Cedex, France; <sup>2</sup>Aeromedical Center, Percy Military Hospital, Clamart, France

**INTRODUCTION:** Type 2 (T2) diabetic patients with a long duration of disease must be considered at high cardiovascular risk. The European Aviation Safety Agency (EASA) has allowed pilots of Light Aircraft Pilot Licence to fly with insulin therapy. There have been many discussions and lobbying for months to extend these regulations in all private and professional pilots in Europe. Objective: to explain the discordance between what we know about the heart of diabetic patients and the insidious potential consequences of the new European regulations.

**METHODS:** A presentation of the common cardiovascular complications in T2 diabetes with their implications on the screening and prevention. A presentation of why the requirements of EASA, to avoid the in-flight hypoglycemia episodes that are feared by the Authority, are not acceptable and feasible in regard to ethics and practice in medicine.

**RESULTS:** T2 diabetes is frequently associated with other cardiovascular risk factors which can lead to an early, progressive and multivessel coronary artery disease, with no symptoms due to vegetative neuropathy and a worsening microvascular cardiomyopathy. There is a lack of sensitivity for the screening exercise tests. International recommendations are in favor of HbA1c < 7% to optimize the long-term cardiologic prognosis. The European regulations have imposed a new HbA1c target (7.5-8.5%) for flight safety reasons, considering the high rate of symptomatic or severe hypoglycemia in real life. To minimize this risk, some requirements are surprising, such as the review of symptoms, the assessment of hypoglycemia awareness, the yearly follow-up with review of all data logging of blood sugar and the 5-yearly exercise ECG. Furthermore, these pilots must regularly check their glycaemia on board, with a control by the safety pilot and also the aeromedical expert.

**DISCUSSION:** The European regulations have demonstrated a new step in the evolution of expertise philosophy, considering firstly the aeromedical fitness of diabetics and secondly the good health of such pilots. As evidence, these pilots are asked to be aware of a higher risk of cardiovascular complications when following this protocol.

#### Learning Objectives:

1. To remind the specificities of coronary artery disease in type 2 diabetic patients.
2. To know and understand the international recommendations for HbA1c target in type 2 diabetes.
3. To understand why the HbA1c target recommended by the European Aviation Safety Agency is a non-ethical proposal.

**Monday, May 11**  
**Americas Seminar**

**2:30 P.M.**

### [XVIII.] POSTER: MILITARY AND CIVILIAN INJURY, PROTECTION AND PERFORMANCE ISSUES

**Co-Chair: Casey Pruett**  
Cologne, Germany

**Co-Chair: Volker Damann**  
Cologne, Germany

#### [092] AIR MEDICAL TRANSPORT OF PRISONERS: WHO, HOW, WHEN?

E. Urquieta<sup>2</sup> and J. Varon<sup>1,3</sup>

<sup>1</sup>The University of Texas Health Science Center at Houston, Houston, TX; <sup>2</sup>Division of Aerospace Medicine, Wright State University, Kettering, OH; <sup>3</sup>The University of Texas Medical Branch at Galveston, Houston, TX

**INTRODUCTION:** Mexico City Police Department HEMS provided more than 2,500 aeromedical evacuations during 2013 with a fleet of seven helicopters, and is the only helicopter emergency medical service (HEMS) in the city. Prisoners have specific requirements for a safe transport. The literature is scant in how prisoners are transported via air ambulance. The purpose of our study was to describe the characteristics of HEMS transports of prisoners from a crime scene to the hospital, as well as attempt to

determine which variables are related to the outcome of these individuals.

**METHODS:** Retrospective chart analysis using data from the Mexico City Police HEMS for air medical transport of prisoners between January 1, 2000 and December 31, 2013. Subject demographics, injury, procedures performed, transport time, Glasgow Coma Scale (GCS), and outcome data were collected. Chi-square crosstabs analysis and T-test for independent samples analysis were performed using SPSS. Statistical significance was assumed to be  $p \leq 0.05$  for two-sided hypothesis. **RESULTS:** Fifty-three patients (0.16% of 32,500 HEMS transports) were included after meeting inclusion criteria during the study period. Of the 53 patients, 42 were males and 11 were females. The median age of the patients was 30 years (17 - 47 years). The Mexico City Police Department HEMS serves a circumference of 12 nautical miles in radius and prisoners were retrieved from different locations inside that area. The median total transport time defined as minutes from helicopter arrival at the scene to patient delivery at the emergency department was 23 minutes (15 - 32 minutes). A total of 11 patients required an on-board medical procedure (CPR, intubation, or needle decompression). The statistical analysis showed the following variables to be predictors of mortality: Heart rate, systolic blood pressure, Glasgow coma scale, age, CPR. **DISCUSSION:** Our study is unique as it provides insight on predictors of outcome in prisoners transported via air medical transport in Mexico city. We demonstrate the usefulness of different parameters (Heart rate, systolic blood pressure, Glasgow coma scale, age, and CPR) as a pre-hospital trauma triage tool and as a predictor of mortality during helicopter transport.

#### Learning Objectives:

1. To understand the parameters associated with outcome and mortality during the air medical transportation of prisoners.
2. To understand the special characteristics of the prisoners transported via helicopter emergency medical services.
3. To understand the special needs and requirements during the air medical transportation of prisoners.

#### [093] CHARACTERIZING MUSCULOSKELETAL INJURY RISKS IN AEROMEDICAL EVACUATION PERSONNEL: A SAMPLING STUDY

D. Pohlman<sup>1,2</sup>, J. Serres<sup>1</sup>, and B. Fouts<sup>1,2</sup>

<sup>1</sup>Aeromedical Research Department, U.S. School of Aerospace Medicine, Wright-Patterson AFB, OH; <sup>2</sup>Oak Ridge Institute for Science and Education, Oak Ridge, TN

**INTRODUCTION:** The confined and stressful environment in which aeromedical evacuation (AE) personnel operate may lead to an increase in musculoskeletal injuries (MSIs) among AE healthcare providers.

Configuring an aircraft for an AE mission and then maneuvering patients onto the aircraft, often while they are weighed down with equipment, likely puts AE personnel at a higher risk for MSIs than non-flying healthcare providers. **METHODS:** A sampling study was conducted to identify which tasks AE personnel associated with MSIs. A questionnaire with three sections covering demographics, symptoms by body region, and work experience and activity was used. Independent two-tailed t-tests were used to test for significant differences in the occurrence of MSIs based on demographics. Pearson correlation values were calculated to find the strength of correlation between the variables. **RESULTS:** AE medical technicians experienced significantly more shoulder pain than AE nurses ( $p=.01$ ). Male AE personnel were significantly more likely to be placed on restricted duty ( $p=.037$ ) and to be absent from duty ( $p=.039$ ) due to musculoskeletal pain than females. There was a significant correlation between being absent from duty and being placed on restricted duty. Aircraft configuration and patient loading were identified as the two tasks most commonly associated with pain in the various regions of the body. **DISCUSSION:** There was not a significant difference in the musculoskeletal pain experienced by male and female AE personnel, which suggests the causes of these injuries are not sex dependent. AE medical technicians experienced significantly more shoulder pain than AE nurses, probably because technicians often take part in more lifting tasks than nurses during loading and unloading of the aircraft. Patient loading is a physically demanding task, and the heavy lifting associated with it could be the reason it is identified as a pain-inducing task. Additionally, pain was frequently attributed to aircraft configuration. This could be due to extensive flexion and awkward



postures associated with configuring the aircraft. These postures, even with proper lifting technique, can be biomechanically stressful and may cause musculoskeletal pain.

#### Learning Objectives:

1. Identify which AE tasks are commonly associated with musculoskeletal pain.
2. Discuss potential reasons why certain demographics cause significant differences in the amount of pain experienced in particular regions of the body.
3. Examine how body mass index, musculoskeletal pain, and duty restrictions correlate with each other.

#### [094] IDENTIFICATION OF MEASURES AND MODERATORS TO IMPROVE PREDICTION OF IMPAIRMENTS DUE TO CHRONIC SLEEP LOSS

B.M. Hartzler<sup>1</sup>, D.F. Chandler<sup>2</sup>, and C.B. Sill<sup>1</sup>

<sup>1</sup>Aeromedical, Naval Medical Research Unit Dayton, Wright-Patterson AFB, OH; <sup>2</sup>Psychology, Birmingham-Southern College, Birmingham, AL

**INTRODUCTION:** Individual differences in fatigue susceptibility during sleep loss have been widely recognized, with some people experiencing little impairment due to sleep loss, and others exhibiting significant impairment after missing just a few hours. Moreover, these impairments may manifest differently in acute versus chronic sleep loss situations. Such variability is of particular concern in arduous operational contexts involving short reporting times or little sleep. Existing biomathematical modeling tools, such as the Fatigue Avoidance Scheduling Tool (FAST), fail to account for these individual and contextual differences. The purpose of the present analyses was to identify measures and moderating factors that might be used to develop better individualized predictions of fatigue susceptibility during chronic sleep restriction. **METHODS:** A series of enter-method, linear regression analyses were conducted on data from a chronic sleep restriction study ( $n = 24$ ; 4hr sleep for 4 nights) to identify which factors had the greatest value in predicting performance impairments due to fatigue. **RESULTS:** In these analyses, FAST estimates rarely predicted more than 5% of the variance in performance. With the addition of other factors the predictive value typically exceeded 35%. The best predictors included factors from the Profile of Mood States (Fatigue/Inertia and Total Mood Disturbance), and the amount of time-off-target on a flight simulation task. The predictive value of these algorithms was further improved by constraining the data based on factors such as personality facets and time of testing session. **DISCUSSION:** The results of these analyses indicate that the predictive efficacy of generalized biomathematical models may be greatly improved by pairing the performance estimates with other factors encompassing subjective and objective assessments of the individual's current state. Successful improvement and subsequent use of these types of algorithms could help optimize both mission efficacy and safety by identifying personnel who are best able to maintain performance under fatigued operational conditions.

#### Learning Objectives:

1. Results of this study revealed that the predictive efficacy of a widely-used generalized biomathematical model to predict impairment due to chronic sleep restriction could be improved with the inclusion of other factors. These other factors include subjective assessments of the individual's current emotional state as well as measures of attention and response control. Moreover, the predictive value could be further improved by factoring in certain personality facets.

#### [095] ASSESSING IMPLEMENTATION OF NEW CHANGES TO CONDITIONS AMES CAN ISSUE

A. Norris, V. Skaggs, and T. Chidester  
FAA-CAMI, Oklahoma City, OK

**INTRODUCTION:** When an aviation medical examiner (AME) examines an airman during the medical certification process, there are conditions for which an AME must defer to Aerospace Medicine before the airman's certificate is issued. In 2013, the Office of Aerospace Medicine (OAM) implemented changes for nine specific conditions to

allow AMEs to process more applicants immediately following the examination. This process became known as Conditions an AME Can Issue (CACI). OAM determined the nine conditions that posed low safety risk in certification. However, a safety assurance review was needed to document the certification changes over time. Therefore, this study describes the results from the CACI monitoring process. **METHODS:** Three months of medical certification data were analyzed to determine the number of CACI-related conditions processed in the system. The study criteria for the first analysis included only those certificates that had at least one of the CACI pathologies and where the AME issued a non-time limited certificate. Criteria for the second analysis included certificates that only had one condition assigned to it, and that condition was a CACI. Certificates were individually examined to determine whether AMEs utilized the CACI process appropriately. **RESULTS:** We reviewed 493 cases from the first analysis, with 253 exams meeting the study criteria. In 80% of the exams, AMEs issued certificates correctly. However, only 25% of these certificates properly noted CACI protocol where indicated. More than 20% of certificates were either issued incorrectly or without proper documentation of proof to issue. We included 85 exams in the second analysis. Of the CACI-related certificates, 40% of the time an AME could have issued without a time-limited restriction but did not. Only 18% of the certificates properly noted CACI protocol where indicated. **DISCUSSION:** These analyses indicate a need for more education and promotion of CACI procedures and documentation requirements among AMEs. However, CACI implementation does not appear to increase safety concerns of AME exam issuance. The Federal Air Surgeon published additional AME guidance based on these results and has requested a follow-up analysis for 2014 data.

#### Learning Objectives:

1. Evaluate the safety and efficiency of changes to medical conditions AMEs can issue.

#### [096] DEVELOPMENT OF COGNITIVE TASKS FOR MEASURING THE SPATIAL COGNITIVE ABILITY OF PILOT CANDIDATES AND PILOTS: A PILOT STUDY

Y. Aiba, M. Arake, T. Ogawa, A. Tsuruhara, R. Ihara, M. Ushijima, and Y. Tomitsuka

Aeromedical Laboratory JASDF, Tachikawa, Japan

**INTRODUCTION:** The ability to maintain a sense of direction and location while flying is a fundamental cognitive function of pilots. Although a pilot's spatial or navigational ability differs widely across individuals, no cognitive tasks have been developed to measure it directly. In this study, we developed a computer-based spatial cognitive task and administered the task to pilot candidates, pilot students, and enlisted personnel (as a control group) on a trial basis. We analyzed the data to examine the reliability and validity of the task. **METHODS:** Participants were 25 pilot candidates, 16 student pilots, and 36 enlisted personnel. We coded in the Blitz3D (Blitz Research) to create a desktop virtual flight environment that participants viewed from a first-person perspective. We set a flight path and placed the targets on the inflection point. The targets are set to appear when the participants approach to the point. After the participants flew toward the target in the predetermined flight path, they completed three types of spatial tasks: a cardinal judgment task, a judgment about the location of the object task, and a path integration task. We analyzed the group differences regarding the tracking, cardinal judgment, judgment about the location of the object, and path integration tasks. In addition, we examined whether each task could detect the differences in flight aptitude within each group by examining the proportion of each group among different spatial cognition task grade quartiles. **RESULTS:** The score and response time of the cardinal directional task and the judgment about the location of the object task score differed significantly between the groups. The analysis of the spatial cognition task grade quartile showed that the percentage of enlisted personnel differed from that pilots and pilot candidates in each quartile. **DISCUSSION:** We developed a spatial cognition task to measure pilots' spatial cognition ability in a 3-D flight environment from a first-person perspective. The pilots and pilot candidates achieved better scores on the spatial cognition task than did enlisted personnel. This result suggests that our spatial cognition task could detect differences between pilot or pilot candidates and enlisted personnel.

**Learning Objectives:**

1. Describe cognitive tasks to measure pilots' spatial cognition ability in a 3-D flight environment.

**[097] AME PERFORMANCE SURVEILLANCE**

V. Skaggs, A. Norris, and T. Chidester  
FAA-CAMI, Oklahoma City, OK

**INTRODUCTION:** The purpose of this analysis is to develop an objective methodology to identify aviation medical examiners (AMEs) that may need additional training or enhanced surveillance. This proactive monitoring system will provide an effective way to allocate resources for AME education. **METHODS:** Data were collected from the AME quarterly reports and the AME Information System (AMEIS) for the years 2009-2012. For each AME, we retained their most recent year of data. The variables collected include the most recent year of data for percent of exams deferred or denied, percent of exams with an inadequate history or reversal, total exams submitted, total exams with delayed transmission greater than 60 days, average age of the airmen examined, total exams performed during the AME's career, years as an AME, AME's age, gender, medical specialty, region, senior examiner status, pilot license status, and AME type. **RESULTS:** A total of 3,866 AMEs were included in this analysis. Outcome variables were defined as follows. A positive (1) **defer risk** was defined as AMEs that either deferred less than 2.5% or deferred more than 20% of the exams performed in a year. A positive (2) **error risk** was defined as AMEs that had a 5% or higher error rate. A positive (3) **delay risk** was defined as AMEs that delayed transmission for 60 days or more on 1% or more of the exams performed. A positive (4) **exam risk** was defined as an AME that performed fewer than 10 exams that year. An overall outcome variable was defined as having at least two of the defined risk variables. Using this approach, we identified the most extreme AMEs along multiple dimensions of potential risk. This resulted in 3.5% of the AME population being identified as at-risk for needing additional training or enhanced surveillance. **DISCUSSION:** Based on the analysis, we would recommend using the methodology above to proactively identify those with at least two of the defined risk variables and focus surveillance and quality assurance on this subset of AMEs.

**Learning Objectives:**

1. Identify methodologies to differentiate between groups based on performance factors.

**[098] MUSCULOSKELETAL COMPLAINTS AND INJURIES IN SWEDISH AIR FORCE HELICOPTER CREW COMPARED TO ARMY SOLDIERS. IMPLICATIONS FOR INTERVENTIONS**

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<sup>1</sup>Dept. of Community Medicine and Rehabilitation, Division of Physiotherapy, Umeå University, Umeå, Sweden; <sup>2</sup>Dept. of Neurobiology, Care Sciences and Society, Division of Physiotherapy, Karolinska Institutet, Huddinge, Sweden; <sup>3</sup>The Swedish Armed Forces, Stockholm, Sweden

**INTRODUCTION:** A newly developed intervention program, "Optimize the training and preparation", is under implementation in the Swedish Armed Forces in order to decrease Musculoskeletal Complaints or Injuries (MSCI) thus enhancing military readiness. To effectively handle and plan for proper interventions, MSCI is systematically monitored. The aim of this study was to investigate the one-year and point-prevalence of MSCI and life-style factors among Swedish Air Force helicopter pilots in comparison with non-pilot aircrew, soldiers on mission and army recruits entering service. **METHODS:** Helicopter pilots (n=72) and non-pilot aircrew (n=34) at one air base, all army recruits entering basic military service (n=1545) and soldiers on international mission in Afghanistan (n=355) answered a baseline/pre-employment questionnaire. The survey included one-year and point-prevalence of MSCI, rating of severity of symptoms using VAS, and, ratings of life-style factors. **RESULTS:** Pilots reported higher prevalence in numbers of body regions with current MSCI compared to soldiers (p=0,001) and recruits (p<0,001) and rated significantly higher pain intensity on VAS than soldiers (median 46 vs 26, p=0,004) and recruits

(median 46 vs 25, p=0,001) did. More pilots (19%) reported that the MSCI bothered them constantly, compared to soldiers (4%, p<0,001) and recruits (2%, p<0,001). No differences were found between pilots and non-pilot aircrew. Almost all participants rated their physical and mental health as being good or excellent, significantly fewer pilots used nicotine than soldiers did. **DISCUSSION:** Previous and ongoing MSCI were common among helicopter pilots and non-pilot crew. The MSCI needs to be further clinically examined and sub-classified in order to enhance an optimal intervention strategy. Also, MSCI has in previous studies shown to increase with age and has been associated with discharge from military service. Since Swedish soldiers now stay in service for longer periods it is indicated that the workload in different trades is further analyzed in order to determine environmental and individual risk factors for MSCI.

**Learning Objectives:**

1. On completion of this presentation participants will be able to discuss a method for health-monitoring aiming at enhance air crew readiness and minimize the deployable non-ready.

**[099] "FAST FORWARD" CLINIC: OPTIMIZING WORKPLACE INJURY CARE AND REHABILITATION. FIRST YEAR EXPERIENCE AT ROBINS AFB**

D. Rappa<sup>1</sup> and C. Grussendorf<sup>2</sup>  
<sup>1</sup>78th Medical Group, Robins AFB, GA; <sup>2</sup>78th Aerospace Medicine Squadron, Robins AFB, GA

**INTRODUCTION:** The First Aide Station, Treatment, and Forward Operating Rehabilitation of Workers Accentuating Restorative Dynamics (FAST FORWARD) Clinic opened in June 2013. The clinic provides on-site occupational injury care and rehabilitation services resulting in significant savings and enhanced quality of care. Our experience supports ongoing efforts to provide direct care occupational medicine services. **METHODS:** The FAST FORWARD clinic is located in the heart of the Warner Robins Industrial Complex, sharing space within an aircraft maintenance facility. Staffing includes a nurse practitioner, 3 sports rehabilitation specialists, and 2 administrative technicians. Operations are managed by the Director of Occupational Medicine Services. Duty hours are 1230-2130 for first-aid/provider, and 0730-1930 for rehab services. This schedule provides service during peak hours of industrial operation and covers hours for night/swing shift employees. The clinic operations resulted from a partnership between the Warner Robins Air Logistics Complex and the 78th Air Base Wing, and are funded by the Depot Maintenance Activity Group (DMAG). **RESULTS:** In its first year, the FAST FORWARD Clinic completed 494 provider visits resulting in direct medical savings of 277.9K, and absenteeism savings of 642 man hours valued at \$105.8K. Rehabilitation services provided 1,167 visits resulting in direct medical savings of \$192.3K, and absenteeism savings of 1,517 man hours valued at \$105.8K. FAST FORWARD Clinic operations led to improvement in OSHA quality metrics. The Total Case Incident Rate (TCIR) fell by 24%. The Days Away, Restricted, or Job Transfer Rate (DART) fell by 28%. The benefit was attributed in part to timely care, and the clinic's return-to-duty process. **DISCUSSION:** The FAST FORWARD Clinic demonstrated cost savings, quality, and enhanced teamwork between labor, management, and medical staff. This model is scalable to any employee health operation. The author provided direct injury care in another Flight Medicine Clinic recapturing 187 non-emergent injuries over a 2 year period; realizing benefits on a smaller scale. These authors recommend on-site provision of such services wherever employers seek to optimize workplace health and safety.

**Learning Objectives:**

1. On-site occupational injury care and rehabilitation services should be considered by an organization as a means to deliver optimal care for employees, generate cost savings, enhance productivity, and improve regulatory health and safety compliance.
2. The benefits of on-site occupational injury care programs could be realized through integration or recapture of employee health into existing clinic operations/models. The operations of the FAST FORWARD Clinic at Robins AFB could be scaled up or down to meet various employee health requirements.

**[100] ASSESSMENT OF AN ALTERNATIVE FLIGHT EYEWEAR**D.V. Walsh<sup>1</sup>, G.M. Jurek<sup>1</sup>, and J.E. Capo-Aponte<sup>2</sup><sup>1</sup>Vision Protection and Performance Division (VPPD), U.S. Army Aeromedical Lab (USAARL), Fort Rucker, AL; <sup>2</sup>Optometry, Womack Army Medical Center, Fort Bragg, NC

**INTRODUCTION:** Army aircrew members work under unique stress demands and environments. Currently, aircrews are issued the HGU-4/P aviator spectacles. However, a recently published survey found high dissatisfaction with the current frames. The purpose of this study was to test an Air Force Aircrew Flight Frame (AFF-OP) among aircrew, and to evaluate frame performance and compatibility under operational conditions. **METHODS:** Sixty-nine aircrew members (65 rotary and 2 fixed wing pilots, and 2 non-pilots) wore the AFF-OP eyewear during normal operational duties over a 3-month period and completed a Likert scale survey (1=much better, 2=slight better, 3=SAME, 4=slightly worse, 5=much worse) at 1, 6, and 12-week intervals. Fourteen questions were asked in the survey with the main outcome measure being frame preference. For inclusion into the study, participants must have had at least 6 months prior experience wearing the current HGU-4/P eyewear. **RESULTS:** The AFF-OP eyewear was significantly more preferred than the current HGU-4/P ( $p < 0.001$ ). The three highest subjective reasons for AFF-OP preference were: 1) Comfort around ears without helmet or headset (mean =  $1.75 \pm 0.82$ ); 2) Comfort around ears with helmet or headset (mean =  $1.90 \pm 1.04$ ); 3) Effect on ear cup seal (mean =  $1.94 \pm 0.80$ ). Finally, there were no statistically significant differences in survey responses across the three surveyed time-periods. **DISCUSSION:** Army aircrew preferred the AFF-OP over the current HGU-56-P eyewear. Two of the top three highest subjective reasons for AFF-OP preference coincided with two of the top three operational eyewear problems reported in the 2010 published survey paper. If Army aircrews do not wear the current Army issued frame, they may purchase their own frame out of pocket. However, this can lead to unnecessary expenses and utilization of a frame that has not been tested for compatibility and performance with aircrew life support equipment.

**Learning Objectives:**

1. To identify if an alternative aviation flight eyewear is a more viable option for U.S. Army aircrew than the current aviator frame.

**[101] A SURVEY OF UV EXPOSURE IN A MEDIUM ALTITUDE TURBOPROP AIRCRAFT**

T.L. Powell and S. Dillard

*Pacific Air Forces, U.S. Air Force, Ocala, FL*

**INTRODUCTION:** Many of the U.S. Air Force aircraft stationed in East Asia are turboprop and helicopter aircraft operating at low and medium altitudes between the latitudes of 0-10 degrees. Many of these aircrew operate in austere, tropical environments for long days in heavily windowed cockpits due to the high degree visibility required for their mission sets. Crew complaints of frequent sunburn generated a survey of average cockpit ultraviolet radiation (UV) exposures during a typical mission, which we describe here. **METHODS:** Aircraft surveyed was the Beechcraft 1900C, a widely used commuter airliner, which cruises at altitudes of 7000-8500m. This aircraft possesses a cockpit layout representative of many turboprop aircraft. A volunteer pilot wore an attachable UV device and placed it on various predetermined areas on his body and around the cockpit. Measurements were recorded once the aircraft reached cruise and just prior to descent on 2-hour legs. These measurements were compared against the measurements of an identical UV sensor on the ground. **DISCUSSION:** The area of the body which experienced the highest levels of UV were the forearms and waist. Compared to UV measurements taken on the ground, airborne cockpit exposures were on average 10-15% of the exposure a person on the ground would experience. This is a testament to the ability of the glass and polycarbonate used in modern aircraft to protect crew members from high altitude UV radiation. Still, 10-15% of the ground-level tropical UV exposure over long mission durations can result in a significant exposure over the long term. Crews operating such aircraft should be warned of the risks and educated on UV protection strategies.

**Learning Objectives:**

1. The objective for this survey was to begin discussion on measuring total accumulated UV exposures pilots and other crewmembers experience while operating turboprop aircraft. With the known dangers of UV exposure being well documented, research into this field will improve quality of life and the future health of persons involved in this type of work.

**[102] USAF/RAAF EXCHANGE FLIGHT SURGEON PROGRAM - BUILDING PARTNERSHIPS AND ENHANCING INTEROPERABILITY**

E.W. Schroeder

*Joint Health Command, USAF/RAAF Exchange, Canberra, ACT, Australia*

**INTRODUCTION:** The objective of the United States Air Force / Royal Australian Air Force (USAF/RAAF) Military Personnel Exchange Program is to promote mutual understanding and trust, enhance interoperability, and develop long-term personal and professional relationships between officers in the two nations' Armed Forces. The Exchange Program aims to meet the objective by building partnerships, exchanging best practices, collaborating on projects, and facilitating the sharing of information. The flight surgeon serving as the USAF/RAAF Exchange Officer is responsible for fully integrating into the Australian Defence Force (ADF), developing and modifying aviation medicine policy for the ADF, serving as the aviation medicine point of contact for Joint Health Command (JHC), chairing the Aviation Medicine Working Group, and serving as a consultant for the RAAF Institute of Aviation Medicine. The flight surgeon is assigned to the ADF's JHC, the tri-service organization charged with providing medical and health support to the Australian Regular Army, the Royal Australian Navy, and the Royal Australian Air Force. This presentation will describe the USAF/RAAF Flight Surgeon Exchange Officer position, detail organizational differences, summarize current projects and challenges, and highlight cultural experiences.

**Learning Objectives:**

1. Learn about the role and responsibilities of the USAF/RAAF Exchange Flight Surgeon.
2. Understand the importance of the USAF/RAAF relationship.

**[103] EXPLORATION OF THE BIOPHYSICAL INTERACTION MECHANISM(S) AND DOWNSTREAM PHYSIOLOGICAL CONSEQUENCES OF CELLULAR EXPOSURE TO INTENSE ELECTRIC PULSES**B.L. Ibey<sup>1</sup>, G. Tolstykh<sup>2</sup>, G.L. Thompson<sup>3</sup>, J. Payne<sup>1</sup>, J.C. Ullery<sup>2</sup>, L. Estlack<sup>2</sup>, C.C. Roth<sup>4</sup>, and H. Beier<sup>1</sup><sup>1</sup>Radio Frequency Bioeffects Branch, Air Force Research Laboratory, Fort Sam Houston, TX; <sup>2</sup>General Dynamics Information Technology, Joint Base San Antonio, TX; <sup>3</sup>Oak Ridge Institute for Science and Education, Joint Base San Antonio, TX; <sup>4</sup>Radiology, University of Texas Health Science Center, San Antonio, TX

**INTRODUCTION:** Recent studies have demonstrated that nanosecond pulse electric field (nsPEF) exposure of cells form small, recoverable pores in the plasma membrane, termed nanopores, which allow passage of small ions for minutes after exposure. Despite much research, direct empirical evidence of and the mechanism(s) behind the formation of such pores remains unclear. **METHODS:** Using second harmonic generation imaging, we demonstrate that phospholipid rearrangement is occurring during nsPEF exposure, further validating nanopore formation. Additionally, we explore the biophysics behind nsPEF by using a probe beam deflection technique to evaluate the potential of pressure waves forming at the metal/saline interface. For the first time, we have demonstrated that a pressure wave is indeed formed during nsPEF, suggesting that nsPEF bioeffects may not be solely caused by electromagnetic fields. Beyond the fundamental biophysics, we have also explored physiological response of cells to nsPEF both acute (cell-death) and long-term, specifically focusing on the activation of secondary pathways derived at or near the plasma membrane. **RESULTS:** We have conclusively shown that nsPEF overexposure will cause activation of extrinsic apoptotic death via the death



receptors found in the plasma membrane in contrast to previous claims of a mitochondrial-damage-induced death mechanism. In addition, we present evidence that nsPEF activates phosphoinositide-specific lipid signaling, mirroring a drug-induced response, but without the necessity of a specific membrane receptor. **DISCUSSION:** Activation of this cellular pathway has significant physiological consequences as it controls ion channel activation and cell-to-cell communication essential to all neurological processes. Selective activation of intracellular pathways by an external electrical stimulus enables direct and specific activation of tissues. Targeted application of nsPEF could, therefore, lead to rapidly enhanced cognitive performance, motor reflexes, and metabolism.

#### Learning Objectives:

1. Understanding of the biological consequences of intense electric pulse exposure.

#### [104] SLEEP, CONCENTRATION, ENERGY AND QUALITY OF LIFE OF AIR TRAFFIC CONTROLLERS WITH 2 DIFFERENT SHIFTS WORK, SÃO PAULO, BRAZIL

J.G. Sonati<sup>1</sup>, M.M. De Martino<sup>1</sup>, R. Vilarta<sup>2</sup>, S. Maciel<sup>3</sup>, E.O. Moreira<sup>4</sup>, F.M. Sanchez<sup>4</sup>, and R.J. Sonati<sup>1</sup>

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**INTRODUCTION:** The shift-work alters circadian rhythms and lead to physiological and social changes on workers. The objective this study was to verify the association between the variables sleep, concentration and energy with the quality of life of the air traffic controllers in shift work alternating and rotating. **METHODS:** The study assessed 43 air traffic controllers from two Brazilian International Airports in State of São Paulo. The Whoqol-bref questionnaire was used to verify the quality of life, sleep satisfaction, concentration capacity and energy to day. **RESULTS:** The sample from Airport 1 (AIR 1) was 16 air traffic controllers (46% of the total sample), 50% females and 50% males, median age 41 years old, 50% have 15 years or more of study, 44% singles, with alternating shift work of 8 hours - 3 days work and 2 days off (Shift 1: 7:00hr - 15:00hr/Shift 2: 15:00hr - 23:00hr/Shift 3: 23:00hr - 6:00hr). The Airport 2 (AIR 2) was 27 air traffic controllers (52% of the total sample), 67% males and 33% females; median of age 42 years old, 57% have 15 years or more of study, 47% married and with rotating shift work 6 hours - 4 days work and 2 days off (Shift 1: 6:00hr - 12:00hr/Shift 2: 12:00hr - 18:00hr/Shift 3: 18:00hr - 24:00hr/Shift 4: 24:00 - 6:00hr). The quality of life had a positive association with the sleep satisfaction ( $r=0.5156$  to AIR 1 and  $r=0.5390$  to AIR 2) and energy ( $r=0.689$  to AIR 1 and  $r=0.6714$  to AIR 2). The study did not show the association between quality of life and concentration. **DISCUSSION:** Generally, the air traffic controllers adapt to shift work by different pathways that are dependent on endogenous and exogenous. Rotating scales are used in various parts of the world including Brazil. This type of shift is seen by many researchers as a way to minimize the effects of a chronic desynchronization of the circadian clock. This study has shown that both air traffic controllers with alternating shifts and air traffic controllers with rotating shifts presented similar positive associations between sleep, energy, and overall quality of life.

#### Learning Objectives:

1. The air traffic controller's sleep and energy are associated with quality of life independent models of scales (rotating or alternating).

#### [105] AN ANALYSIS OF FLIGHT ATTENDANT HEADSET COMMUNICATION BY A COMMERCIAL AIRLINE TO A GROUND MEDICAL SERVICES PROVIDER

T.J. Doyle

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**INTRODUCTION:** Many commercial airlines contract with a ground medical services provider for inflight medical consultation. Advances in aircraft and communication technology have enabled direct connection via headset to the flight attendant or medical provider involved in an

inflight emergency. This study will examine the efficacy of radio communications using a headset on the flight attendant to communicate with a ground medical services provider. **METHODS:** Data from a large North American commercial carrier that uses headsets and radio communication to UPMC was reviewed retrospectively over a 12 month period. Four main communication categories were reviewed: 1. Communication with flight attendant via headset was good; 2. Communication with flight attendant was cutting in and out; 3. Flight attendant not connected/captain relay; and 4. Unable to communicate with aircraft/radio service relay. This airline uses variants of one type of Boeing aircraft. Data from ground based or screening calls, and data from inflight calls where a category could not be identified was excluded. **RESULTS:** 2707 inflight medical consults were reviewed. 1675 of these medical consults had a good connection where the flight attendant could be understood and relay information (62%). 299 medical consults had communication issues where the flight attendant was cutting in and out (11%). 652 medical consults were relayed via the captain (25%). 3 medical consultations occurred where the flight could not be contacted directly and a ground radio service had to be used. (0%). **DISCUSSION:** In this study good communication with the flight attendant was only established 62% of the time. The captain had to relay the information and the flight attendant was not used 25% of the time. One limitation of the study is that it is not known if in these cases the flight attendant could not get the headset to work, or if the captain chose to communicate directly. A flight attendant with a headset would still be the most effective way to relay information and provide real time updates on passenger status. The limitations of this type of communication should be recognized, and alternative means of data relay such as a medical assistance form should be quickly available.

#### Learning Objectives:

1. To determine the efficacy of flight attendant headset communication from a commercial airline to a ground based medical service provider.

#### [106] ERGONOMICS TRAINING IN COCKPIT, THE NEW ASPECT IN PREVENTION OF NECK PAIN IN THE FINNISH AIR FORCE

S. Feberg<sup>1</sup>, T. Honkanen<sup>2</sup>, M. Mäntysaari<sup>2</sup>, and T.K. Leino<sup>3</sup>

<sup>1</sup>Field Medicine Service Unit, Centre for Military Medicine, Utti, Finland; <sup>2</sup>Aero Medical Centre, Centre for Military Medicine, Helsinki, Finland; <sup>3</sup>Air Force Command, Tikkakoski, Finland

**INTRODUCTION:** It is a common view that pilots flying high performance aircraft have increased risk for neck disorders. There is evidence that flying high performance aircraft has an adverse effect on the cervical spine. One solution in the Finnish Air Force (FINAF) was to implement a special ergonomics training program in the cockpit (SETPC). The aim of this project is to prevent FINAF fighter pilots' limitations in fitness to fly caused by neck dysfunction and overuse injuries. **METHODS:** All Finnish Air Force fighter pilots participate in the SETPC as a mandatory part of their flight training. The SETPC consists of theory lectures in classroom and practice in a cockpit directed by physiotherapists specialized in occupational health care. The lectures include basic information of human anatomy and sitting ergonomics, in the cockpit and at the office. After pilots have undergone the theory part of the SETPC they move to practice. The main part of the practice of the SETPC is videotaping pilots' movements in the cockpit. The first video session is done while the plane is in the hangar and later sessions in-flight on a mission. After videotaping each pilot receives individual feedback of their head movements and neck range of movement. Individually tailored procedures are taught in order to decrease the loading of cervical spine during flight. **DISCUSSION:** The pilots' attitude towards this new method has been good. Besides the decrease in cervical loading some pilots have also experienced better operative efficiency while they have learned new patterns to move their head. The possible effects of this project in reducing cervical injuries are not yet clarified and future research will be done to reveal the benefits of this project.

#### Learning Objectives:

1. The audience will learn about ergonomics in the cockpit.
2. The special program of ergonomics training in the Finnish Air Force will be presented to the audience.

**[107] A MOBILE APPLICATION FOR PREDICTION OF ACUTE MOUNTAIN SICKNESS, WORK PERFORMANCE, AND ALTITUDE ACCLIMATIZATION**

J.E. Staab, B.A. Beidleman, C.S. Fulco, T.J. Driscoll, A. Cymerman, and S.R. Muza

TMMD, U.S. Army Research Institute of Environmental Medicine, Natick, MA

**INTRODUCTION:** Unacclimatized Service Members rapidly deployed to altitudes above 1200 m will likely experience acute mountain sickness (AMS) and impaired work capabilities. Therefore, to minimize risks to the Service Member and to optimize operational effectiveness, mission planners and leaders need accurate estimates of AMS, work performance, and acclimatization status at various altitudes. However, predictive models to provide these estimates are not currently available in a user-friendly format. **METHODS:** The objective was to design a decision aid software application that provides easy-to-use screens for entering relevant mission parameters and displaying estimates of AMS, work performance and altitude acclimatization status in both text and graphic formats for altitudes ranging from 2000 m to 4500 m. The prediction models utilized in the software were developed at the USARIEM using inputs of target altitude, time at altitude, gender, work rate, and body mass index. User needs and preferences were also solicited to design the graphical user interfaces. The software application functions on an Android-based mobile device per U.S. Army Nett Warrior program specifications.

**RESULTS:** The software application is organized into three modules. The AMS module provides an estimate of the prevalence and severity of AMS as a function of time at the target altitude. The work performance module provides an estimate of the duration to complete a physical task at the target altitude relative to sea level performance. The altitude acclimatization module calculates the exposure duration to a selected staging altitude required to induce acclimatization to a higher target altitude.

**DISCUSSION:** This decision aid will support a wide range of military users to include mission planners, medical personnel and unit leaders for combat and humanitarian missions. Future versions may run on other platforms including personal computers, tablets and web-based sites. The views expressed in this abstract are those of the authors and do not reflect the official policy of the Department of Army, Department of Defense, or the U.S. Government.

**Learning Objectives:**

1. Attendee will recall that a software decision aid application is available to estimate risks of acute mountain sickness, performance impairment, and appropriate altitude acclimatization guidance to mitigate these risks.
2. Attendee will be able to describe the use of this software decision aid application in preparation of the medical annex of an operation order (OPORD).

**[108] ANALYSIS OF ADVERSE PHYSIOLOGICAL EVENTS IN USN AND USMC AVIATION HAZARDOUS REPORTS 2004-2014**B. Ledden<sup>2</sup> and G.M. Rice<sup>1</sup><sup>1</sup>Residency in Aerospace Medicine, NAMI, Pensacola, FL;<sup>2</sup>Naval Aeromedical Institute, Navy, Pensacola, FL

**INTRODUCTION:** Hazardous reports (HAZREPs) are utilized in the U.S. Navy and Marine Corps to highlight aviation hazards before such hazards contribute to a mishap. HAZREPs are submitted whenever the potential for damage or injury exists, or if a hazard resulted in damage of less than \$20,000 with no injury. Such aviation "close calls" are a valuable source of information to help prevent future mishap accidents. **METHODS:** Physiological HAZREPs were queried from the Naval Safety Center database of mishaps. A total of 359 anonymous physiological HAZREPs from 2004-2014 were obtained from the database. HAZREPs that were classified in the database as a 'physiologic episode' were included in this study. These HAZREPs were categorized with respect to adverse physiological states and perceptual factors as described in the Human Factors Analysis and Classification Systems (HFACS). While HFACS criteria encompasses most adverse physiological events, additional categories such as vertigo were created to enhance categorization. **RESULTS:** While

final results are pending with statistical analysis, initial categorization results indicate that 62% of physiological HAZREPs from 2004-2014 were related to hypoxia, 11% were related to effects of G forces, 5% to decompression symptoms, 4% to trapped gas disorders such as sinus or otic barotrauma, 3% to spatial disorientation, and 3% to vertigo.

**DISCUSSION:** Results from this characterization may serve to assist aeromedical professionals and aviation commanders with regards to prioritizing and developing strategies to mitigate these physiologic hazards. Further characterization of individual physiologic HAZREP categories such as hypoxia and G-related HAZREPs may be helpful in defining specific risk factors that are associated with these events, with the ultimate goal of reducing these physiologic threats and potential mishaps.

**Learning Objectives:**

1. Discuss characteristics of USN and USMC aviation physiologic Hazardous Reports (HAZREPs).

**[109] "AEROSOUND" - A MORE REALISTIC SPEECH DISCRIMINATING TEST FOR AIRLINE PILOTS?**K. Uike<sup>1</sup>, H. Briner<sup>2</sup>, and D. Bron<sup>1</sup><sup>1</sup>Swiss Air Force - Institute of Aviation Medicine, Duebendorf,Switzerland; <sup>2</sup>ORL-Zentrum Klinik Hirslanden, Zurich, Switzerland

**INTRODUCTION:** Radio communication is relevant in the airline business. It often takes place with unfavourable interferences and ambient background noise. Hence, not only the sense of hearing but also speech comprehension is very important. The assessment of the pilot's fitness to fly, respective to hearing is currently based on pure tone audiometry and speech discrimination tests in quiet environment. However these tests don't reflect the realistic pilot's conditions in a cockpit. The aim of this study is to test the practicability and validity of "Aerosound", a speech discrimination test designed especially for pilots. **METHODS:** "Aerosound" is a speech discriminating test in real conditions providing a database of speech (air traffic control messages) and background sounds recorded from the cockpit. Ten most suitable sentences were selected after in-depth analysis in collaboration with an experienced airliner pilot. The cockpit noise of an Airbus A 320 was chosen as a background sound and intensity adjusted to realistic sound levels by means of an audiometer. Twenty experienced pilots with normal hearing function conducted the "Aerosound" test. They were allowed to use their own headsets. The results were subsequently compared with the pure tone and speech audiogram that had been performed previously. **RESULTS:** So far our results show a good correlation between the results of the "Aerosound"-test and those of the pure tone and speech audiogram. **DISCUSSION:** "Aerosound" is a practicable and realistic test for speech perception in noise for pilots. Further studies are needed for the implementation of the "Aerosound"-test as an official tool for aeromedical assessment of airline pilots.

**Learning Objectives:**

1. "Aerosound", a speech discrimination test designed especially for pilots, can be used as a more realistic speech discriminating test for airline pilots.

**[110] CIVIL AVIATION MEDICAL EXAMINATION RESULTS IN A UNIVERSITY HOSPITAL**Z. Dulkadir<sup>1</sup>, N. Ata<sup>2</sup>, and E. Aydin<sup>3</sup><sup>1</sup>Aerospace Medicine, Gulhane Military Medical Academy, Eskisehir, Turkey; <sup>2</sup>Aircrew's Health, Research and Training Center, Eskisehir, Turkey; <sup>3</sup>Medical Faculty, Baskent University, Ankara, Turkey

**INTRODUCTION:** In Turkey, until 2003 civil aviation medical examinations were performed by physicians not trained in the field of aviation medicine. After 2003, these examinations were performed by flight surgeons. The aim of this study was to determine the diseases identified in one of aeromedical centers (AMC) at the first 3 year period of civil aviation examinations, performed according to Joint Aviation Requirements for Flight Crew Licensing Part-3 (JAR FCL-3)

(JAR FCL-3 currently is in a transition phase to EASA Annex IV Part-MED) and International Civil Aviation Organization (ICAO) Annex 1.

**METHODS:** The study population included 361 aircrew who came to one of AMC to revalidate or obtain a new medical certificate from the beginning of 2003 to the end of 2005. Data from the medical history questionnaire and examination results was entered into a database.

**RESULTS:** In 2003, 20 aircrew were examined and 14 of them got a diagnosis, but all assessed as fit. Of the 136 aircrew examined in 2004, 78 of them got a diagnosis; 59 assessed as fit without limitation and 12 assessed as fit with a limitation. Six aircrew were assessed as unfit and one of aircrew quit the examination in 2004. In 2005, 205 aircrew were examined and 83 of them got a diagnosis; 79 assessed as fit and 4 assessed as unfit. Most commonly diagnosed disease was hyperlipidemia which was detected in 37 aircrew. **DISCUSSION:** After making aeromedical examinations according to the JAR FCL-3 rules, aeromedical examinations conform to the same standards in Turkey as with other European countries. After aeromedical examinations being held by flight surgeons in Turkey, this situation has contributed to aviation safety.

#### Learning Objectives:

1. Civil aviation medical examinations have been performed according to JAR FCL-3 rules (currently is in a transition phase to EASA Annex IV Part-MED rules) since 2003 in Turkey.

#### [111] THE DESCRIPTIVE EPIDEMIOLOGY OF NECK PAIN IN DOD AVIATORS

E.B. Rizo<sup>2</sup> and G.M. Rice<sup>1</sup>

<sup>1</sup>Residency in Aerospace Medicine, NAMI, Pensacola, FL; <sup>2</sup>NAMI, NMOTC, Pensacola, FL

**INTRODUCTION:** Within recent aeromedical literature there is an established causal relationship between neck injury and aviation duties. Most of these studies however have relied on cross sectional surveys, to assess the prevalence of neck pain in aviators, leaving the true incidence of neck disorders amongst aviators in question. Most importantly, there has yet to be an established link between specific aviation platforms and cervical disorders. The primary objective of this study was to use a recently developed comprehensive Department of Defense (DoD) medical surveillance database to determine the incidence of service related cervical disorders among aviation personnel with an emphasis on determining if a significant difference exists among aviation platforms. **METHODS:** Using the (DoD) Armed Forces Health Surveillance Center's (AFHSC) Defense Medical Surveillance System (DMSS) from 2008 to 2013, we queried ICD-9 codes related to acute cervical injury on flying status. DMSS contains over 14 million person years of health surveillance for DoD personnel. Incidence density rates (IDRs) were calculated by dividing ICD counts for cervical injury by person years of specific platforms or service. Cervical related diagnoses resulting from autoimmune, congenital or other non-mechanical injuries were excluded. **RESULTS:** Preliminary data from DMSS reveals an incidence density of cervical disorders in rotary-wing platforms for all services of 5.34 per 1000 person-years compared to 3.22 per 1000 person-years for tactical fixed-wing platforms, and 3.40 per 1000 person-years in non-tactical fixed wing platforms. **DISCUSSION:** These preliminary results suggest similar incidence of cervical disorders between tactical fixed wing and non-tactical fixed platforms, however the IDR for rotary-wing aviators is 1.66 compared to tactical fixed and 1.57 compared to non-tactical fixed wing platforms, suggesting a higher risk of cervical disorders among rotary-wing aviators. Determining true rates of service related neck disorders within aviation platforms affords the possibility of identifying which platforms are at risk for cervical injury and subsequently the ability to direct future research towards mitigating strategies.

#### Learning Objectives:

1. The incidence of neck pain in aviators is described.
2. The comparison of neck pain in aviators across platforms and services is described.

Monday, May 11

S. Hemisphere 1

4:00 P.M.

#### [XIX.] SLIDE: WORKING TIRELESSLY TO MANAGE FATIGUE

Chair: Troy Faaborg

Alexandria, VA

4:00 p.m.

#### [112] A RECONSIDERATION OF FATIGUE-RELATED DATA FROM EARLIER RESEARCH

M. Corbett

RAAF Institute of Aviation Medicine, Walkerville, SA, Australia

**INTRODUCTION:** Periodically it is invaluable to re-investigate the data from earlier studies, with a view to applying more contemporary perspectives. This presentation will deal with the fatigue-related findings from a study into crew performance of aircrew working very long duty periods. **METHODS:** Multiple physiological and psychological performance data metrics were utilized on crew patterns comprising a pattern of three flying-duty days, with suitable rest periods between. Data was additionally collected for three days either side of the pattern. The data collection tools included actigraphy, PVT, Samn-Perelli scale, work-rest diary, and a neurocognitive test battery. **RESULTS:** Nine aircrew participated, with most subjects involved in multiple data collection patterns. Although the data set was small, it accurately represented the population of aircrew on that aircraft type at that time. Data was analyzed after making allowance for multiple data points from single participants, circadian-time, and local-time effects. **DISCUSSION:** Data analysis revealed that participants over-reported sleep by approximately 15%. This is noteworthy when considering whether an aviator obtained sufficient sleep during the scheduled rest period. It was revealed that the fatigue state of aircrew immediately prior to deployment was higher than had previously been expected. This is an important issue for military and potentially civilian operations, when considering where to apportion resources to reduce fatigue-related risk. However, not all of the data had negative connotations; with an improvement in PVT performance noted at the end of very long crew duty periods. This performance rallying effect should not be relied upon as a mitigator for the fatigue resulting from long crew duty periods. Further research into these areas may be warranted.

#### Learning Objectives:

1. To identify fatigue-related threats to operational safety.

4:15 p.m.

#### [113] FATIGUE MANAGEMENT IN NAVAL AVIATION: REVISION OF THE NAVAL AVIATION FATIGUE MANAGEMENT PROGRAM; A GUIDE FOR FLIGHT SURGEONS

R.J. Krause

<sup>1</sup>Naval Aerospace Medical Institute, U.S. Navy, Pensacola, FL; <sup>2</sup>School of Aviation Medicine, U.S. Army, Pensacola, FL

**INTRODUCTION:** Over 15 years ago a guide was developed to assist Navy Flight Surgeons in the management of fatigue in Naval Aviators. It included both fatigue management techniques as well as the use of pharmacological countermeasures during periods of continuous and sustained operations. Since the initial publishing in January of 2000, newer medications to counter fatigue and help sleep have become available with studies to support more favorable efficacy and safety profiles. This revision will update the current understanding of combating fatigue, the acceptance of new medications, and will establish more specific guidelines for usage, documentation, and reporting requirements. The program will also address areas outside of continuous and sustained operations to include operations across the spectrum of air warfare that were not previously envisioned during the initial roll out of the program.



**DISCUSSION:** The Naval Aviation Fatigue Management Program has gone through a complete revision and has formally incorporated new medications, analysis of best practices from the fleet, as well as expert opinion on fatigue. The program will have the ability to evolve as best practices change and input is provided from the fleet. Better documentation and standardization of the pharmacological countermeasures will ultimately provide more reliable and actionable data as to the efficiency of the program as well as identify inappropriate use.

#### Learning Objectives:

1. To understand and be able to incorporate the fundamental changes of the Naval Aviation Fatigue Management Program.

4:30 p.m.

#### [114] AIR FORCE GLOBAL STRIKE COMMAND (AFGSC) CONTINUOUS HELICOPTER OPERATIONS (CHO): A RETROSPECTIVE FATIGUE STUDY

J.R. Harvey

*U.S. Air Force Chief of Safety, Headquarters U.S. Air Force, Pentagon, Washington, DC*

**INTRODUCTION:** The Continuous Helicopter Operations (CHO) mission which operated from February 2012 and ended recently in August 2014, was a new concept for the UH-1N missile-security aircraft located at three missile wings throughout the command (Malmstrom AFB, FE Warren AFB and Minot AFB). This study attempted to identify and quantify aircrew fatigue issues during a two-week time period within 24/7 CHO in AFGSC. **METHODS:** Investigators had aircrew fill out 2-week sleep logs that documented their wake, sleep and work intervals. Data was inputted into FAST (Fatigue Avoidance Scheduling Tool) which generated effective performance levels. Individual sortie Risk Management (RM) worksheets were collected and matched with aircrew sorties flown during the 2-week period. The objective and subjective RM scores were collected and matched with average effectiveness from FAST output during the time of each sortie.

**RESULTS:** To determine if there was a correlation between RM worksheets and FAST output effectiveness and performance metrics, each RM fatigue score was collected from the eight aircrew members and combined into one data set along with their corresponding average FAST effectiveness scores for each sortie. The correlation coefficient, which is an indicator of a relationship between variables, was calculated using *Total Fatigue Factors* and the *Subjective Fatigue*, and was measured against *FAST effectiveness* to determine a relationship, if any. **DISCUSSION:** Helicopter Risk Management worksheets and the FAST program are two effective tools to assess fatigue in flying operations. Both give appropriate assessments of aircrew fatigue and can be utilized in different ways to mitigate risk, however historical methods by AFGSC (and the reporting 20 AF) to use pooled squadron data to assess the fatigue risk level of an entire squadron negates a primary principal in aviation safety: identifying the most at risk individual at the lowest point in their performance.

#### Learning Objectives:

1. Understand FAST output in the form of performance metrics and how it relates to aircrew performance on a given sortie.
2. Understand how fatigue and human factors are reported to commanders in an AF flying squadron and the purpose of fatigue analysis in aircrew members.

4:45 p.m.

#### [115] CHARACTERIZE THE PRESENCE OF FATIGUE IN A COLOMBIAN AIRLINE BETWEEN JULY AND SEPTEMBER 2013

J.F. Vasquez<sup>1</sup> and F. Escobar-Córdoba<sup>2</sup>

<sup>1</sup>Independent, Surquillo, Peru; <sup>2</sup>School of Medicine, Universidad Nacional de Colombia, Bogota DC, Colombia

**INTRODUCTION:** Fatigue is one of the most important concerns in flight safety because of its link with incidents and accidents. The aim of this research was characterize the presence of fatigue in a

group of Colombian airline pilots. **METHODS:** The group consisted of 12 pilots of fixed-wing aircraft. They completed the Epworth Somnolence Scale (ESS) and their personal information once, and 5 times (different days) the Samn-Perelli Fatigue Scale (SPS) in three points of their duty day (get in to the cockpit, top descent and turn off engine). Data analysis was conducted using SPSS Statistical Package V.20

**RESULTS:** 67% of them reported no somnolence and the other 33% had slight daytime somnolence. Furthermore, the fatigue was increased with the number of flight sectors ( $r=0.896$ ,  $p<0.01$ ,  $CI=95\%$ ) and flight time ( $r=0.69$ ,  $p<0.01$ ,  $CI=95\%$ ), with tendency in Windows of Circadian Low. No relationship with duty time ( $r=0.233$ ,  $p=0.073$ ,  $CI=95\%$ ) or time awake ( $r=0.198$ ,  $p=0.129$ ,  $CI=95\%$ ). The multivariate analysis found the relationship between flight sectors, duty time and flight time with fatigue previous last top descend.

**DISCUSSION:** Fatigue is multidimensional and has several factors to consider, being relevant to the operational but not the only responsible; there are other contributing factors like individuals, medicals and environmental. Additionally, the difficult measurement in objective form. At the moment, the best way to control it is applying the countermeasures that recommend the Fatigue Risk Management System in conscious and right form.

#### Learning Objectives:

1. Emphasize that human factor issues are the main threat to flight safety and fatigue is the controllable primary component if the crew and airline work together.

5:00 p.m.

#### [116] MODELING WORK EFFECTIVENESS OF FIREFIGHTERS WITH VARYING SHIFT SCHEDULES

S. Williams and V. McDonough

*Physiology, USAF, APO, AE*

**INTRODUCTION:** The subjective nature of fatigue can make it difficult for researchers and/or investigators to delineate what impact it has on performance. To combat this issue, researchers such as Härmä (1995) and Van Dongen (2009) have introduced an emphasis on the endogenous neurobiology underlying sleep/wake regulation and the 24-h circadian rhythm. As expected, Van Dongen (2009) noted that individuals cannot be relied upon to accurately self-assess their own propensity for performance impairment due to sleep loss.

**METHODS:** One approach to mitigating these effects is utilizing a Fatigue Risk Management System. This would provide a perspective on how performance is affected by the various schedules, time awake, and quality of sleep. For the purposes of this study, the Fatigue Avoidance Scheduling Tool (Hursh et al., 2004) was selected. For 14 days, a total of 34 firefighters were given a Likert-based anonymous sleep survey. They were asked to document their perceived quality of sleep as well as hours worked, any abnormalities with sleep, naps taken, and circadian rhythm synchrony. **RESULTS:** The data depicted an exponential decrease in effectiveness as the work week progressed. The benefit of strategic naps was reinforced by one of the 24-h teams, where half of the team consistently utilized them. It was revealed that most members had a circadian rhythm synchrony. Members were also working extended hours on a regular basis, which in turn impacted their homeostatic balance. Finally, this analysis gave leadership their first opportunity to see a subjective topic (fatigue) in an objective fashion. **DISCUSSION:** "In safety-sensitive operations, reliable identification of workers who are most at risk of errors and accidents due to sleep loss would allow targeted application of fatigue countermeasures or removal of these individuals from harm's way" (Van Dongen & Belenky, 2009). Identification of individuals at most risk, for fatigue based errors, is still subjective in nature and requires both a qualitative and quantitative approach to identifying appropriate fatigue countermeasures for certain military career fields.

#### Learning Objectives:

1. Understanding the basic mechanisms for sleep/wake regulation and the 24-h circadian rhythm.

5:15 p.m.

**[117] EFFECT OF ADMINISTRATION OF MODAFINIL DURING EXTENDED WAKEFULNESS ON SUBSEQUENT SLEEP QUALITY, SLEEPINESS AND FATIGUE**H. Singh<sup>2</sup>, K. Tripathi<sup>1</sup>, N.K. Tripathy<sup>1</sup>, and S. Chowdhary<sup>1</sup><sup>1</sup>Institute of Aerospace Medicine, Bangalore, India, Bangalore, India;<sup>2</sup>Indian Navy, Port Blair, India

**INTRODUCTION:** Modafinil, a analeptic is under investigation for its value in mitigating effects of sleep & fatigue. Its effects on subsequent quality of sleep and restorative value have not been explored adequately. The present study examined if administration of Modafinil during extended wakefulness (EW) of 24-32 hours significantly modulates the quality & restorative value of subsequent induced sleep (IS). **METHODS:** In a placebo controlled, double blind, mixed design, sleep was induced with Zolpidem (10 mg)/ Placebo after an EW for 24 to 32 hours. Two doses of Modafinil (200 mg)/ Placebo were administered at 17th and 24th hour of EW. Subjects were woken up 6 hours after administration of Zolpidem and were evaluated for quality of the IS (Groningen Sleep Quality Scale), Sleepiness (Stanford Sleepiness Scale) and Fatigue (Chalder Fatigue Questionnaire) after a given task. These indices were compared amongst the four groups viz, 'M-Z' (Modafinil during EW, Zolpidem before IS), 'M-P' (Modafinil during EW, Placebo before IS), 'P-P' (Placebo during EW and before IS) and 'P-Z' (Placebo during EW, Zolpidem before IS) and also with base line values. Heart rate, Oral Temperature and Mean Arterial Pressure (MAP) were also measured in this timeframe. **RESULTS:** In the groups M-P and M-Z, MAP after induced sleep was significantly higher than baseline. In all the groups except P-P, quality of induced sleep was significantly inferior to that in the night prior to the study. Sleepiness and Fatigue scores after induced sleep were significantly higher than their base line values in all the groups except P-P. **DISCUSSION:** Increase in MAP induced by Modafinil, persists for an appreciable time. The quality of induced sleep after a period of extended wakefulness and administration of a total of 400 mg of Modafinil was significantly inferior to that in the night prior to the commencement of the study. It was also less refreshing and restorative; participants were more sleepy and fatigued after they were woken up after induced sleep compared to when they woke up on their own after a restful sleep in the night prior to the study. The detrimental effects of Modafinil on, both, quality and restorative value of sleep were not attenuated with the pharmacological assistance of Zolpidem.

**Learning Objectives:**

1. Quality of induced sleep after a period of extended wakefulness and administration of a total of 400 mg of Modafinil was significantly inferior.
2. The detrimental effects of Modafinil on quality and restorative value of sleep were not attenuated with the pharmacological assistance of Zolpidem.

Monday, May 11

S. Hemisphere 2

4:00 P.M.

**[XX.] SLIDE: DEPLOYMENTS TO EXTREME ENVIRONMENTS**

Chair: Philippe Souvestre

Vancouver, British Columbia, Canada

4:00 p.m.

**[118] ASSESSMENT OF DEPLOYMENT-RELATED EXPOSURES ON RISK OF INCIDENT MENTAL HEALTH DIAGNOSES AMONG AIR FORCE CRITICAL CARE PROVIDERS: NESTED CASE-CONTROL STUDY**A.P. Tvaryanas<sup>1</sup>, G. Maupin<sup>3</sup>, and B. Fouts<sup>2</sup><sup>1</sup>HP, 711th Human Performance Wing, Wright-Patterson AFB, OH;<sup>2</sup>Aeromedical Research Department, Wright-Patterson AFB, OH;<sup>3</sup>USAFSAM - FHC, 711th Human Performance Wing, Wright-Patterson AFB, OH

**INTRODUCTION:** The purpose of this study was to determine the risk of having deployment-related exposure risk factors for incident post-deployment mental health (PDMH) conditions in a defined population of military healthcare professionals working in the deployed critical care environment. **METHODS:** A nested case-control study compared cohort members with a PDMH condition (cases,  $N = 146$ ) with those without a PDMH condition (controls,  $N = 800$ ) in terms of deployment-related exposures as ascertained using Post-Deployment Health Assessment DD 2796 questionnaire data. Multivariate logistic regression models were used to compute odds ratios. **RESULTS:** Non-physician career fields (i.e., nurses and medical technicians), exposure to dead bodies or people killed/wounded, history of a vehicular accident/crash, exposure to sand/dust, exposure to lasers, and use of mission-oriented protective posture (MOPP) overgarments were associated with increased likelihood for a PDMH condition. The infrequent exposures (i.e., vehicular accident/crash, lasers, and MOPP overgarments) were the exposures most strongly associated with subsequent PDMH conditions. **DISCUSSION:** For military healthcare providers returning from the deployed environment, several exposures are useful for predicting those at increased risk for a PDMH condition. However, there are likely many other important risk factors beyond those captured on the DD 2796 questionnaire.

**Learning Objectives:**

1. Non-physician career fields exposure to deployment related risk factors for a PDMH condition.
2. It is unknown if a larger  $n$  for laser, vehicular accident/crash, and use of MOPP overgarments (Laser  $n=28$ ; VA  $n=7$ ; MOPP  $n=6$ ) would result in similar associations.

4:00 p.m.

**[119] AEROSPACE TELEMEDICINE & TELECARDIOLOGY - GETTING UNITED STATES AIR FORCE AIRCREW BACK TO FLYING FASTER**E.D. Davenport<sup>1</sup>, E. Palileo<sup>1</sup>, A. Eppolito<sup>2</sup>, and R.A. Varian<sup>2</sup><sup>1</sup>Aeromedical Consultation Service, U.S. Air Force School ofAerospace Medicine, Wright Patterson AFB, OH; <sup>2</sup>Defense Health Headquarters, Washington, DC

**INTRODUCTION:** Quick, accurate, and evidence based disposition of aircrew is essential for an aviator's health and safety of flight. The United States Air Force (USAF) digitized all cardiac studies done on USAF aircrew since 1957. This allowed for world-wide electronic submission of cardiac studies in original raw digital data format for review, disposition, and research capabilities. **METHODS:** Development of a fully digital electronic cardiac imaging library was validated by the USAF Surgeon General Requirements for Operational Capabilities. Digitization of all cardiac studies to include ECG, holter/ event monitor, echocardiogram, coronary angiogram, nuclear stress, CT, and MRI data was done and all new studies were then accepted electronically. Expert cardiovascular and aerospace consultation and disposition time and efficiency rates were analyzed. **RESULTS:** From July 2009 to the present; a fully integrated digital cardiology database was installed and tested. Information Technology (IT) and security testing was performed and multiple databases have been joined into the world's largest single aviator cardiac digital library containing over 1.2 million studies on over 280,000 aviators. Aircrew cardiac disposition time has decreased from 2 weeks average to 4 hours and commonly done "real-time." **DISCUSSION:** Digital storage with long term archival of medical data and electronic submission is of great importance in the aerospace medicine community. Quick and accurate expert consultation to and from aerospace medicine experts will result in higher quality and more efficient delivery of medical care. This will lead to increased mission completion in the military and can also be used in the civilian section for increased cost savings, pilot satisfaction, and flight safety for all aviators.

**Learning Objectives:**

1. Provide an overview of the U.S. Air Force ECG Library and development of the World's largest all digital aviator cardiac database and how this can be adopted for all of Aerospace Medicine.
2. Discuss the impact of digital study submission and telecardiology capability on mission completion and expedited return to flying, long term storage, and research potential.
3. Discuss possible ways aerospace telemedicine and teleconsultation can lead to increased cost savings, pilot satisfaction, and flight safety for all aviators.

**4:00 p.m.****[120] ACETAZOLAMIDE AND ACUTE MOUNTAIN SICKNESS AT THE SOUTH POLE**M. Harrison<sup>1</sup> and B. Johnson<sup>2</sup><sup>1</sup>Emergency Medicine, Henry Ford Hospital, Detroit, MI; <sup>2</sup>Mayo Clinic, Rochester, MN

**INTRODUCTION:** Altitude exposure is associated with the development of acute mountain sickness (AMS). Acetazolamide (ATZ), a carbonic anhydrase inhibitor, remains the only approved pharmaceutical prophylaxis. The literature suggests without definitive evidence that ATZ's ability to prevent AMS is due to diuresis and increased alveolar ventilation in response to metabolic acidosis. **METHODS:** To identify physiological variables related to the ATZ's mechanism of AMS prevention, 226 healthy adults traveled by airplane from sea level (SL) to the South Pole (ALT), ~3200m. Participants provided Lake Louise Symptom Scores (LLSS) on a daily basis for 1 week. Pulmonary function tests, blood samples, and urine samples were collected at SL and at ALT. ATZ was available to any participant desiring prophylaxis. Comparisons were made between the ATZ/AMS (n=42), ATZ/No AMS (n=49), No ATZ/AMS (n=56), and the No ATZ/No AMS (n=79) groups. Statistical analysis included Chi-squared and one-way ANOVA with Bonferroni post-hoc tests. Significance was p<0.05. **RESULTS:** No significant differences were found in rate of AMS development between ATZ and No ATZ groups for sex, age, or altitude of residence. ATZ/AMS reported the greatest LLSS and had greater BMI, red cell distribution width, and total-cholesterol-to-HDL ratio while having the lowest serum HDL concentration. No ATZ/No AMS had the greatest red blood cell concentration and ATZ/No AMS had the highest oxygen saturation (O<sub>2</sub>Sat) at ALT. No significant differences were found in serum electrolyte concentrations or PFT results. **DISCUSSION:** ATZ/No AMS maintained the greatest O<sub>2</sub>Sat at ALT while ATZ/AMS results suggested a lower level of baseline health as compared to the other groups. One of ATZ's proposed mechanisms of action involves increased ventilatory response and arterial oxygen saturation in response to metabolic acidosis; our results support this proposal. Our results also suggest that ATZ during rapid ascent does not protect individuals against more severe AMS based on LLSS.

**Learning Objectives:**

1. Acetazolamide may not prevent the more severe cases of AMS after rapid transport to altitude.
2. More research should be conducted to determine the specific mechanism by which acetazolamide prevents AMS.

**4:00 p.m.****[121] INHALATION OF HYDROGEN GAS PROTECT RADIATION SKIN INJURY IN RATS**M. Fujita<sup>1,2</sup>, S. Watanabe<sup>3</sup>, M. Ishihara<sup>4</sup>, S. Tachibana<sup>2</sup>, K. Takada<sup>2</sup>, Y. Yamamoto<sup>2</sup>, T. Kaji<sup>3</sup>, T. Kawauchi<sup>3</sup>, and Y. Kanatani<sup>5</sup>

<sup>1</sup>Second Division, Aeromedical Laboratory, Japan, Tachikawa, Japan; <sup>2</sup>Division of Environmental Medicine, National Defense Medical College Research Institute, Tokorozawa, Japan; <sup>3</sup>Department of Radiology, National Defense Medical College, Tokorozawa, Japan; <sup>4</sup>Division of Biomedical Engineering, National Defense Medical College Research Institute, Tokorozawa, Japan; <sup>5</sup>Department of Health Crisis Management, National Institute of Public Health, Wako, Japan

**INTRODUCTION:** Radiation-induced injury is one of major topics in the field of clinical medicine or aerospace medicine. Due to the major role of the reactive oxygen species (ROS) in the injury, hydrogen was anticipated therapy or prophylaxis. Recently, it has been demonstrated that molecular hydrogen (H<sub>2</sub>) can selectively reduce cytotoxic ROS. We tried to examine the efficacy of inhalation of hydrogen-containing gas (hydrogen (1.3%) + oxygen (20.8%) + nitrogen (77.9%)) (HCG) using the radiation-induced healing-impaired skin injury. **METHODS:** The effect of inhalation of HCG on radiation-induced dermatitis and healing of healing-impaired skin wounds was examined using Male Sprague-Dawley rats weighing about 350 g (10 weeks old). An X-ray dose of 20 Gy was irradiated onto the lower part of the back. Irradiation was performed before or after inhalation of HCG for 2 h. **RESULTS:** HCG inhalation before irradiation reduced the severity of radiodermatitis, accelerated healing-impaired wound repair, and apoptotic keratinocytes. Therefore, radiation-induced skin injury can potentially be alleviated by the pre-inhalation of HCG. **DISCUSSION:** The inhalation of HCG may be easier and safer pre-treatments to prevent the radiodermatitis. The pre-inhalation of HCG may provide a new clinical therapy in the treatment of radiodermatitis and oxidative damage caused by radiation treatment. Also, inhalation of HCG may be an expected prophylaxis for radiation injury from the aspect of aerospace medicine.

**Learning Objectives:**

1. The effect of Inhalation of HCG for rat radiation injury is described.
2. HCG may be expected prophylaxis for radiation injury from the aspect of aerospace medicine.
3. HCG may be very useful for every kind of ROS related injury.

**Monday, May 11****4:00 P.M.****S. Hemisphere 3****[XXI.] PANEL: JUNIOR FLIGHT SURGEON GRAND ROUNDS: CHALLENGING ASSUMPTIONS WITH MEDICAL WINGMEN***Sponsored by the Society of United States Air Force Flight Surgeons***Co-Chair: Colby Uptegraft***Keesler AFB, MS***Co-Chair: Kourtnei Starkey***Offutt AFB, NE***Co-Chair: Paul Nelson***Biloxi, MS*

**PANEL OVERVIEW:** Junior Flight Surgeons often lack significant prior outpatient or primary care medical training. They frequently arrive at their initial assignment after a short aerospace medicine training course expected to immediately provide primary care and aeromedical dispositions to an aviation or operational population. Frequently with only a cursory introduction and always expected to excel, they may work functionally in a solo-practice setting without senior or accessible peer mentors. This situation contrasts sharply with the military aviation culture where even experienced senior aviators are expected to go thru local area orientation with an instructor pilot prior to flying solo at a new base or being qualified as fully mission ready. To fully realize the vision of HPCONOPS as articulated by the Air Force Surgeon General, senior practitioners of Aerospace Medicine should thoughtfully consider how they enculturate and mentor those who will take their place, sharing a passion of both art, science, and a spirit of innovation. As modeled by the pioneers of our profession, we should learn from those who came before us, as well as from the aviation community we support. This panel, sponsored by the Society of United States Air Force Flight Surgeons, will present a series of common aeromedical problems in a Grand-Rounds format. It will emphasize the application of the best evidence-based clinical medicine applied to our population of aviators and special duty



personnel. The presenters, junior Flight Surgeons, have been paired with senior Flight Surgeons who have volunteered to be "instructor pilots", illustrating the importance of peer-to-peer mentoring. They will purposely challenge assumptions and ingrained culture as they prepare our young medical wingmen to always "Medicate, Navigate, and Communicate" in order to best serve those who fly. The panel will conclude with a presentation on how we can develop a true learning environment for those practitioners who will ultimately move our profession of Aerospace Medicine forward.

## **[122] COMMON COLD, EASY SOLUTIONS: HOW TO DECREASE MORBIDITY AND INCREASE MISSION READINESS IN AVIATORS AND SPECIAL DUTY PERSONNEL**

C.C. Uptegraft and D. Ritter  
81 MDG, USAF, Keesler AFB, MS

**INTRODUCTION:** The "common cold" is universal across medical practice settings including the Flight Surgeon's office. "Common colds" or upper respiratory infections (URIs) account for 20-million office visits per year in the civilian population in the United States, and according to a 1990 article in *Aviation, Space, and Environmental Medicine*, URIs are the leading cause of illness within the flying community with a median downtime of six days. Grounding flyers or special duty personnel for six days during training or high operational settings can severely impair an individual's training progress or overall mission performance. Evidence-based strategies exist for the appropriate management of this condition as it occurs in the general population, but few studies evaluate URI management and treatment in the aviation population. The demographics and healthcare needs of special duty and aviator populations are obviously different than those of civilian patients; however, symptomatic management for URIs remains the mainstay across all arenas. Cochrane systematic reviews suggest certain dietary and vitamin supplements may benefit civilian subpopulations when used prophylactically and/or therapeutically. Because special duty personnel and aviators mirror these subpopulations, prophylaxis and more aggressive treatment of these personnel should be considered during elevated operational tempos and training to maximize mission readiness and minimize training delays. This Ground Rounds presentation will discuss a URI case and review the relevant evidenced-based medical and aeromedical literature. It will then challenge treatment assumptions in the flying population, suggest different therapeutic and preventive strategies, and propose areas of future research to reduce the mission and individual impact of this common condition on the aviation and special duty community.

### **Learning Objectives:**

1. To present URI-relevant clinical literature and relate the applicable findings to the flying and special duty community.
2. To challenge current URI treatment assumptions and suggest future avenues of research that may reduce mission and individual morbidity.

## **[123] METABOLIC SYNDROME--A GROWING PROBLEM IN THE POPULATION AND AVIATORS ALIKE: PREVENTION, TREATMENT, AND AEROMEDICAL APPLICATION**

C. Starkey<sup>1</sup> and D. Ritter<sup>2</sup>

<sup>1</sup>45 RS, USAF, Offutt AFB, NE; <sup>2</sup>81 MDG, USAF, Keesler AFB, MS

**INTRODUCTION:** Obesity and concomitant metabolic syndrome (hypertension, insulin resistance, central obesity, dyslipidemia) are growing problems in the American population. Military aviators, as a subset of this population, are also susceptible to this syndrome and its comorbidities. In fact the high operational tempo experienced by the military aviation community may make healthy living habits more difficult for them than for the general population. Thus, they are clearly susceptible to obesity, metabolic syndrome, and their many complications. These effects are often insidious. If unrecognized they place the aviator at increased risk for human performance failures under the stressors of flight. While there is a large body of research regarding metabolic syndrome within the civilian population, minimal research exists on its aeromedical implications. As aerospace medicine specialists, our primary responsibility is to provide top quality medical care. We must

be able to recognize how are our population is the same and yet different from the general population. Using a case-presentation format, this presentation will discuss the available data on obesity among USAF aviators and how current standard-of-care recommendations for identifying and managing obesity and metabolic syndrome may be appropriately applied to a military aviation population. Finally, we will identify areas where additional research is needed in order to optimize care for our patients.

### **Learning Objectives:**

1. To present clinical literature relevant to the treatment of metabolic syndrome and relate these findings to the flying community.
2. To suggest future research directions on metabolic syndrome that may reduce mission and individual morbidity.

## **[124] TALES FROM THE ANNUAL FLIGHT PHYSICAL: THE SUPER DRINK OFF & THE 10% TRUTH: HOW DOES A JUNIOR FLIGHT SURGEON HANDLE IT?**

C. Brown<sup>1</sup> and R.R. Ireland<sup>2</sup>

<sup>1</sup>14 MDOS, USAF, Columbus AFB, MS; <sup>2</sup>USAF, Claremont, CA

**INTRODUCTION:** So there I was...standard flight doc encounter with one of the fighter guys. "So I see that you have an adult beverage once a month..." "Well doc, sometimes I have a few...but only on the weekends... and roll call, football games and such." Later that evening at roll call...a "super drink off" ensues at the bar, and sure enough it is your guy who only drinks once a month. The rest of the evening is a blur for the majority of the squadron, filled with standard shenanigans, vomiting into potted plants, and thankfully many designated drivers. Everyone gets home safe and nobody goes to the Emergency Room. Your squadron commander hopes that no one employed a digital camera to document the escapades. What does the junior Flight Surgeon do with limited experience in this situation? Who is ultimately responsible for what happens next? Alcohol is the most widely abused substance in the world with historical significance in the world surrounding military aviation. Steeped in tradition and celebration, alcohol is typically part of every promotion, roll call, retirement, upgrade, new aviator's gift to the squadron, or when the beer light comes on. How does a junior Flight Surgeon handle the situation as mentioned above when he or she encounters it at the flight physical or the Monday following roll call? This Grand Rounds discussion will tackle the interpretation of how much an aviator drinks while understanding the context of their alcohol use and the culture they represent. Additionally, it will discuss approaches to maintain both medical honesty and integrity while maintaining your own credibility within the squadron while making aeromedical recommendations, referrals, and line commander notifications.

### **Learning Objectives:**

1. To learn how to navigate the culture of EtOH use in USAF aviators.
2. To determine when to call the "knock it off" and engage with the aviator with regard to their EtOH intake, aeromedical determination, enlistment of Mental Health, and line notification.

## **[125] A CASE STUDY OF AN AVIATOR WITH ULCERATIVE COLITIS: ART AND SCIENCE WHILE PRACTICING GOOD MEDICINE**

C. Prakash<sup>2</sup> and C.P. Mueller<sup>1</sup>

<sup>1</sup>AFMC, USAF, Wright-Patterson AFB, OH; <sup>2</sup>49 TES, USAF, Barksdale AFB, LA

**INTRODUCTION:** Junior Flight Surgeons are often confronted with medical cases whose complex aeromedical and operational dispositions do not fit cleanly or expeditiously into the current service specific regulations or waiver guides. These cases can be frustrating for both the aviator and Flight Surgeon but are often where the Flight Surgeon gains his reputation in both the medical and aviation communities that he serves. Along the way, junior Flight Surgeons encounter significant ethical pitfalls as they serve concurrently as an advocate for an individual patient and his or her desires, as well as a company physician charged with ensuring a safe aviation environment.

The Flight Surgeon is charged with practicing good standard-of-care medicine first, using the best evidence-based medicine and consultation with appropriate clinical specialists where applicable. He must then apply the known science with the art of aviation medicine to both maximize potential for successful mission completion and minimize the potential risk of disease and treatment on aviation safety. In more complex cases, successful navigation of the bureaucratic safety system in place often becomes far more challenging than the actual medical recommendations, as does management of expectations of both the individual aviator and the supported flying unit. This Grand Rounds presentation will discuss a case of an aviator with ulcerative colitis who is now considering initiation of medications currently not approved by service-specific waiver authorities. The author will analyze the implications of current policy and aeromedical guidance on this aviator's continued military service and approaches that may be taken to consider a safe return to flying status either in restricted or unrestricted ways. The organizational influences of this decision will be discussed. Finally, the author will describe the impact of these decision points on the individual aviator and his relationship with the treating Flight Surgeon as the face of the aeromedical community and discuss some of the inherent practical and ethical dilemmas.

#### Learning Objectives:

1. To demonstrate the use of the waiver guide, regulations, evidence based medicine, expert opinion, and other resources to guide an aeromedical disposition.
2. To discuss the practical dilemmas common throughout the aeromedical decision making waiver process from the perspective of the junior Flight Surgeon.
3. To understand that for good aviation medicine to advance we must challenge assumptions to fully realize the vision of HPCONOPS.

#### [126] CHANGE MANAGEMENT: THE CRITICAL ROLE OF EDUCATION

L. Steinkraus

*Mayo Clinic, Rochester, MN*

**INTRODUCTION:** During the Base Operational Medical Cell (BOMC) testbed re-engineering process it became apparent that team members at several levels were not adequately prepared to constructively engage in necessary change steps. Successful innovation is usually linked to what is referred to as a "learning culture." This culture or mindset cannot be imposed but must be developed and practiced at all organizational levels. Training, or instilling defined behaviors and thought patterns, may be part of a change process but does not usually support innovation. The ideal learning model, however, not only allows for training but for individual growth and capability with respect to identifying needed change and effectively driving necessary action. Most true learning organizations have embedded educational and behavioral structures that encourage and reward personal and small group participation in identifying gaps/pain points/errors followed by local solution development. This panel will discuss what is likely the most important element in ensuring successful change - the educated airman **METHODS:** The panel members will review principles of a learning organization, lessons learned during the BOMC re-engineering process, and suggested way-ahead for future change efforts relative to the AF Surgeon General's Human Performance (HP) thrust areas. **RESULTS:** Current flight surgeon, aeromedical technician, and medical support staff understanding of required change principles and application approaches was not optimal during the BOMC effort. This resulted in delays in implementing needed changes, missed targets, and dissatisfaction for all involved teams.

**DISCUSSION:** People remain the most important element in any re-engineering effort. Successful innovation requires that organizations develop and foster true learning cultures. The key to future effective HP innovation is airmen who not only understand how to do their jobs, but understand how to recognize the need for developing and testing new approaches when needed.

#### Learning Objectives:

1. Understand the importance of a true learning culture for effective innovation.

**Monday, May 11**

**S. Hemisphere 4**

**4:00 P.M.**

#### [XXII.] SLIDE: AVIATION MISHAPS: PAST AND PRODROME

**Co-Chair: Douglas Boyd**

*Houston, TX*

**Co-Chair: Peter Mapes**

*Rockville, MD*

**4:00 p.m.**

#### [127] OCCUPANT INJURY AND FATALITY IN GENERAL AVIATION AIRCRAFT FOR WHICH DYNAMIC CRASH TESTING IS CERTIFICATION-MANDATED

D. Boyd

*University of Texas, Houston, TX*

**INTRODUCTION:** Towards improving general aviation aircraft crashworthiness, multi-axis dynamic tests have been required for aircraft certification (14CFR23.562) since 1985. The objective herein was to determine if occupants in aircraft certified to these higher standards show mitigated fatality rate and/or injury severity. **METHODS:** The NTSB database was queried for accidents occurring between 2002 and 2012 involving aircraft certified to, or immune from, dynamic crash testing. Statistical analysis employed Fishers Exact test and logistic regression. **RESULTS:** A NTSB database query identified 85 and 84 accidents in aircraft subject to, or exempt from, dynamic crash testing respectively over the 2002-2012 period. Off-airport landings carry high decelerative forces; however for such landings, the fraction of fatal accidents for aircraft subject to, or exempt from, dynamic crash testing was 0.53 and 0.55 respectively-this difference was not statistically significant. Improved crashworthiness standards would be expected to translate into a reduced accident injury severity. For survivable accidents, the fraction of no, minor and serious injuries was reduced for occupants in aircraft certified to the higher standards although these differences were not statistically significant ( $p=0.71, 0.10, 0.10$  respectively). Surprisingly, a higher fatality rate ( $p<0.002$ ) was evident for occupants in aircraft subject to dynamic crash tests. To shed light on the latter unexpected finding, flight history, airman demographics and post-impact fires were examined. For the aircraft subject to the higher standard, the median distance of the accident flight was nearly three times higher. Logistic regression indicated an odds ratio of 2.2 (95% CI 1.1, 4.3) for fatality for flights over 150 nm. Aircraft subject to dynamic crash testing were also involved in a greater fraction (0.25 versus 0.12 respectively) of post-impact fires. **DISCUSSION:** While the more stringent crashworthiness standards have translated into a modest mitigation in injury severity, surprisingly an elevated fatal accident rate is associated with these aircraft. A higher fatality rate may reflect partly (a) fatigue associated with longer flight distances and (b) a greater fraction of post-impact fires.

#### Learning Objectives:

1. Accidents involving aircraft for which dynamic crash testing is mandatory show a non-statistical reduction in accident severity.
2. A higher fatality rate is evident for aircraft certified to the higher crashworthiness standards.
3. Fatigue associated with longer flight duration and an increased chance of post-impact fire likely contribute to the elevated fatality rate for occupants of aircraft certified to the higher crashworthiness standards.

**4:15 p.m.**

#### [128] HEAD KINEMATIC RESPONSE TO COMBINED LOADING IN UNHELMETED MALE VOLUNTEERS

G. Paskoff<sup>1</sup>, B.S. Shender<sup>1</sup>, K.L. Miller<sup>1</sup>, K. Chiu<sup>1</sup>, V.C. Chancey<sup>2</sup>, and D.B. Dorman<sup>2</sup>

<sup>1</sup>Human Systems, NAVAIR, Patuxent River, MD; <sup>2</sup>USAARL, Fort Rucker, AL

**INTRODUCTION:** Development of advanced ejection and crashworthy seating systems, restraints and neck injury mitigation technologies require understanding the kinematics of head motion during aircraft emergencies. Such motion depends on the initial posture, aircrew anthropometry as well as the loading imposed on the body.

**METHODS:** Two datasets from studies conducted at the former Naval Biodynamics Laboratory were analyzed. Seventeen male subjects were exposed to combined vertical (+Gz) and horizontal (-Gx) high onset crash pulse loading ranging from +3 to 8G in 1G increments. The initial position of ten subjects was 10° (p10) and seven at 30° (p30) pitched forward. Volunteers were fitted with custom restraints to minimize torso movement. Sensors attached to mounts at the mouth (bite bar) and base of neck (T1) provided linear and rotational head and neck responses. Data analysis of peak head angular velocity (AV) and head angular displacement (AD) included ANOVA with Tukey-Kramer post hoc tests performed using G-level, posture, sitting height (SH), body weight (WT), head circumference (HC), and neck circumference (NC) as factors ( $p \leq 0.05$ ). For the analyses, subject data were divided into three groups for each of the four anthropometric factors. **RESULTS:** In all cases, since the effect of G was overwhelmingly greater than the other factors, separate analyses were conducted at each G level. AD response was significantly affected by posture at all G levels with p10 less than p30; ranging from 3G (p10=27.5°; p30=49.6°) to 7G (p10=71.5°; p30=87.9°). Time to AD was significantly longer at p10 than p30. At 7G, this time was shorter for the lightest WT, shortest SH, and narrowest HC and NC (~30-40ms). AV response was significantly affected by posture at all G levels with p10 less than p30; ranging from 3G (p10=297.2°/s; p30=521.9°/s) to 7G (p10=775.4°/s; p30=1037.4°/s). Time to AV was significantly longer at p10 than p30, though only at 3G (p10=0.14s; p30=0.12s) and 5G (p10=0.13s; p30=0.11s). At 5G, time was significantly shorter for the widest HC and p30. **DISCUSSION:** These data quantify the importance of initial posture during combined impact loading, which has implications in the design of head mounted equipment and side facing aircraft troop seats.

#### Learning Objectives:

1. To investigate whether anatomic factors such as weight, head circumference, neck circumference, or seated height are significant variables in predicting and understanding head kinematic response to combined acceleration.

#### 4:30 p.m.

##### [129] THE GILLINGHAM ILLUSION IN AN AVIATION ACCIDENT

M.A. Garber<sup>1</sup> and W. Ercoline<sup>2</sup>

<sup>1</sup>ESI, Norcross, GA; <sup>2</sup>Science, Technology & Engineering Group, Wyle, San Antonio, TX

**INTRODUCTION:** A Piper PA-46-500TP Malibu Meridian was on an instrument approach in instrument meteorological conditions, making turns to comply with air traffic control instructions, when it suddenly lost altitude and impacted terrain, killing both occupants on board. Data recorded on the pilot's Primary Flight Display (PFD) indicated that the aircraft experienced multiple roll position changes toward the end of the flight, and ultimately maintained an approximately 70 degree right bank while losing more than 2000 feet of altitude. This bank angle and a vertical acceleration increasing to more than 4 Gs in the final turn were consistent with the well-described Graveyard Spiral illusion. However, the Graveyard Spiral illusion does not adequately explain the preceding events, including the aircraft's continuously increasing bank when a decrease was needed. The Gillingham Illusion (GI) has been described as the tendency for a pilot, upon cessation of a constant velocity roll, to increase bank angle in the direction of the previous roll. Although the illusion has been demonstrated in flight and simulator-based studies, there are no identified reports in aeromedical literature establishing this illusion as a factor in an aviation accident. A review of the flight data shows that the aircraft had rolled right from about 6 degrees left bank to 70 degrees right bank over a period of approximately 18 seconds, with a brief left roll about 8 seconds after initiation of the right roll. These actions are consistent with pilot behavior in the GI studies, which show that for 3-9s after attempting to stabilize an ongoing roll, a pilot is likely to apply pressure on the control stick in the direction of the previous roll (when not using flight instruments for correct bank angle). The pilot's

unrecognized spatial disorientation prevented him from maintaining level flight or recovering in time to prevent the accident. This study is a classic example of applying known research to a specific aircraft accident. An in-depth look at the events leading up to impact reveals the primary cause of this accident, and points to the significance of spatial disorientation (SD) in general aviation accident investigation.

#### Learning Objectives:

1. Attendees will be able to identify the characteristics of the Gillingham illusion and will understand how it applies to the particular aviation accident case presented.

#### 4:45 p.m.

##### [130] AVIATION EXPERTISE, AGE AND CONTRAST SENSITIVITY PREDICT GA PILOTS' SIMULATOR LANDING DECISIONS IN FOG

J.L. Taylor<sup>1,2</sup>, Q. Kennedy<sup>1,2</sup>, B. Hernandez<sup>2,1</sup>, and J.A. Yesavage<sup>1,2</sup>

<sup>1</sup>Sierra-Pacific MIRECC, VA Palo Alto Health Care System, Palo Alto, CA; <sup>2</sup>Psychiatry & Behavioral Sciences, Stanford University School of Medicine, Stanford, CA

**INTRODUCTION:** Flying in low visibility is a challenging task, in which pilot error can lead to a fatal accident. To help identify situations and pilot characteristics that are predictive of errors, we created a light-aircraft simulator scenario that featured simulated fog and tested IFR pilots who spanned a range of ages (19 to 77 years) and certifications. **METHODS:** Of 49 GA pilots, 25 were IFR-rated ("IFR private"), and 24 also held CFII or ATP ratings. Each pilot flew three ILS approaches starting at 1200 feet altitude. At 200 feet AGL, they were to make a decision whether to land. There were two fog conditions: the runway markers were either barely Visible (legal to land) or Not Visible at 200 feet (illegal to land) (V vs. NV conditions). Pilots were randomly assigned to one of two testing sequences: either "V-V-NV" or "V-NV-V". Pilots were not told that the fog would vary, but they did fly practice approaches with no fog. **RESULTS:** During the test proper, 14 of 49 pilots flew off course or reported unstable approaches. Five flew off course twice, leaving them one opportunity to make a "land/no land" decision at 200 feet. Compared to CFII/ATP-rated pilots, IFR private pilots were more likely to fly defective approaches. IFR private pilots were also less accurate in making landing decisions, as some were more likely to land even when legal markers were not visible at 200 feet. Testing sequence mattered, with the "V-V-NV" sequence having lower landing-decision accuracy on average. This sequence was especially problematic for older pilots and pilots with lower contrast sensitivity, as having either characteristic was associated with missing the opportunity to land on the first two approaches when the runway was barely but legally visible. **DISCUSSION:** These results may help inform strategies for more effective aviation refresher training (e.g. IFR flight simulator exercises) and vision screening of pilots.

#### Learning Objectives:

1. To learn one or more characteristics of IFR pilots that may predict lower performance on IFR-IMC flight simulator exercises.
2. Learn why assessment of contrast sensitivity is at least as important as assessment of visual acuity.
3. Gain information regarding strategies for more effective aviation refresher and safety training of IFR pilots in general aviation.

#### 5:00 p.m.

##### [131] HISTOLOGICAL MARKERS OF MYOCARDIAL ISCHEMIA AND THEIR USE IN AIRCRAFT ACCIDENT INVESTIGATION.

M.J. Schwerer<sup>1,2</sup>, B. Mayr<sup>1</sup>, O. Peschel<sup>2</sup>, and M. Graw<sup>2</sup>

<sup>1</sup>German Air Force Center for Aerospace Medicine, Fuerstenfeldbruck, Germany; <sup>2</sup>Forensic Medicine, Ludwig-Maximilians-University, Munich, Germany

**INTRODUCTION:** An abundance of histological markers have been published for the assessment of myocardial hypoxia. These



indicators of cellular damage have become markers for a chronic ischemic heart disease due to impaired coronary vessel perfusion. However, little is known about the expression of these markers in the hearts of healthy pilots after reduced oxygen supply during flights up to 12,000 ft AMSL. Knowing the expression of these markers in a pilot's myocardium with or without signs of trauma would be of significant value for investigating aircraft accidents. **METHODS:** Formalin-fixed, paraffin embedded heart tissue from 8 victims of aircraft accidents were retrieved from the archives of the Institute of Forensic Medicine in Munich. Representative tissue sections of different regions of the left ventricular wall were chosen. Sections 3-5  $\mu$ m thick were cut and stained with Hematoxylin-eosin and a panel of histological markers for myocardial hypoxia. For comparison, heart tissue from 20 autopsy cases comprising road accident victims and patients dying from ischemic heart disease were investigated. **RESULTS:** Changes in cytoplasmatic homeostasis, loss of specific cellular structures and reactive protein expression were revealed in hypoxic myocardial cells. Specific staining patterns of Luxol-fast-blue, Hematoxylin basic fuchsin picric acid, fibronectin, C5b-9, CD56, desmin, myoglobin, and hypoxia-inducible-factor-1 in hypoxic myocardial tissues were demonstrated. **DISCUSSION:** To our knowledge the present study is the first report up to now assessing such a widespread spectrum of markers on cardiac tissue sections of aircraft accident victims.

#### Learning Objectives:

1. Knowing the different markers of hypoxia in the myocardium and their value in investigating aircraft accidents.

**Monday, May 11**  
**S. Hemisphere 5**

**4:00 P.M.**

### [XXIII.] SLIDE: AVIATION STRESSORS

**Co-Chair: Thomas Nesthus**  
*Oklahoma City, OK*

**Co-Chair: David Schroeder**  
*Oklahoma City, OK*

**4:00 p.m.**

#### [132] POST-TRAUMATIC STRESS DISORDER SYMPTOMS REPORTED BY UNITED STATES AIR FORCE CRITICAL CARE AIR TRANSPORT TEAM CREW MEMBERS

W. Chappelle<sup>3</sup>, J. Swearingen<sup>1</sup>, S. Cowper<sup>2</sup>, T. Goodman<sup>1</sup>, and W. Thompson<sup>1</sup>

<sup>1</sup>Neurostat Analytical Solutions, LLC, San Antonio, TX; <sup>2</sup>Neurostat Analytical Solutions, San Antonio, TX; <sup>3</sup>Neuropsychiatry Branch, USAF School of Aerospace Medicine, Wright Patterson AFB, OH

**INTRODUCTION:** United States Air Force Critical Care Air Transport Team (CCATTs) members are highly specialized medical assets of the aeromedical evacuation (AE) system. These medical professionals are uniquely trained and equipped to provide en route care of critically ill or injured patients whose medical issues require constant stabilization, life-saving interventions, and life or death decisions. The purpose of this study was to identify the rate and severity of self-reported post-traumatic stress disorder (PTSD) symptoms (i.e., re-experiencing, avoidance, and arousal), as well as demographic and occupational factors associated with diagnostic criteria. The study also compared and contrasted rates and severity of PTSD symptoms among CCATT crew members with their AE aircrew counterparts. **METHODS:** A total of 50 CCATT (nurses, respiratory therapists) members and 138 AE (nurses, medical technicians) aircrew participated in the study. Participants completed a demographic and occupational questionnaire that included the PTSD Checklist - Military Version to measure the prevalence of PTSD symptoms. Individual scale items were evaluated for moderate to extreme severity ratings and categorized according to re-experience, avoidance, and arousal/hypervigilance symptoms. Group differences to individual scale items

and percentage of those meeting diagnostic criteria between CCATT and AE participants were identified. Contingency table analyses were conducted to assess associations between meeting PTSD symptom criteria and demographic and occupational variables. **RESULTS:** Overall, 14.00% of CCATT and 4.35% of AE crew members met PTSD symptom criteria. CCATT crew members were 3.22 times (95% confidence interval = 1.14 - 9.12) more likely to meet PTSD symptom criteria than AE crew members. Symptoms of moderate to extreme severity varied significantly between CCATT crew members and AE aircrew. **DISCUSSION:** Results demonstrate the importance of assessing and monitoring PTSD among CCATT and AE crew members, especially those who care exclusively for critically ill and injured patients. The elevated prevalence of PTSD symptoms among CCATT members encourages the discussion of potential protective and risk factors in these high-risk personnel.

#### Learning Objectives:

1. Describe symptoms of PTSD as defined by the Diagnostic Statistical Manual of Mental Disorders, 4th and 5th Editions.
2. Understand and describe the rates of PTSD symptomology reported by a sample of AE aircrew and CCATT crew members.
3. Identify the rate of PTSD symptoms (i.e., re-experiencing, avoidance, and arousal/hypervigilance) with moderate to extreme severity reported by a sample of AE aircrew and CCATT crew members.

**4:15 p.m.**

#### [133] THE DESCRIPTIVE EPIDEMIOLOGY OF MENTAL HEALTH DISORDERS IN U.S. MILITARY AVIATORS

C.C. Schultheiss<sup>2</sup> and G.M. Rice<sup>1</sup>

<sup>1</sup>Residency in Aerospace Medicine, NAMI, Pensacola, FL;

<sup>2</sup>Naval Aerospace Medical Institute, Pensacola, FL

**INTRODUCTION:** The primary objective of this study was to determine the current incidence rates of mental health disorders (MHD) among U.S. military aviators across military services and platforms utilizing a retrospective data analysis from the Armed Forces Health Surveillance Center's (AFHSC) Defense Medical Surveillance System (DMSS). **METHODS:** DMSS was utilized to obtain data ranging from 2003-2012 for diagnostic codes specific for MHD in U.S. military personnel (Air Force, Army, Marine Corps, and Navy). Fixed-Wing Fighter and Bomber Pilots (FWFB), Other Fixed-Wing Pilots (FWO), and Helicopter Pilots (HELO) were considered "aviators" for inclusion in this study, comprising 331,196 person years. Incidence density rates (IDR) were calculated based on ICD-9 codes specific for MHD (number of events per patient years multiplied by 1000). MHD ICD-9 codes included nine Mental Disorder groups and six Mental Health problem groups (6,593 incident cases). **RESULTS:** The IDR of all MHD for all aviators was 19.91/1000PY. All MHD IDR for all Army pilots was 31.14/1000PY compared to 15.60/1000PY for all other service pilots with an incidence rate ratio (IRR) of 2.00, 95% CI=1.90-2.10. PTSD IDR for all Army pilots was 2.35/1000PY compared to 0.28/1000PY for all other service pilots with an IRR of 8.53, 95% CI=6.47-11.23. PTSD IDR for all HELO was 1.85/1000PY compared to 0.29/1000PY for all other platform pilots with an IRR of 6.32, 95% CI=4.73-8.45. PTSD IDR for Army HELO was 2.43/1000PY compared to 1.20/1000PY for all other HELO with an IRR of 2.02, 95% CI=1.53-2.66. **DISCUSSION:** Our data suggests a two-fold increase in incidence of MDH within U.S. Army pilots compared to all other service pilots. PTSD within the helicopter community and Army pilots, during the time period we evaluated, was significantly higher than all other platforms and services. Future studies should review specific occupational hazards that may be causal to increased incidence of MHD in general, and PTSD in particular, as well as relationships to various aviation platforms and mission demand. Aircrew should also receive review to determine similar effect.

#### Learning Objectives:

1. Determine incidence density rates and incidence rate ratios of mental health disorders in U.S. military aviators.

4:30 p.m.

**[134] EJECTION NECK INJURY RISK WITH NVG/HMD DEVICES**J. Tulloch<sup>1</sup>, M. Ruddell<sup>2</sup>, M. Andries<sup>3</sup>, and B. Billings<sup>4</sup><sup>1</sup>UTC Aerospace Systems, Colorado Springs, CO; <sup>2</sup>Kirtland AFB, USAF, Albuquerque, NM; <sup>3</sup>Wright-Patterson AFB, USAF, Dayton, OH;<sup>4</sup>Aircrew Escape Services, Tipp City, OH

**INTRODUCTION:** The USAF began using Helmet Mounted Devices (HMD) in ejection seat equipped aircraft in the mid-1990s with the introduction of Night Vision Goggles (NVG), followed by the Joint Helmet Mounted Cueing System (JHMCS) and more recent testing on the Scorpion system. These type helmets present a higher risk of a neck injury during an emergency escape as they are typically heavier and have a center of gravity (CG) position significantly further forward than legacy aircrew helmets. USAF ejections to date with NVG/HMD type helmets have been few accounting for only 23 ejections from 261 USAF ACES II ejections in the time period that these type helmets have been in service. **METHODS:** A review of USAF ejection experience with HMDs was analyzed and compared with known limitations from test data with these devices. An analysis of helmet mass and CG position was also conducted, along with a review of current ejection seat criteria that are used to control the ejection dynamic environment. The ability of these current requirements to control the neck injury risk was investigated. **RESULTS:** The analysis of USAF ACES II ejections showed there have been very few ejections in a high speed or low aircrew weight condition where the neck injury risk would be expected to be significantly higher. Current requirements, HMD and ejection seat, were shown to fall short in the ability to adequately control the injury risk for NVG/HMD type helmets. **DISCUSSION:** Proposed changes to Neck Injury Criteria were presented, along with recommended improvements to ejection seat requirements to control the dynamic environment, reduce head and neck loading, and mitigate injury risk to occupants. Further research on neck injury criteria is also proposed to better control the injury risk associated with a typical ejection.

**Learning Objectives:**

1. Ejection seat and helmet requirements that drive a neck injury risk during an ejection event are detailed in this study.

4:45 p.m.

**[135] ESTIMATING MITIGATING SOLUTIONS TO NECK STRAIN ON GRIFFON HELICOPTER AIRCREWS USING A SIMULATION TOOL BASED ON MISSION TASK ANALYSIS AND PHYSICAL DEMANDS ANALYSIS**

G. Fusina, T. Karakolis, and P. Farrell

Defence R&amp;D Canada, Toronto Research Centre, Toronto, ON, Canada

**INTRODUCTION:** Seventy percent of Canadian Forces Griffon helicopter crewmembers (pilots and flight engineers) reported "neck pain" in a recent 2014 survey. In a few cases the problem is so severe that 23% of crewmembers that reported neck pain were grounded by medical staff and 25% grounded themselves. Cumulative neck loading leading to tissue damage is theorized as being the source of the problem. Previous work [1] identified task demands and physical demands of the Griffon aircrew and led to the development of a software tool where cumulative loads on the neck of Griffon aircrew personnel can be calculated. This was achieved by first decomposing Griffon missions into postural sequences for each of the aircrew; motion capture data obtained for six pilots and seven flight engineers for each of the postural sequences was then combined with a single-joint neck model to calculate seven different loads on the neck. [1] Work done under contract between DRDC and HSI Inc., Contract # W7711-088136/001/TOR **METHODS:** This software tool and database can now be used to analyze existing mission profiles, or to alter current mission profiles in order to minimize, or at least lower, the loads on the neck of the Griffon aircrew. This tool can also be used to estimate neck strain if changes are made to the aircrew's procedures: for example, if the flight engineer were able to monitor the outside of the aircraft using cameras mounted on the helicopter's exterior - instead of physically looking outside the cabin - we would be able to estimate the

resulting reduction in the flight engineer's neck loading. The software tool has been configured as an easy-to-use MATLAB GUI (MathWorks, Natick, MA), where a customized mission can be built by selecting a sequence of tasks, which have associated postural sequences. **RESULTS:** The model and simulation tool results will be presented where different missions will be analyzed with the developed simulation tool and altered to represent possible mitigation strategies for neck strain in Griffon aircrew. The effect of different interventions will also be analyzed to estimate their effect on Griffon aircrew cumulative neck loading.

**Learning Objectives:**

1. Using Motion Capture data to calculate neck-joint loading.

5:00 p.m.

**[136] THE USE OF CARDIAC AUTONOMIC ACTIVITY TO MONITOR SLEEP STABILITY IN AN UNDERSEA SPACE ANALOG ENVIRONMENT**M. O. Griofa<sup>1</sup>, R. Thomas<sup>2</sup>, B. Rai<sup>3</sup>, and D. O'Keeffe<sup>1</sup><sup>1</sup>ECE, University of Limerick, Las Vegas, NV; <sup>2</sup>Beth Israel Deaconess Medical Center, Boston, MA; <sup>3</sup>Kepler Space University, Bluffton, SC

**INTRODUCTION:** Sleep disruption and deprivation can have a detrimental effect on both human performance and cognitive function which affect mission outcomes and success in both spaceflight and other operational extreme environments. During this research the Cardiac Adapted Sleep Parameters Electrocardiogram Recorder (CASPER) experiment was deployed to the Aquarius Undersea Habitat which is situated ~5km off the Key Largo coast. A crew of 6 aquanauts were monitored during 2 consecutive weeks as part of a NEEMO (NASA Extreme Environments Mission Operations) Mission. Crewmembers underwent cardiac autonomic activity monitoring for sleep instability and also had core body temperature and hormonal biomarkers measured in addition to completion of a subjective sleep diary. **METHODS:** The single lead electrocardiograph (ECG) was used to correlate traditional ECG heart rate variability (HRV) and cardiopulmonary coupling (CPC) as a measure of sleep stability. Correlation between both sets of cardiac autonomic measurements was calculated using the Pearson product-moment (PPM) function and SIMPLS algorithm. **RESULTS:** Core body temperature, hormonal biomarkers nor traditional heart rate variability indicated any significant difference between early (days 1-7), late (8-14) or baseline data. However, all three of the CPC demonstrated a significant difference between early, late and baseline readings ( $P < 0.05$ ) which also correlated significantly with the results of the crewmembers subjective sleep diary during the mission. **DISCUSSION:** The ECG HRV recordings were confounded by a substantial low frequency noise component. In contrast, the CPC data had a greater correlation with the subjective results from the adapted Pittsburgh Sleep Diary completed pre- and post-sleep by the crew. This highlights not only the value of the CPC parameter but also of its fidelity in monitoring different aspects of sleep stability and the flexibility of using both the data and technology in an operational environment combining both objective and subjective input.

**Learning Objectives:**

1. Examine changes in cardiac autonomic activity as a surrogate marker for sleep stability.

5:15 p.m.

**[137] SCIENTIFIC PARTICIPATION THROUGHOUT THE 14 CFR PART 117.7 FATIGUE RISK MANAGEMENT SYSTEM (FRMS) AUTHORIZATION PROCESS**

T.E. Nesthus

Aerospace Human Factors Research Division, FAA CAMI, Oklahoma City, OK

**INTRODUCTION:** The Flightcrew Member Duty and Rest requirements found in 14 CFR Part 117 were designed to improve the management of pilot fatigue and went into full effect January 2014. Scientific knowledge of sleep, circadian rhythm, and fatigue formed the

basis for the rule's internal components of flight time, duty period, and rest. Section 117.7, Fatigue Risk Management System (FRMS), of the rule contains an optional provision permitting air carriers flexibility for operations that might occur outside of the rule's limits. This presentation focuses on the optional FRMS provision and authorization process, and where scientific participation and evaluation take place during the process. **METHODS:** Guidance for the authorization process is found in FAA Advisory Circular (AC) 120-103A - Fatigue Risk Management Systems for Aviation Safety. The AC describes the basic concepts of an FRMS. It provides information on FRMS components needed for certificate holder's operations-specific applications. The AC provides certificate holders with detailed guidance and step-by-step procedures required for FRMS proposals and the approval process; development of required documentation and safety assurance processes; data collection requirements and analysis procedures; and the FAA's scientific evaluation and validation process. **RESULTS:** The authorization process involves five phases: 1) pre-application assessment, planning, and preparation, 2) formal application, 3) detailed documentation for data collection and analysis, 4) demonstration and validation of safe operation, and 5) authorization, implementation, continuous monitoring and reporting. **DISCUSSION:** If a certificate holder determines that the rule constrains or restricts a certain city-pair flight operation, an FRMS can be proposed to the FAA with mitigation strategies that provide for an alternative method of compliance to the rule. The FAA FRMS authorization process follows a systematic and progressive approach, including scientific review and evaluation of proposed alternative methods. Following scientific demonstration and validation of results, an Operation Specification authorizes implementation of that carrier-specific flight operation with continued monitoring, reporting, and revisions.

#### Learning Objectives:

1. Attendees will learn about how sleep, circadian rhythm, and fatigue sciences were integrated into the new flight and duty time and rest regulations.
2. Attendees will learn how the new regulation provides flexibilities for certificate holder's to propose flight operations outside the limitations of the rule through the application of a Fatigue Risk Management System (FRMS).
3. Attendees will learn about how science continues to be considered during the Fatigue Risk Management System authorization process.

**Monday, May 11**  
**S. Hemisphere E3**

**4:00 P.M.**

### [XXIV.] SLIDE: NEUROLOGICAL CONUNDRUMS FOR MEDICAL CLEARANCE AND CERTIFICATION

**Co-Chair: James DeVoll**  
Washington, DC

**Co-Chair: Ellis Boudreau**  
Lake Oswego, OR

**4:00 p.m.**

#### [138] ACUTE VERTEBRAL ARTERY DISSECTION IN AN OTHERWISE HEALTHY U.S. ARMY AVIATOR. THE RISKS OF SPINAL MANIPULATION AND VERTEBRAL ARTERY DISSECTION

S. Mull<sup>1,2</sup> and S. Batten<sup>1</sup>

<sup>1</sup>South Carolina Army National Guard, Eastover, SC; <sup>2</sup>Family Medicine, University of South Carolina, Columbia, SC

**INTRODUCTION:** Spinal manipulation therapy (SMT) is a common treatment for neck and back pain and generally considered to be safe. SMT has a small risk of severe complications such as vertebral artery dissection. The published evidence in support of SMT is limited however the potential complications may be severe. The risks versus

benefits will be outlined utilizing the latest literature. **METHODS:** A 39 year old healthy U.S. Army Aviator presented to primary care complaining of a severe headache for three days, tingling in right thumb, index, and middle fingers. He was initially treated for the headache and released however after two days of worsening symptoms, returned and was diagnosed with a right cerebellar infarction via MRI. It was determined that this infarction was caused by a right vertebral artery dissection caused by SMT five days prior. **RESULTS:** The aviator was released from Neurology three months after dissection to return to full duties with Flight Surgeon determining aviation duties. The follow up MRI reported encephalomalacia of the right cerebellum without evidence of residual vertebral artery dissection. The aviator returned to full flight status eleven months after dissection and has remained symptom free with no long term complications. **DISCUSSION:** A comprehensive literature search was performed and all recent published literature was reviewed concerning manipulation of the spine and serious complications. One particularly interesting study using the Veterans Administration indicates a strong association between and spinal manipulation and cerebral artery dissection. Interestingly this association may be stronger in a younger age group (<45). Other studies have failed to identify a direct link with good statistical significance. This is complicated by relatively small case rates and the necessarily retrospective nature of the studies.

#### Learning Objectives:

1. To identify the risk factors, symptoms, and management of acute stroke associated with vertebral artery dissection.
2. To discuss the risks and benefits, including the current evidenced based literature concerning spinal manipulation therapy and its association with adverse outcomes.

**4:15 p.m.**

#### [139] FAA EXPERIENCE WITH TRANSIENT GLOBAL AMNESIA

J.R. DeVoll  
Office of Aerospace Medicine, FAA, Washington, DC

**INTRODUCTION:** Transient global amnesia (TGA) reversibly affects anterograde memory, is characterized by repetitive questioning, and typically occurs in middle- to older-aged individuals. Because TGA interferes with the formation and retrieval of new episodic memories, a TGA episode occurring during flight would adversely detract from safe performance of pilot duties. No consensus exists on causes, but hypothesized etiologies include vascular abnormalities, migraine, seizure, and psychogenic origins. The risk-assessment challenge for aerospace medicine regulatory authorities is to address the differential diagnosis and risk for recurrence. This study reviews the FAA experience with assessing the aeromedical risks of TGA. **METHODS:** The Medical Appeals Branch database was queried for Federal Air Surgeon appeals cases from January 2007 through July 2014 mentioning a diagnosis of TGA. **RESULTS:** 8 male pilots were identified, age range 24-65 years (mean 52.1; SD 12.6), with 2 first-, 3 second- and 3 third-class applicants. None were engaged in flying at the time of the episode. Notable prior "activities" included flying, driving, vigorous exercise, and chronic stress. Episode durations ranged from < 1 to 24 hours (mean 9.3; SD 7.5). Except for one airman whose duration of amnesia appeared to be < 1 hour, all TGA diagnostic criteria were met. No relevant medications or co-morbid conditions were identified. 6/8 had brain MRI and CT study results available (all negative), and 7/8 had available EEGs (all negative). No other potentially explanatory medical conditions were reported on follow-up. 5 were certificated, and 2 of 3 denied for inadequate follow-up time were later issued (1 did not re-apply). Available information showed no reported TGA recurrence, other neurological conditions or aviation mishaps. **DISCUSSION:** Presenting TGA symptoms are strikingly worrisome, and the broad differential diagnosis requires a comprehensive exclusionary work-up. However, for those meeting strict diagnostic criteria, TGA has a benign prognosis, very low risk for recurrence, and no known association with other medical or neurological conditions. Medical certification for aviation duties may be considered following a prudent observation period (e.g., 6 months).



**Learning Objectives:**

1. To provide an overview of the complexities of aeromedical risk assessment faced by aerospace medicine regulatory agencies in making certification decisions for airmen with a diagnosis of transient global amnesia (TGA).
2. To review the diagnostic clinical criteria for TGA, a framework for risk assessment, and recommendations for medical certification.

**4:30 p.m.****[140] AERO MEDICAL EVALUATION OF 20 CASES OF THE AIRCREWS WITH INTRACRANIAL TUMOR (ICT) AND LITERATURE REVIEW**

H. Liu

*Airforce General Hospital of PLA, China, Beijing, China*

**INTRODUCTION:** To provide references for the aero medical evaluation of the aircrews with Intracranial tumor (ICT), we analyzed the clinic data of 20 cases of aircrews with ICT hospitalized in Air Force General Hospital of PLA from January, 2004 ~ December, 2013 and reviewed the related literatures. **METHODS:** The clinic data of 20 cases of aircrews with ICT were analyzed and related literatures were reviewed. **RESULTS:** Nine cases of arachnoid's cyst, asymptomatic 4 cases with normal relevant inspections and 1 case with pituitary adenoma but without symptoms were qualified; 1 case with airsickness and another with hyperthyroidism were disqualified; 2 cases with headache and vestibular dysfunction respectively were temporary disqualified; there of 6 cases of pituitary adenoma were qualified, asymptomatic 1 case with rising prolactin still taking medicine was temporary disqualified; 1 case of acromegalia with rising growth hormone underwent via sphenoid sinus of pituitary adenoma resection and recovered well, but grounded by overage; 1 high performance fighter pilot with irregular headache underwent the same operation as above but had postoperative hypopituitarism and the curative effect of hormone replacement was poor, ultimately grounded; 2 cases of acoustic neuroma suffered from hearing loss and tinnitus and 1 underwent operation another underwent gamma knife treatment, the effects were good and both qualified; 1 case of meningioma with hyposmia grounded after craniotomy; 1 case of neuroepithelial cyst grounded because of obvious headache; 1 cases of gliomatosis cerebri died after 1 year's comprehensive treatment; 1 cases of lung cancer with brain metastases died after 5 year's comprehensive treatment. **DISCUSSION:** On the basis of both the illness severity and whether to have complications, ICT aero medical evaluation should be according to the current Chinese PLA Air Force Aircrew Examination Standard, refer to the United States AFI 48-123, the Air Force Waiver Guide as well as the Manual of Civil Aviation Medicine. Some cases could be waived to qualification according to the "1% rule" of the international clinical aviation medicine on the base of weighing the type of aircraft that pilot served his flying duty and experiences as well as the personal desire.

**Learning Objectives:**

1. To provide references for the aero medical evaluation of the aircrews with Intracranial tumor (ICT).

**4:45 p.m.****[141] RETURN TO FLYING DUTIES IN THE F16 AFTER SUFFERING A BRAIN TUMOR-A CASE STUDY OF AN OPERATIONAL RISK MANAGEMENT APPROACH**

O. Lundseng, H. Ranfelt, and A.S. Wagstaff

*Institute of Aviation Medicine, Blindern, Norway*

**INTRODUCTION:** Neurological symptoms and brain tumors are often disqualifying for flying duty. Following brain surgery the risk of epileptic seizures is the main concern. A 43yr old pilot presented with an increasing headache developing over the last 2 days. Symptoms included photophobia and emesis. A CT/MR scan revealed a 6 cm meningioma located near the sphenoid wing in the left hemisphere. Methylprednisolone relieved the symptoms, and the patient went to surgery after 6 days. The procedure was uncomplicated, but resulted in postoperative (PO) aphasia and temporary loss of sight, as well as partial loss of motor control in the left eye. Most of these symptoms were alleviated after 15 months. A

return to any flying status was initially not thought possible. **METHODS:** A waiver request for returning to limited flying status was submitted after 21 months. EEG studies, including sleep-deprived, were found normal. Cognitive and motor-skill tests showed normal to above normal results. Expert opinion and literature review regarding the risk of post-traumatic epilepsy was completed. Hypobaric testing at 25000 feet including rapid decompression was performed. Centrifuge testing of resting +Gz tolerance and up to 9+Gz with MR-scans pre- and post-exposure was completed. An Operational Risk Management (ORM) study was performed. **RESULTS:** All investigations returned normal or near-normal values. The ORM study showed that increased risks could be managed by procedural adjustments. The aviator was returned to limited flight duty as a non-flying pilot. **DISCUSSION:** This case illustrates the difficulties in assessing the risk of sudden incapacitation. A central location of tumor and absence of seizures after surgery lowers the risk. A normal EEG estimates the risk of developing seizures at around 10%. Most studies are done on cross-section populations. Extensive testing to trigger seizures showed no signs of this occurring. The ORM-process mitigated some of the risks involved. A close co-operation between the Flight Surgeon, the Institute of Aviation medicine, the aviator in question as well as involving the squadron, gave a best possible basis to make an informed decision. The aviator's rating was approved as a non-flying aircrew, i.e. with a qualified pilot in a two-seat F16B.

**Learning Objectives:**

1. To provide an increased understanding of the potential benefits of close cooperation between aeromedical personnel and operation aircrew regarding difficult aeromedical assessments.

**Monday, May 11****S. Hemisphere E4****4:00 P.M.****[XXV.] PANEL: OVERVIEW OF ANTARCTIC MEDICAL OPERATIONS: LESSONS FOR SPACEFLIGHT AND OTHER EXTREME ENVIRONMENTS****Chair: Scott Parazynski***Houston, TX*

**PANEL OVERVIEW:** The Center for Polar Medical Operations (CPMO) at the University of Texas Medical Branch in Galveston, TX, currently oversees all medical support for the U.S. Antarctic Program. The CPMO's position within an academic medical institution has afforded the opportunity to review and publish the latest medical data regarding Antarctic healthcare. This panel will serve to update prior literature by reviewing current Antarctic medical operations, including the evolution of medical standards for staff selection, clinic utilization, medical evacuations, and operational constraints. The lessons learned herein serve as a useful analog for the operational medical support required for space exploration and other expeditions in extreme environments.

**[142] U.S. ANTARCTIC DEPLOYMENT HEALTH SCREENING PILLARS AND THEIR UTILITY AS AN EXTREME ENVIRONMENT ANALOG**S. Parazynski<sup>1</sup>, N. Chough<sup>2</sup>, and D. Reyes<sup>3</sup><sup>1</sup>Center for Polar Medical Operations, UTMB, Galveston, TX;<sup>2</sup>Preventive Medicine & Community Health, UTMB, Webster, TX;<sup>3</sup>PMCH, UTMB, Galveston, TX

**INTRODUCTION:** Careful medical and dental screening is carried out for roughly 2,000 U.S. Antarctic participants each austral summer (October-February), with additional medical and psychological assessments for another 250 hoping to stay through the winter, when aeromedical evacuation (MEDEVAC) is all but impossible. Polar deployment screening is based on three conceptual pillars: 1) assessing fitness-to-deploy against season-specific medical guidelines; 2) assessing immediate and potential healthcare needs against station clinic capabilities; and 3) reporting significant issues identified during screening to primary care providers (PCPs), assuring proper follow-up.

A comparison of Antarctic medical guidelines with the selection criteria from other organizations may be instructive. **METHODS:** Current standards and recommendations and overall philosophical approach for the screening and selection of personnel for the U.S. Antarctic Program, NASA astronauts, commercial spaceflight participants (SFP), and commercial aviation were compared. **RESULTS:** Polar deployment is long-duration with limited medical capabilities and MEDEVAC options, and participants have significant daily responsibilities. NASA selections operate under a similar paradigm. Commercial airline flights are short-duration with easier MEDEVAC/diversion, but pilots have significant responsibility. Commercial SFPs have limited responsibility during short-duration flights, although the physiologic challenge of certain suborbital flights will be taxing, and MEDEVAC from remote launch facilities will not be trivial. While all 3 pillars apply to polar and NASA deployments, only the first and third apply to the other paradigms. **DISCUSSION:** Physicians responsible for qualifying individuals to serve in austere environments must weigh the individual's health against the physical and psychological stressors of such locales. Additionally, where MEDEVAC is not readily available, an individual's medical risk must be weighed against the resources available. Health screening professionals must assure that participants seek attention for any significant medical concerns from their PCPs, as screeners cannot offer definitive, long-term care.

#### Learning Objectives:

1. Understand how the three pillars of medical screening are applied to different types of personnel serving in remote, austere environments.

#### [143] PRIMARY CARE IN EXTREME ENVIRONMENTS: MEDICAL CLINIC UTILIZATION AT ANTARCTIC STATIONS, 2013-2014

J. Pattarini<sup>1</sup>, J. Scarborough<sup>2</sup>, V.L. Sombito<sup>2</sup>, and S. Parazynski<sup>2</sup>  
<sup>1</sup>Aerospace Medicine, University of Texas Medical Branch, Galveston, TX; <sup>2</sup>University of Texas Medical Branch, Galveston, TX

**INTRODUCTION:** The unique challenges posed by the Antarctic environment include both the physiological and psychological stressors to the individual as well as the limited on-site medical capabilities available to address them. Decreased physical activity, exposure to prolonged day/night periods, relative isolation, and severe changes in altitude all contribute to medical incidents at the U.S. Antarctic stations. This report compares medical clinic utilization between three U.S. Antarctic stations to identify differences in diagnostic frequency and utilization of clinic resources. **METHODS:** Clinic data from three Antarctic locations (McMurdo Station, Amundsen-Scott South Pole Station, and Palmer Station) for the 2013-2014 Antarctic year were reviewed for patient encounters, diagnostic frequency, and similar parameters. Differences between visit and diagnostic frequency were analyzed. **RESULTS:** The McMurdo clinic encountered 1555 patient encounters, with South Pole Station reporting 744 and Palmer with 128 patients over the year. Most frequent reasons for clinic visits were orthopedic and dermatologic, with increased visits at the more remote locations for neurologic complaints and insomnia. Altitude sickness was reported only at McMurdo and South Pole stations. **DISCUSSION:** The clinic volume predictably correlated with station population. Frequent complaints of mild disequilibrium and malaise attributed to sea-sickness were seen at Palmer station. Insomnia and headache complaints, reported only at the Pole, are likely associated with the increased elevation at that site, though could be attributable to psychological stress from the isolated environment. Further advances in screening, improved recognition of pre-emergent conditions, and improved emergency management resources could have significant improvements in healthcare delivery on the ice.

#### Learning Objectives:

1. Understand how U.S. Antarctic stations vary by environment and population throughout the austral year.
2. Appreciate the chief contributing diagnoses to Antarctic station clinic demand, and how these vary by location.

#### [144] REPORTS FROM THE U.S. ANTARCTIC PROGRAM 2014-2015: OPERATIONAL CHALLENGES IN AN EXTREME ENVIRONMENT AND SPACEFLIGHT ANALOG

N. Chough, J. Pattarini, and S. Parazynski  
 UTMB, Galveston, TX

**INTRODUCTION:** Antarctica presents a unique, austere environment in which to practice medicine. Resources are limited, leading to reduced diagnostic capabilities, improvised medical treatments or evacuation to a higher level of care. The following discussion of case presentations serve as an update to previous Antarctic seasons, highlighting both improvements to historic Antarctic medical care, and the operational challenges of working in this remote clinical setting as an analog to spaceflight and other resource-limited environments. **METHODS:** Cases were selected from the UTMB Center for Polar Medical Operations medical records from the 2014-2015 seasons at McMurdo, South Pole, and Palmer Stations. Those that warranted diagnostic testing, procedural intervention or medevac for psychiatric, medical or surgical conditions that presented operational limitations (defined as insufficient resources as compared to a tertiary care facility) resulting in loss of man-hours were reviewed for final selection. **RESULTS:** Clinical outcomes of pertinent cases from the past season that highlight operational constraints will be presented. **DISCUSSION:** Medical care in Antarctica underscores the challenges for healthcare providers working in austere environments. While care has improved from previous decades, the case reports presented demonstrate the spectrum of conditions seen, while simultaneously identifying continued operational gaps and potential medical needs for future terrestrial and spaceflight expeditions.

#### Learning Objectives:

1. Audience will learn the current operational constraints of Antarctic medical care.

#### [145] EMERGENCY MEDICAL EVACUATIONS FROM U. S. ANTARCTIC STATIONS, 2001-2014

D. Reyes<sup>1</sup>, J. Pattarini<sup>1</sup>, and S. Parazynski<sup>2</sup>  
<sup>1</sup>PMCH-Aerospace Medicine, UTMB, Galveston, TX; <sup>2</sup>Center for Polar Medical Operations, UMTB, Galveston, TX

**INTRODUCTION:** The austere Antarctic environment poses unique challenges for the emergency medical evacuation (MEDEVAC) of ill or injured personnel. All individuals deploying to Antarctica undergo medical screening prior to departure. However, the combination of environmental factors, chronic disease states and relative isolation results in a number of emergent cases each year that require the mobilization of significant resources to get these patients to definitive care. **METHODS:** Evacuation data from three U.S. Antarctic locations (McMurdo Station, Amundsen-Scott South Pole Station, and Palmer Station) for the Antarctic seasons from 2001 to 2014 were reviewed for evacuation site of origin, diagnostic category, and other parameters. Differences between site of origin and category of diagnosis were analyzed. **RESULTS:** A total of 239 MEDEVACs were recorded during the study period, with a mean of 18.4 evacuations annually, ranging from 5 to 40 MEDEVACs per year. Of these, 165 (69%) originated from McMurdo station, 48 (20%) originated at the South Pole station, 9 (4%) from Palmer station, and 17 (7%) from other locations. The top three reasons for evacuation include trauma (n=74, 30%); gastrointestinal complaints, such as undifferentiated pain, bleeding or appendicitis (35, 15%); and cardiovascular complaints including chest pain (34, 14%). **DISCUSSION:** The majority of MEDEVACs were due to acute medical events, including trauma. Some of the MEDEVACs may be related to exacerbation of preexisting conditions that were missed during the screening process. Adjustment of pre-deployment screening requirements may reduce the need for MEDEVACs due to preexisting factors, although these adjustments must be balanced with staffing requirements. Trauma diagnoses reinforce the unique hazards posed by the Antarctic environment. This data will be used to refine screening, estimate the types of medical issues that may arise, and help determine staffing and equipment needs for missions to other austere environments, including deep space.

#### Learning Objectives:

1. Learn about the MEDEVAC trends from U.S. Antarctic stations over the preceding decade and some possible applications of this knowledge to screening, and the selection of appropriate medical capabilities to other austere environments, such as space.

**[146] REACTIVATION OF LATENT VIRUSES UNDER STRESS IN ANTARCTIC PERSONNEL**

D. Reyes<sup>4</sup>, A. Brinley<sup>2</sup>, A. Allen<sup>1</sup>, and S. Parazynski<sup>3</sup>  
<sup>1</sup>7th Medical Group, USAF, Dyess AFB, TX; <sup>2</sup>School of Medicine, UTMB, Galveston, TX; <sup>3</sup>Center for Polar Medical Operations, UTMB, Galveston, TX; <sup>4</sup>PMCH-Aerospace Medicine, UTMB, Galveston, TX

**INTRODUCTION:** Antarctica is a unique environment in which personnel must perform their duties under significant physical and psychological stress. Stress can lead to immune suppression and reactivation of latent viruses. Significant stressors are also found in other extreme environments, such as spaceflight. **METHODS:** The medical records for U.S. Antarctic personnel living at McMurdo and Palmer Stations during the 2014 winter season were reviewed for occurrence of herpes zoster as a marker of viral reactivation. The number of cases was used to determine the incidence rate, which was compared to the incidence in the general population. **RESULTS:** Five cases of zoster reactivation occurred in the U.S. Antarctic Station population, including one case with ocular involvement. Four of the 5 cases were in persons under 40 years of age, in a population of about 182 persons wintering over, for a total population incidence of 27 per 1,000, and about 22 per 1,000, in persons 30 to 39 years of age. The usual incidence of zoster is roughly 4 per 1,000 person years in the U.S. population, and 2 per 1,000 in the 30 to 39 year old age group. **DISCUSSION:** The incidence of zoster at McMurdo Station this winter represents over an eight-fold increase in the overall incidence found in the general U.S. population, and an even larger, 11-fold increase in the 30 to 39 year old population. Working and living in an extreme environment can cause significant physiologic and psychological stress that can lead to altered immune function, such as increased expression of inflammatory cytokines and decreased cell-mediated immunity. Reduced immune function can lead to reactivation of latent viruses, increased viral shedding, and symptomatic reactivation leading to clinical syndromes such as zoster. Such changes have been observed in Antarctic personnel, U.S. astronauts, and others. The nature of these immune changes must be well defined to better manage the care of Antarctic personnel and, more critically, before undertaking human exploration of deep space. Antarctica and the International Space Station are natural, and reciprocal analogs for this work.

**Learning Objectives:**

1. Understand that viral reactivation can be a significant medical issue for personnel working in austere environments.

**Tuesday, May 12**

**8:30 A.M.**

**Northern Hemisphere Ballroom**

**2<sup>ND</sup> MEMORIAL EUGEN REINARTZ LECTURE****Moving Beyond Earth: Our Future in Deep Space**

Thomas Jones, Ph.D.  
 Veteran Astronaut, Space Shuttle Payload Commander, Scientist, and Author

**Tuesday, May 12**

**10:00 A.M.**

**Americas Seminar**

**[XXVI.] POSTER: HUMAN PERFORMANCE: FROM MOLECULES TO NEURONS**

**Co-chair: Gordon Landsman**  
 Aurora, CO

**Co-chair: Royden Marsh**  
 San Antonio, TX

**[147] THE EFFECT OF 0.2 HZ AND 1.0 HZ FREQUENCY OF LATENCY AND 100 MS AND 20 - 100 MS AMPLITUDE OF LATENCY ON SIMULATOR SICKNESS IN A HEAD MOUNTED DISPLAY**

A. Kinsella<sup>2</sup>, R. Mattfeld<sup>1</sup>, A. Hoover<sup>1</sup>, and E. Muth<sup>2</sup>  
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**INTRODUCTION:** The purpose of this experiment was to build upon previous findings regarding the effect of variable latency on simulator sickness in a head mounted display (HMD). Motion sickness has been studied for decades in a variety of vehicles including ships, planes, trains and automobiles. More recently virtual environments, including those utilizing an HMD, can generate significant sickness, often termed simulator sickness. Many studies have linked system latency to simulator sickness and recent research has found that with current technology latency is not a constant; but rather it varies systematically over time due to sensor errors and clock asynchronization. **METHODS:** One hundred twenty participants were randomly assigned to one of four conditions (0.2 Hz frequency of latency with 100 ms fixed amplitude of sinusoidal latency; 0.2 Hz frequency of latency with 20 - 100 ms varying amplitude of sinusoidal latency; 1.0 Hz frequency of latency with 100 ms fixed amplitude of sinusoidal latency; 1.0 Hz frequency of latency with 20 - 100 ms varying amplitude of sinusoidal latency). Participants donned an HMD and completed five trials of an object location task. Participants reported their subjective sickness symptoms via the Simulator Sickness Questionnaire and Motion Sickness Assessment Questionnaire. Collected data were analyzed using an analysis of variance. **RESULTS:** A main effect of frequency of latency was found, and data trended toward a main effect of amplitude of latency. Participants reported greater sickness in 0.2 Hz frequency conditions and in the 1 Hz varying amplitude condition, indicating both frequency and amplitude of latency contribute to simulator sickness. **DISCUSSION:** Results from this study support previous findings showing an effect of frequency on simulator sickness, specifically 0.2 Hz frequency causing an increase in sickness symptoms. This study provides evidence that amplitude of latency plays a role in simulator sickness as well. The specific role of amplitude of latency needs to be further explored in future studies. Future work in this area has the potential to solidify the notion that varying amplitude contributes to simulator sickness, and will give insight on the extent to which varying amplitude influences system latency.

**Learning Objectives:**

1. This experiment aids in understanding that system latency is variable, not constant, and this variable latency has a negative effect on humans.

**[148] COGNITIVE RESERVE THEORY AND USAF PILOTS WITH A TRAUMATIC BRAIN INJURY**

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**INTRODUCTION:** Frequently individuals who have suffered a traumatic brain injury (TBI) will have a reduction in their cognitive abilities. However, cognitive reserve (CR) theory postulates that individuals with higher intelligence quotients, education levels, and occupational attainment are more protected against cognitive decline following a TBI. United States Air Force (USAF) pilots meet such criteria. Most USAF pilots seen at the Aeromedical Consultation Service (ACS) for waiver consideration due to a TBI usually return to pre-injury levels of cognitive functioning. This study explores the hypothesis of CR theory in relation to USAF pilots with a history of TBI. **METHODS:** Between 2000-2014, USAF pilots (n = 32) with a history of mild to severe TBI were evaluated at the ACS. As part of their evaluation, they were administered computer based intelligence testing (Multidimensional Aptitude Battery-II) and a comprehensive neuropsychological screening