

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

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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

2ND 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

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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

(MicroCog). These tests assessed for: attention/concentration, memory, reasoning/calculation, spatial processing, reaction time, information processing speed and accuracy, as well as general cognitive proficiency. Post-injury testing was compared to pre-injury baseline testing obtained prior to pilot training. **RESULTS:** Pre-injury and post-injury scores on full-scale and performance intelligence, while both in the superior range, were found to be significantly different. Mean scores for performance intelligence post-injury ($M=127$) were significantly higher ($p < .05$) than pre-injury scores ($M=120$). Post-injury mean scores ($M=126$) for full-scale intelligence were also significantly higher than pre-injury ($M=121$) scores. **DISCUSSION:** The results of the study support CR theory. USAF pilots, who have attributes of superior intelligence, advanced education and positions with occupational complexity, had generally improved performance on cognitive measures compared to pre-morbid results. Implications and recommendations for aeromedical evaluation, management and assessment of readiness to return-to-fly are provided.

Learning Objectives:

1. Understand how the theory of cognitive reserve relates to the post-TBI functioning of USAF aviators.
2. Understand typical range of performance on intelligence and neuropsychological testing for aviators with a history of TBI and recommendations for a return to fly.

[149] W/D

[150] POSTURAL EFFECTS ON CEREBROVASCULAR AND CARDIOVASCULAR TP RESPONSES WITH SUPERIMPOSED SINUSOIDAL LOWER BODY NEGATIVE PRESSURE

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INTRODUCTION: The reaction of dynamic vascular conductance (DVC) to orthostatic stress was examined using superimposed sinusoidal lower body negative pressure (SS-LBNP) in sitting and supine postures. Our previous study showed the low-pass filter characteristics of DVC in both the middle cerebral arterial blood flow velocity (MCAv) and cardiac output (CO) using single sinusoidal LBNP (SLBNP) in the supine position. To examine frequency characteristics with SLBNP, multiple measurements in each periodical condition are necessary. As SS-LBNP contains multiple fluctuations in the LBNP curve, we presumed that use of the SS-LBNP would provide multiple periodical characteristics of DVC at each time point. We tested the hypothesis that the results obtained by SS-LBNP would be equivalent to our previous findings. We also examined the hypothesis that the sitting posture would have a static gravitational blood shift to the lower body that would influence the frequency characteristics of the DVC. **METHODS:** MAP, MCAv, and CO was measured in 12 male subjects. SS-LBNP was configured for two periodical changes (0.011-Hz and 0.056-Hz of 0 to -25 mmHg) of SLBNP. The transfer functions of gain from MAP to MCAv and CO were calculated at the point of driven frequency. **RESULTS:** Both the DVC in MCAv and CO at 0.011-Hz was significantly larger than at 0.056-Hz ($p < 0.01$). These results indicate that frequency characteristics obtained with the SS-LBNP could be equivalent to those found with the multiple measurements of the SLBNP. Moreover, when subjects assumed the sitting posture, their total peripheral resistance and cerebrovascular resistance index were significantly higher than in the supine posture ($p < 0.01$). With sitting, although the DVC of CO was significantly lower than with the supine posture ($p < 0.01$), the DVC of MCAv was not. **DISCUSSION:** These results suggest that the frequency characteristics of DVC in cerebrovascular system are more stable than those in the systemic cardiovascular system.

Learning Objectives:

1. Frequency characteristics of circulatory system.

[151] PERFORMANCE COSTS ASSOCIATED WITH MODIFICATIONS TO THE OXYGEN DELIVERY SCHEDULE OF THE ON-BOARD OXYGEN GENERATING SYSTEM

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INTRODUCTION: The On-Board Oxygen Generating System (OBOGS) is the latest oxygen delivery technology employed in modern air platforms. Currently, the OBOGS operates in two settings: a low altitude function (less than 11,000 ft) wherein a lower concentration of oxygen is delivered, and a high altitude function, which delivers a higher concentration. While higher oxygen concentrations (greater than 103 mmHg PaO₂ within the lung) are thought to be necessary to offset the reduction in ambient barometric pressure and to ensure adequate oxygenation, it is unknown if these oxygen concentration profiles are ideal for maintaining adequate levels of performance. Given the dichotomous nature of these OBOGS settings, it is possible that the high concentrations of oxygen could lead to a state of hyperoxia and the disruption of normal performance. **METHODS:** Fourteen active duty military personnel were subjected to 11,000 and 16,000 ft altitudes in an altitude chamber. Three oxygen concentrations (all greater than the minimum amount required for adequate lung perfusion) were delivered to participants on subsequent flights, during which a simple reaction time (SRT) task was completed. Additionally, a sea-level baseline measure was established prior to altitude exposure, to which comparisons could be made.

RESULTS: Separate repeated measures ANOVAs revealed no significant differences between the SRT baseline measures or those recorded during altitude exposure. Further, no significant differences were found in performance between oxygen concentrations within altitudes. **DISCUSSION:** Given the potentially negative consequences associated with hyperoxia, the goal of this study was to document the effects of a graduated oxygen delivery schedule on cognitive task performance, and to determine whether modifications to the in-flight O₂ delivery schedule would be adequate to maintain peak performance during operational use. With regard to the SRT task, preliminary results of this study indicate that varying oxygen concentrations and altitudes have no effect on task performance.

Learning Objectives:

1. The objective for this study was to examine the effects of oxygen concentrations lower than that currently employed on reaction time performance at high altitudes.

[152] INVESTIGATION OF BIOMARKERS OF LASER EYE INJURY USING MASS SPECTROMETRIC IMAGING

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INTRODUCTION: Matrix Assisted Laser Desorption/Ionization (MALDI) Mass Spectrometric Imaging (MSI) provides information on the spatial distribution and abundances of molecules within biological tissues. Laser-induced eye damage leads to the leakage of proteins from damaged cells into the surrounding ocular tissue. MSI can be used to identify candidate protein biomarkers in situ indicative of laser eye injury. **METHODS:** Mass spectra were acquired using an Autoflex Time-of-Flight tandem mass spectrometer (MS/MS), equipped with a Nd:YAG laser (355 nm, 1 kHz) for the MALDI source. Images were acquired with an average of 500 laser shots/pixel. Images were generated using FlexImaging 3.0. MALDI matrix was applied to the samples by pneumatic spraying with an artistic airbrush. Sixteen-micrometer slices of ocular tissue from rat, rabbit, swine, and rhesus monkey were obtained with a cryostat at -20°C and thaw-mounted onto indium tin oxide (ITO) coated glass slides for MALDI imaging. Select slices of ocular tissue were thaw-mounted onto positively charged glass slides and stained with hematoxylin and eosin (H and E) for histological observation. **RESULTS:** Comparisons were made between fixed and fresh (no fixation) ocular tissue slices as well as comparisons between healthy ocular tissue and ocular tissue with laser-induced damage. Embedding of whole eyes in Optimum Cutting Temperature (OCT) polymer was beneficial for preserving tissue morphology by preventing wrinkling and folding of the tissue during sectioning; however, OCT provided mass spectral interference from m/z 1150 to 1950. Ions not derived from matrix or OCT were identified through MS/MS

and imaged. **DISCUSSION:** MSI provided information on the localization and abundance of proteins and lipids in ocular tissue. Spatial distributions and identity of lipids and proteins were shown to be unique to specific regions of the eye for both healthy and laser-damaged tissue.

Learning Objectives:

1. Identify biomarkers for laser eye injury and describe their localization within the ocular tissue.

[153] +GZ-INDUCED VISUAL SYMPTOMS IN A MILITARY HELICOPTER PILOT: A CASE REPORT

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INTRODUCTION: Military helicopters are increasingly agile and capable of producing significant +Gz loads. In the tactical environment, factors such as dehydration and fatigue can adversely affect a pilot's +Gz tolerance. +Gz-induced symptomatology may be seen in such situations at lower +Gz levels than might otherwise be the case. As a result, the potential for adverse consequences of +Gz exposure to affect flight safety in military helicopter operations needs to be recognized. This case report describes a military helicopter pilot who experienced +Gz-induced visual impairment during low-level flight. **RESULTS:** The subject pilot was a 25-yr old Australian Army Blackhawk pilot. He was an experienced pilot, with 1500 total flying hours including 500 hours on the Blackhawk type. The incident occurred during a tactical training exercise in a tropical environment, with an ambient temperature of around 35°C. Due to the operational tempo of the exercise and the environmental conditions, aircrew were generally fatigued and dehydrated. During a low-level tactical flight at 200 feet, the pilot initiated a steep turn at approximately 30-40 degrees angle of bank. During the turn, the pilot noticed a significant deterioration of vision consistent with the grey-out phenomenon. The +Gz level was estimated at around +2.5 Gz. After releasing the bank angle, the pilot's vision returned to normal. The remainder of the flight was conducted without further incident. **DISCUSSION:** This case highlights the potential dangers of +Gz exposure in modern tactical helicopters. Although the +Gz level was moderate, the pilot's +Gz tolerance was reduced by the combined effects of dehydration and fatigue, allowing grey-out to occur at a lower +Gz level than normal. The dangers of such +Gz-induced visual impairment while operating at low level are clear. Loss of visual reference to the ground and an overall reduction in situational awareness could lead to ground impact. This case illustrates the need for more awareness of +Gz physiology and +Gz tolerance reducing factors in helicopter operations.

Learning Objectives:

1. Participants will learn about the dangers of +Gz exposure in helicopter pilots during low-level operations.

[154] IMPROVED QUALITY OF HYPOXIA TRAINING FOR HELICOPTER AIRCREWS

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INTRODUCTION: Helicopter aircrews may be exposed to moderately high altitudes (up to 18,000 feet). Hypoxia and its performance effects could be a realistic hazard. Therefore German helicopter aircrews of the Bundeswehr use a special helicopter breathing device. Prior to using the system in flight, the aircrews were familiarized with the device in the hypobaric chamber during regular aviation physiology training. The goals of the training were to demonstrate the ease of use and the protection against hypoxia. **METHODS:** The 6 seats of the hypobaric chamber were equipped with the helicopter oxygen system. The system consists of an oxygen store, a pulse dose oxygen system and a nasal cannula. The system releases a bolus of oxygen when a pressure drop induced by an inspiratory effort is detected.

After pilots (n=20) experienced their hypoxia symptoms at 18,000 ft in the altitude chamber, they turned on the breathing device to get oxygen through the cannula. The oxygen saturation was monitored. **RESULTS:** At 18,000 ft the oxygen saturation of the pilots dropped down to approximately 70 - 75%. After turning on the oxygen system it takes 45-60 seconds to reach full oxygen saturation. This period was 15 ± 4 seconds longer compared to breathing 100% oxygen through an oronasal mask system. To get a full and stable saturation it was necessary that pilots focused on an efficient inhaling (not breathing through the mouth). **DISCUSSION:** Helicopter pilots (CH 53) of the Bundeswehr now undergo their hypoxia training by using a helicopter breathing device which is already equipped in German helicopters (CH 53). In the hypobaric chamber pilots have the opportunity to familiarize themselves with the breathing device before using it in flight. After a test phase this training is now well established. With this system aircrews are protected from hypoxia at moderate altitudes.

Learning Objectives:

1. Understand a new method for helicopter aircrews to prevent hypoxia at altitude in a hypobaric chamber.

[155] THE HUMAN PUPILLARY LIGHT REFLEX RECORDED AT MEAN SEA LEVEL AND AT A NORMOBARIC APPROXIMATION TO AN ALTITUDE OF 14,000 FEET

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INTRODUCTION: We report the effects on the pupillary light reflex (PLR) of an exposure to normobaric hypoxia that approximated an altitude of 14,000 ft. above mean sea level (MSL). **METHODS:** The monocular PLR was recorded for 5 seconds using a commercial, off-the-shelf, hand-held clinical instrument that generated a 100 ms. full-field light flash of $10 \mu\text{w}/\text{cm}^2$. The PLR was recorded at MSL and at 14,000 ft. Of the 26 military aviator volunteers, half were tested at MSL before being tested at 14,000 ft.; this order was reversed for the other half. Testing began after at least 15 minutes adaptation to the MSL and to the 14,000 ft. conditions. The right eye was always tested immediately before the left eye. The PLR was scored along eight response parameters: (1) maximum pupil diameter, (2) minimum pupil diameter, (3) percent pupillary constriction, (4) PLR latency, (5) average constriction velocity, (6) maximum constriction velocity, (7) average dilation velocity, and (8) time for the pupil to return to 75% of its maximum diameter. Furthermore, the volunteers' workload required to make the PLR recording at MSL and at 14,000 ft. was assessed using the NASA-Task Load Index (NASA-TLX). **RESULTS:** An Analysis of Variance of the PLR data showed a complex 3-way interaction of altitude (MSL vs. 14,000 ft.) by eye (Left vs. Right) by order (MSL vs. 14,000 ft. first) that is most parsimoniously understood as reflecting higher-order cognitive and emotional influences on the PLR. The strongest statistically significant effect of the hypoxic stress involved the NASA-TLX, which demonstrated that PLR recording did entail a small but measurable workload that increased by a factor of 3 when hypoxic. **DISCUSSION:** While the results provided little evidence that hypoxia altered the PLR, recording the PLR at MSL imposed a slight but measurable workload that increased with hypoxia.

Learning Objectives:

1. To introduce the attendees to the pupillary light reflex (PLR), its measurements and characteristics, the effect of hypoxia, and the measurement of workload.

[156] THE EFFECT OF A CONSTANT MATB INFORMATION INPUT RATE ON HUMAN PERFORMANCE WITH INCREASING NUMBER OF TASKS AND TASK COMBINATIONS

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INTRODUCTION: Human multitasking is of central importance to military, industrial, and aerospace applications. Numerous studies have investigated the effects of increased number of tasks on multitasking

performance. However, in increasing the number of tasks, typically the total rate of information presented to a human operator also increases. Using a mathematical model based on information theory, the overall system complexity and human performance can be described in a single, objective metric. The goal of this study is to assess the effect of a different number of tasks and task combinations on human multitasking performance at a constant information input rate. **METHODS:** The Multiple Attribute Task Battery (MATB) is a testing platform originally developed by NASA to present an operator with four task components: Monitoring (M), Communications (C), Resource (R), and Targeting (T). MATB was recently modified by AFRL (AF-MATB) to include, in part, an information throughput mode (AF-MATB-IT) used in this study. Thirty-one participants performed four three-task combinations (MCT, MCR, MRT, CRT) and one four-task combination (MCRT) at a constant information input rate of 1.2 bits/s. Trial order was randomized to control for learning effects. **RESULTS:** Statistical power to detect performance differences of 0.1 at the $\alpha=0.05$ level was calculated to be over 99%. Results show that multitasking performance (information throughput) was not significantly affected by task combination ($p=0.5253$) nor by number of tasks ($p=0.2097$). **DISCUSSION:** The results of this study suggest that multitasking performance may be more dependent on the rate of information presented to a human operator, rather than the number of concurrent tasks. No previous study has been able to examine this topic in this way due to a lack of an objective metric. By using a model based on information theory, future studies can quantitatively examine factors (e.g., fatigue) that affect human multitasking performance.

Learning Objectives:

1. A mathematical model of multitasking based on information theory has been developed. Results indicate that multitasking performance may be more dependent on the rate of information presented to a human operator, rather than the number of concurrent tasks.

[157] VISUAL SCAN PATTERNS IN NOVICE AND EXPERT HELICOPTER PILOTS DURING UNUSUAL ATTITUDE RECOVERY

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INTRODUCTION: Unusual attitude (UA) in a helicopter is a serious event, potentially leading to loss of control. Pilots must recognize and recover quickly by scanning the instruments and the outside world. This study is part of a wider investigation into scanning patterns and information acquisition by pilots. The aims of this study were to find out what pilots look at and when during UA recovery, and the effect of flight experience on their scanning strategy. **METHODS:** Six participants with varying level of experience flew day VFR flights in Swinburne's helicopter simulator. At a random point, the investigator took control and placed the aircraft in an unusual attitude, with the subject pilot (eyes closed) unaware of the resultant attitude change. The participants were then asked to take control and recover to straight and level flight. During the experiment the pilots wore a head-mounted eye tracker, which provided objective data on what they looked at. Fixation time was expressed as a percentage of the total recovery time. **RESULTS:** During the UA recovery, the airspeed indicator was the most referred to instrument (15%), followed by the attitude indicator (10%), the altimeter (6%) and the engine instruments (6%). The attitude indicator was the first instrument scanned by all pilots, and in 67% of cases it was also the last instrument scanned. The average recovery time was 28 seconds. There was a statistically significant difference between the scanning patterns of expert vs novice pilots ($p<0.01$). Experts spent more time on instruments during recovery, while novices spent more time looking outside. There was no significant difference between the recovery times of expert vs novice pilots. **DISCUSSION:** The results of this study highlight the importance of quick and accurate visual acquisition of information from instruments and the outside world during UA recovery. Awareness of aircraft attitude at the outset is of prime importance, shown by the fact that the attitude indicator was the first instrument scanned. The results also show that experts appear to rely on the

instruments more so than novice pilots. The results of this study help to further our understanding of visual scanning and information acquisition by pilots during critical stages of flight.

Learning Objectives:

1. Participants will learn about visual scanning patterns in helicopter pilots during unusual attitude recovery.

[158] ANTI-G STRAINING MANEUVERS INDUCED CEREBRAL OXYGENATION CHANGES DURING PRE-GZ ONSET AND GZ EXPOSURES

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INTRODUCTION: The tissue oxygenation index (TOI, cerebral oxygenation saturation), which was determined by near infrared (NIR) spatially resolved spectroscopy, has been reported to be less prone to contamination from extracranial blood flow. The anti-G straining maneuver (AGSM) occasionally induced TOI drop during Gz onset countdown. The present study was conducted to determine the effect of these pre-Gz intracranial oxygenation drops on anti-G performance during higher Gz exposures. **METHODS:** There were 38 healthy male cadets participated in this study. TOI was measured from the forehead using NIRS during Gz exposures. The NIRS measurements were also recorded during AGSM training on the ground level. Subjects were exposed two centrifuge profiles without anti-Gz system. The profiles included a gradual onset run (GOR, onset rate of 0.1 Gz/sec) with maximum of 8Gz and short-term repeated exposure 10 sec plateau from 4 Gz to 7Gz at an onset rate of 1.0 Gz/sec (ROR). **RESULTS:** All the subjects successfully performed AGSM and maintained or increased TOI during Gz exposure. The AGSM induced TOI drop was observed in 15 subjects at the ground level and in 12 subjects during the Gz onset countdown to ROR. There were 7 subjects showed TOI decrement during both the ground level and the Gz onset. There was no significant difference in the TOI decrement at over 6Gz plateau between groups with and without AGSM TOI drop at the ground level. **DISCUSSION:** The AGSM maintained the intracranial oxygenation levels during higher Gz exposures even though pre-Gz AGSM induced TOI drop, which may be caused by cerebral vasoconstriction. The present results also showed the TOI monitoring may be useful to develop an effective AGSM to prevent intracranial oxygenation decrease during Gz exposures.

Learning Objectives:

1. To understand intracranial oxygenation during anti-G straining maneuver during both ground and Gz exposures.

[159] METRICS AND METHODS FOR REAL-TIME TASK PERFORMANCE ASSESSMENT

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INTRODUCTION: Manual control of any modern spacecraft is a task of shared control between a human or team and the underlying control system. Evaluating human performance in real-time offers the significant advantage of including the human-system performance as a feedback parameter. Meaningful real-time operator monitoring is a key component for a comprehensive assessment of an operator's state and mission performance, and it provides valuable diagnostic information. **METHODS:** A flexible simulation architecture was developed for integrating vehicle models with a real-time metrics engine and algorithms. A control station was also developed for hosting and interfacing with the simulations. Three real-time objective workload metrics were implemented: response time to a two-choice secondary task, hand controller input entropy analysis, and the root mean square error of the attitude error. In addition, we implemented a speech recognition engine to analyze the accuracy of required

system state callouts. **RESULTS:** Piloted lunar landing, Orion/MPCV docking with the ISS, and an ISS SAFER self-rescue simulations were integrated, which included system dynamics models, flight displays, metrics display, configuration, and data logging capability. The secondary task response time was used for comparison against the unobtrusive workload estimates from hand controller analysis and flight performance. The utterances spoken by the user are recognized by the speech engine and then compared against the actual simulated vehicle state and are scored correct based on temporal and spatial parameters. **DISCUSSION:** This simulation providing validated real-time performance monitoring during flight critical piloting tasks offers a platform that enables NASA HRP scientists to explore the relationship between their area of research and performance, as well as assess the efficacy of countermeasures. The development and validation of real-time performance metrics and the quantification of human performance during operationally-relevant tasks and scenarios has applications toward increasing safety and efficiency, as well as improving the design of future vehicles. This work was supported by the National Space Biomedical Research Institute through NASA NCC 9-58, Project HFP03401.

Learning Objectives:

1. The audience will learn how about candidate metrics and methods for estimating pilot performance in real-time.

[160] COLLECTION AND CHARACTERIZATION OF NANO AEROSOL IN CARGO AREA OF C-17

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INTRODUCTION: Nanoaerosols (NAs) are unintentionally formed as a byproduct of combustion. They are made up of nanoparticles with diameter 1 to 100 nm and are more reactive than bulk materials due to their greater surface area per unit mass. The small size of NAs creates the potential to cause toxicity at concentrations significantly lower than the previously established exposure limits recommended by the National Institute for Occupational Safety and Health. **METHODS:** The field sampling was conducted using direct reading instruments and an electrostatic precipitator onboard a C-17 prior to takeoff, in flight, and after landing. Direct reading instruments used to characterize the real-time size distribution and concentration of the NA emitted from the C-17 included a scanning mobility particle sizer and condensation particle counter. NAs collected using the electrostatic precipitator were characterized post-collection for size, morphology, and elemental composition using electron microscopy and energy dispersive spectroscopy. **RESULTS:** Real-time analysis demonstrated that the NA concentration was highest before takeoff and dropped below background during flight. Post-collection analysis indicated that NAs contained aggregated carbonaceous particles with average primary particle size of 44 nm, and sized distribution ranging from 10 to 154 nm. **DISCUSSION:** The results suggest that the greatest concern for inhalation exposure to NAs is before takeoff and that the NAs consist primarily of combustion byproducts. Carbonaceous NAs have a high affinity to adsorb volatile chemicals, which are likely present in the combustion product. Further research should be completed to further characterize NA-chemical mixtures and their toxicological implications. The impact of understanding the exposure environment onboard an aircraft is to protect airmen from inhalation hazards that can degrade their performance.

Learning Objectives:

1. Understand the process and challenges for field sampling of NAs.
2. Realize the point for highest risk of exposure and primary composition of NAs in the environment onboard a C-17.
3. Recognize remaining challenges for toxicological implications of exposure to NAs.

[161] FACILITATING THE TRANSITION FROM BRIGHT TO DIM ENVIRONMENTS

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INTRODUCTION: High among the list of desired capabilities for Warfighters, enumerated by MG Wojdakowski, was combat protective eyewear with lenses that would instantly change the amount of light they transmit (optical density) with changes in lighting conditions. We report our evaluation of the effect of four different protective spectacle lens designs (clear, standard sunglass, step filter, and electro-optical) on a Soldier's ability to rapidly transition from bright to dim environments. Since these protective lenses will be worn at all times in theatre, their effect on the visual performance of volunteers in both bright and dim environments was evaluated. The dependent measures were selected to allow the findings to be evaluated in both clinical and operational terms. **METHODS:** Five different conditions were evaluated. (1) No eyewear, (2) Approved Protective Eyewear List (APEL) Clear eyewear, (3) APEL Sun eyewear, (4) APEL Step Filter eyewear, and (5) Electro-optical eyewear. For each spectacle condition, visual acuity and precision marksmanship were measured under bright conditions (50.7 Foot-Lamberts [FL]). Then the subject's light adapted for four minutes while viewing a brightly illuminated white board (378 FL). Following light adaptation, the flood lights were turned off and under dim illumination the adaptation time to identify objects (heads [2.57x10⁻³FL], torsos [19.1x10⁻⁴ to 0.73x10⁻⁴ FL], rifle [1.03x10⁻⁴]) and lights (from 0.199 to 0.0005 FL) was recorded. Subjects ranked their preferences for the five types of eyewear. **RESULTS:** Visual acuity and marksmanship results were not significantly different between any of the five conditions. The preference ratings show that the Step Filter and Electronic eyewear were preferred over no eyewear, APEL Clear eyewear, and APEL Sun eyewear. No difference in preference was found between the Step Filter and Electronic eyewear. **DISCUSSION:** The Step Filter and Electronic eyewear were preferred. Operational performance of these two devices was at least equal to the other conditions tested.

Learning Objectives:

1. Present the operational importance of spectacle parameters on early visual dark adaptation.

[162] EVALUATION OF THE EFFECTS OF VESTIBULAR STIMULATION ON COGNITIVE PERFORMANCE

R.R. Baptista^{1,2}, E. Rosa^{3,1}, R. Sartori², L. Disiuta¹, I. Lamadrid¹, L. Miéres¹, T. Massoni¹, D.A. Green⁴, and T. Russomano^{1,4}

¹Microgravity Centre, PUCRS, Porto Alegre, Brazil; ²Physical Education School, PUCRS, Porto Alegre, Brazil; ³Cognitive Science Discipline, Umeå University, Umeå, Sweden; ⁴Centre of Human Aerospace and Physiological Sciences, Kings College London, London, United Kingdom

INTRODUCTION: Spatial disorientation in flight and motion sickness during space missions are seen as a consequence of concurrent interactions of inputs coming from the visual, proprioceptive and vestibular systems. This multisensory interaction may compromise higher order functioning in secondary tasks once cognitive resources are engaged in establishing orientation and balance. This study aimed to investigate the effects of spatial disorientation on cognitive processes represented by two simple verbal and spatial tasks. **METHODS:** A total of 24 volunteers participated in 4 randomized rotation runs (2 clockwise, 2 anticlockwise) with a speed of 1200,sec⁻¹ in a Barany's Chair. They were asked to perform distinct spatial and verbal cognitive tasks in the 5 phases of each rotation run: pre-rotation, acceleration, constant speed, sudden-stop (perceived reverse rotation) and post-rotation. Accuracy of responses, reaction time and cognitive throughput were used as being indicative of cognitive performance. Repeated ANOVA with Bonferroni's post-test was performed using GraphPad InStat and GraphPad Prisma with a level of significance of p<0.05. **RESULTS:** There were no significant differences between the 5 phases for accuracy of responses, cognitive throughput and reaction time for both spatial and verbal tasks, considering the clockwise and anticlockwise runs. **DISCUSSION:** The findings of this study have shown that cognitive function in both spatial and verbal tasks did not deteriorate during the 5 phases of the tests, either during clockwise or anticlockwise rotations. Therefore, the results suggest that the vestibular stimulus used in this study was insufficient to cause cognitive impairment. Further investigations should be conducted to evaluate the influence of

a greater degree of vestibular stimulation on cognitive responses to simple tasks.

Learning Objectives:

1. To understand the influence of vestibular stimulation on the performance of spatial and verbal cognitive tasks and the methods used to simulate spatial disorientation on the ground.

[163] QUANTITATIVE MODEL OF TIME-TRIAL PERFORMANCE DECREMENTS AT VARYING ALTITUDES

B.A. Beidleman, C.S. Fulco, S.P. Andrew, J.E. Staab, and S.R. Muza
Thermal and Mountain Medicine Division, USARIEM, Natick, MA

INTRODUCTION: It is well established that endurance exercise performance declines with increasing altitude (ALT). No quantitative models, however, exist that accurately predict the magnitude of these performance decrements from sea level (SL) to ALT over a wide range of altitudes. **METHODS:** Using multiple linear regression and a comprehensive database, we analyzed time-trial (TT) performance on 152 unacclimated men and women who spent between 4 to 12 h at altitudes ranging from 2024 to 4247 m under experimentally-controlled conditions. Covariates were ALT, age, height (Ht), weight (Wt), maximal oxygen uptake (VO_{2max}), gender, TT performance at SL, smoking status, and body mass index (BMI) classification (normal weight vs. overweight). The dependent variable was the % decrement in TT performance from SL to ALT. **RESULTS:** ALT was the largest significant predictor ($P < 0.0001$) of the % decrement in TT performance. BMI classification ($p = 0.009$) and the interaction between BMI classification and altitude ($p = 0.012$) were also significant predictors. From 2000 to 3000 m, the % decrement in TT performance increased from 3.1% to 12.0% in normal weight individuals and from 9.2% to 19.4% in overweight individuals. The TT performance decrement in overweight individuals was 60.7% worse ($p = 0.009$) than that of normal weight individuals at 3000 m. However, as ALT increased from 3000 m, the disparity between groups lessened until 3851 m where the TT performance decrement became progressively worse for normal weight individuals. Age, Ht, Wt, VO_{2max} , gender, TT performance at SL, and smoking status were not significant predictors in the model. **DISCUSSION:** These models can be used by military commanders to estimate endurance performance decrements at ALT and suggest that in addition to increasing ALT, being overweight was associated with larger decrements in TT performance up to 3851 m. **Disclaimer:** 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. At the conclusion of this activity, participants will identify the key parameters associated with endurance performance decrements at altitude.

[164] AFTEREFFECTS FOLLOWING CIRCULAR VECTION EXPOSURE

J. Moss¹ and E. Muth²

¹U.S. Army Research Laboratory-Human Research & Engineering Directorate, SFC Paul Ray Smith Simulation & Training Technology Center (ARL-HRED STTC), Oviedo, FL; ²Psychology, Clemson University, Clemson, SC

INTRODUCTION: When participants are aware that they are being rotated, they are able to incorporate corrections into their reaching movements to counteract anticipated Coriolis forces (Lackner & DiZio, 1994; 1997). It is reasonable to suggest that these findings should extend to locomotion. Anstis (1995) reported aftereffects of moving forward while jogging in place after running on a treadmill. Presumably, participants developed a perceptual recalibration—a forward gait—to prevent them from falling off the treadmill. The purpose of this study was to examine the effects of circular illusory self-motion (i.e., circular-vection; CV) on locomotion. It was predicted that participants would make leftward (counter-clockwise; CCW) locomotion errors after viewing, while stationary, a vection-inducing visual stimulus of a clockwise (CW) rotating dot pattern. **METHODS:** Nineteen participants performed 45 s walk-in-place task trials before and after viewing a CW rotating visual stimulus known to induce

CCW CV. Participants viewed the stimulus while seated and performed the task, while blinded, inside an optokinetic drum. **RESULTS:** Movement measures from four pre-CV exposure trials for each participant were averaged to establish a baseline to examine changes in five post-CV exposure trials. Repeated measures ANOVAs revealed significant changes from baseline in x-axis (i.e., left/right), y-axis (i.e., forward/backward), and angular (i.e., rotation) movement. Net movement (i.e., radial distance) did not significantly change. X-axis and angular movements were towards the left. **DISCUSSION:** The hypothesis was supported—a CW visual stimulus (inducing CCW CV) induced leftward locomotion errors during a post-exposure walk-in-place task. Following the illusory CCW motion, participants demonstrated aftereffects of rotating to the left in a walk-in-place task. The applied implications of these findings demonstrate the reasonable possibility of perceptual aftereffects following stationary simulator/head-mounted display virtual environment (HMD VE) usage. These aftereffects present potential safety concerns (e.g., locomotion errors) and negative training transfer when using simulator/HMD VEs.

Learning Objectives:

1. Perceptual locomotion aftereffects from circular vection exposure are demonstrated and the applied implications on human performance with simulator use are discussed.

[165] AERONAUTICAL PSYCHOLOGY: THE PSYCHO-AEROTYPES A STUDY ON THE PILOT PERSONALITY

J. Mirabal

Sociedad Interamericana De Psicología Aeronautica, Caracas, Venezuela

INTRODUCTION: This work was initiated ten years ago, the goal was to find a psychological profile to define the “ideal” personality of a civil aviation pilot. They interviewed 1,000 aspiring commercial pilots and aviation each interview was made about 30 minutes, they were given a battery of psychological tests and a review of their medical records was performed. Later it became a qualitative and a statistical analysis to analyze different characteristics of your personality, goals, desires and his record of incidents and accidents. As the main objective of the research related to their personality characteristic, the results indicated that there is a unique and distinct personality among civilian pilots studied. However, the data showed several groups of pilots who had very similar characteristics. We proceeded to identify with a letter each group with similar characteristics, and after a second analysis the Psycho-aerotypes arise. These are 5 groups of pilots who have similar behaviors, attitudes to flight, motivation and development of its aviation activities that are common to each different group. The letters of each group are identified: “P”, “I”, “L”, “O”, “T”. These in turn has been given a name: Professional, Informal, Borderline, Omega and Temerarious, this name that helps you easily identify its main feature in the aeronautical activity. **Conclusions:** First, there is a unique and distinct personality for the pilot profession. Second, if there are groups of pilots who have behavioral characteristics, motivation and similar professional development and that can be identified within 6 groups defined, and finally, the Psycho-aerotypes can be a very useful resource to guide the selection, certification, prevention, study of human factors and accident investigation.

Learning Objectives:

1. Aeronautical psychology as applied in pilot selection.

Tuesday, May 12

S. Hemisphere 1

10:30 A.M.

[XXVII.] PANEL: BEHAVIORAL HEALTH AND PERFORMANCE IN HUMAN SPACEFLIGHT

Sponsored by the Space Medicine Association

Chair: Steve Vander Ark

Houston, TX

PANEL OVERVIEW: This panel will provide presentations detailing the Behavioral Health and Performance (BHP) advancements that are occurring in research and operations at NASA Johnson Space Center. In early 2015 the first crew to complete a one-year mission onboard ISS will begin their mission. The panel will include a summary of the BHP support and monitoring that will occur for this mission, as well as a more detailed discussion of the cognitive monitoring tool used for all ISS missions. Further, a description will be provided of two important components of the fatigue management activities for ISS crewmembers and mission controllers, including a mindfulness training strategy and optimizing lighting in NASA's Mission Control Center. Looking beyond ISS missions, the BHP Research team at JSC is systematically considering the challenges that will impact crew performance on exploration missions beyond low Earth orbit. The panel will inform participants of the overall risk to team performance due to the challenges of long-distance spaceflight as well as provide a summary of preliminary study results assessing the impact of a communication delay on task performance by ISS crewmembers.

[166] EFFECTS OF COMMUNICATION DELAYS ON TEAM PERFORMANCE AND FUNCTIONING ABOARD THE INTERNATIONAL SPACE STATION

W.B. Vessey¹, L.A. Palinkas², and L.B. Leveton³

¹Enterprise Advisory Services Inc., League City, TX; ²University of Southern California, Los Angeles, CA; ³NASA Johnson Space Center, Houston, TX

INTRODUCTION: Future space exploration missions will involve significant communication delays between the Earth and exploration spaceflight crews. For example, Mars planetary surface missions could involve communication delays of up to 22 minutes each way. Because of this, future missions will likely require changes to the current status quo of Mission Control (MCC) acting as the primary resource for technical work and support related to the vehicle. Given the coordination demands on the International Space Station (ISS) between crew and MCC, a study was conducted to determine the impacts of communication delays on crew and MCC performance and functioning. **METHODS:** A set of 10 tasks conducted by crews on the ISS were identified for inclusion in the study. Each of these tasks required coordination between crew and MCC, as well as participation of at least two crewmembers in the task. Of these 10 tasks, 6 were included in the control condition of no communication delay and 4 were included in the communication delay condition. For those tasks that were communication delayed, a 50-second one-way communication delay was added to the crew-to-ground communication audio loop. After completing control and communication-delayed tasks, crew and MCC participants completed a short questionnaire on their experiences. All tasks were audio recorded and subsequently content coded. **RESULTS:** Completion of data analysis is pending, with final results to be presented at ASMA. Preliminary results indicate significant differences between control and communication-delayed conditions with respect to performance, time to task completion, and ease of coordination between crew and MCC. **DISCUSSION:** Communication delays seem to have a significant impact on performance of tasks under current spaceflight conditions and with current procedures and technologies. This indicates the criticality of designing vehicles, procedures, and ground support around expected communication delays. Specific recommendations based on the results of data analyses will be discussed.

Learning Objectives:

1. Describe the relationship between communication delays and task performance.

[167] CURRENT EVIDENCE FOR THE RISK OF PERFORMANCE DECREMENTS DUE TO INSUFFICIENT COOPERATION, COORDINATION, COMMUNICATION, AND PSYCHOSOCIAL ADAPTATION WITHIN A TEAM IN SPACEFLIGHT OPERATIONS

W.B. Vessey¹, L.B. Landon², H.N. Patterson³, and C.H. Rokholt⁴

¹Enterprise Advisory Services Inc., League City, TX; ²Wyle Science, Technology and Engineering Group, Houston, TX; ³University of Houston, Houston, TX; ⁴Rice University, Houston, TX

INTRODUCTION: Future long-distance space exploration (LDSE) missions will differ substantially from current low-Earth-orbit International Space Station missions. With respect to crew psychology, critical differences include long-duration social isolation, confinement, danger, a smaller vehicle, and communication delays between the crew and their support on Earth. One driver of crew functioning and performance that may be greatly affected by LDSE challenges is the crew's teamwork. The Behavioral Health and Performance (BHP) Element of the Human Research Program at NASA Johnson Space Center has a portfolio of research dedicated to identifying potential issues of performance and team functioning that could be caused by poor teamwork, including decrements in coordination, cooperation, communication, and adaptation, referred to as the Team Risk. A recent review of evidence from the extant literature and BHP-solicited research has resulted in a reevaluation of the current Team Risk posture for future LDSE missions. **METHODS:** A literature review was conducted by a group of BHP psychologists, with a focus on identifying and synthesizing the available evidence for the likelihood of performance and long-term health decrements due to insufficient teamwork. Literature was first identified via keyword search and then evaluated for degree of relevance to spaceflight missions. Relevant data were then extracted from literature identified as relevant to spaceflight operations. **RESULTS:** The studies examined indicate the criticality of teamwork to team functioning and performance in environments like LDSE. Of particular note is the pattern of results indicating the dynamism of team cohesion over time and between teams, indicating that any countermeasures applied to ameliorate the effects of poor teamwork will need to be individualized to the team in question. **DISCUSSION:** A clear relationship exists between teamwork and performance in environments similar to LDSE missions. Specific findings of interest and critical relationships between teamwork factors and performance are described.

Learning Objectives:

1. Describe the relationship between teamwork and spaceflight crew functioning and performance.

[168] PSYCHOLOGICAL SUPPORT OPERATIONS FOR THE ISS ONE-YEAR MISSION

S. Vander Ark¹, G. Beven², and A. Holland²
¹Wyle, Houston, TX; ²NASA JSC, Houston, TX

INTRODUCTION: Since NASA began human presence on the International Space Station (ISS) in November 1998, crews have spent two to seven months onboard. In March 2015 NASA and Russia will take the next step in ISS utilization, with two of their crewmembers conducting a one-year mission onboard ISS. The mission will allow researchers, mission planners and others to add to their understanding of the human and technological challenges that may be faced on missions beyond Low Earth Orbit. While the NASA Human Research Program completes their investigations, the Johnson Space Center's (JSC's) Space and Clinical Operations Division will complete pre-flight and in-flight operations based on what has been learned from the first 42 ISS missions, and other lessons that may be available from the Russian's Mir crews that were in space for 10-14 months. The Behavioral Health and Performance Group (BHP) at JSC will continue its responsibility to provide pre-flight training, evaluation, and preparation as well as in-flight psychological support for the NASA crewmember. Planning was completed collaboratively with all ISS international partners within the Human Behavior and Performance Working Group to leverage their collective expertise; however, the U.S. and Russian BHP personnel will be responsible for their respective crewmembers. This group of experts agreed that issues of primary importance for a one-year mission include the following: - Managing Work/Rest Schedule - Monitoring Behavioral Health - Time off During Pre-, In- and Post-flight - Comprehensive Contingency Planning - Monitoring Crew-Ground Relationships - Enhanced Psychological Support Resources - Enhanced Communication with International BHP Partners The BHP team at NASA has worked closely with their crewmember and his family to define a specific support plan, and collaborated with his Crew Surgeon and Crew Support Astronaut. These individuals will closely coordinate their support efforts during the mission. It is hoped that we will begin expanding our knowledge in operations and research to inform future exploration missions.

Learning Objectives:

1. This presentation will help participants understand the behavioral health monitoring and support activities planned for crewmembers of a one-year ISS mission, and how these may differ from activities completed for the regular six-month missions.

[169] LEARNED STRESS RESILIENCE

R.C. Moomaw

Wyle/UTMB, Houston, TX

INTRODUCTION: Stress resiliency training is a countermeasure developed to provide two significant benefits to both astronauts and ground crew; mitigation of the physiologic effects of stress both environmental and psychological. The second benefit is decreasing the time required to initiate sleep and return to sleep if awakened during a sleep period. Stress is an environmental or psychological issue that adversely affects an individual's ability to function efficiently. The effect of stress is both physiologic and psychological, compromising efficiency, decreasing the resilience of the individual. Two of the commonly known physiologic effects of stress are reflected by rigidity of the vasculature and production of stress hormones. Recent studies have objective data showing that the physiologic effects of stress can be mitigated by changing an individual's perspective of the stressor. In that it is impossible to eliminate stress, resiliency training is an important component for those individuals that are exposed to high stress environment. Psychological training for resilience to stress is focused on first identifying the stressful environments whether psychological or physical. Using mindfulness training, the individual will experience control of the physiologic responses to stress in a nonthreatening environment and then use this training in high stress environments. The training allows the individual to experience relaxation through focused cognitive techniques. The human mind has the ability to mask and block both sensory and psychological stressors by learning to occupy the two executive domains of consciousness. The human mind can only attend to two executive tasks at one time and by learning to control the focus of the thought process effectively block out unwanted stressors. When an individual is trained to change their perspective of the stressful environment there are physiologic and psychological benefits that mitigate the deleterious effect of a high stress environment.

Learning Objectives:

1. At the end of the presentation, the participants will understand that perception of a stressful event is more deleterious than the stress of the event.

[170] COGNITIVE ASSESSMENT IN LONG-DURATION SPACEFLIGHT: UPDATEK. Seaton¹ and R. Kane²¹*PMCH, UTMB, Houston, TX;* ²*Department of Neurology, Georgetown University Medical Center, Washington, DC*

INTRODUCTION: The Spaceflight Cognitive Assessment Tool for Windows (WinSCAT) was developed for medical operations at NASA's Johnson Space Center in Houston, Texas and includes five cognitive assessment tests. WinSCAT is a medical requirement for long-duration U.S., JAXA, ESA, and CSA astronauts and has been implemented with all expeditions to date on the International Space Station (ISS). Its purpose is to provide crew surgeons with objective clinical data following an unexpected traumatic event, a medical condition, or the cumulative effects of spaceflight that could negatively affect an astronaut's cognitive status and threaten mission success. In 2011, WinSCAT was updated to increase difficulty of mathematics items, to incorporate a moving rather than fixed baseline, to implement stricter interpretation rules, and to add network capability to support a 6-person crew. **METHODS:** WinSCAT results from 38 ISS missions were reviewed to detect potential changes in cognitive functioning in spaceflight. **RESULTS:** Out of 294 test trials, 37 (12.6%) were off-nominal compared to baseline performance. After implementation of the new version and stricter interpretation rules, 18 (18.8%) of 96 test trials have been off-nominal. No evidence was found to suggest that overall cognitive performance declines as a result of 6-month missions on ISS. Possible explanations for individual off-nominal scores will be reviewed. **DISCUSSION:** The ability for crewmembers to have an objective measure

of cognitive functioning will be increasingly important as mission durations increase to one year and longer. Self-assessments with immediate feedback will be essential with increased crew autonomy and communication delay. Immediate objective feedback can provide crewmembers an alert to implement in-flight countermeasures to reduce the risk of errors.

Learning Objectives:

1. Summarize the purpose of cognitive assessment in long-duration spaceflight and describe overall findings.

[171] EVIDENCE-BASED RECOMMENDATIONS FOR OPTIMIZING LIGHT IN DAY-TO-DAY SPACEFLIGHT OPERATIONSA. Whitmire¹, L.B. Leveton², L. Barger³, L. Bollweg², K. Ohnesorge², and G. Brainard⁴¹*Wyle, Houston, TX;* ²*Division of Biomedical Research and Engineering Science, NASA Johnson Space Center, Houston, TX;* ³*Division of Sleep Medicine, Brigham and Women's Hospital, Boston, MA;* ⁴*Department of Neurology, Thomas Jefferson University, Philadelphia, PA*

INTRODUCTION: The NASA Behavioral Health and Performance Element (BHP) has previously reported on efforts to transition evidence-based recommendations for a flexible lighting system on the International Space Station (ISS). Based on these recommendations, starting in 2016, the ISS will replace the current fluorescent-based lights with an LED-based system to optimize visual performance, facilitate circadian alignment, promote sleep, and hasten schedule shifting. Additional efforts related to lighting countermeasures in spaceflight operations have also been underway. As an example, a recent BHP research study led by investigators at Harvard Medical School and Brigham and Women's Hospital, evaluated the acceptability, feasibility and effectiveness of blue-enriched light exposure during exercise breaks for overnight shift workers in the Mission Control Center [J1] at NASA Johnson Space Center. This effort, along with published laboratory studies that have demonstrated the effectiveness of appropriately timed light for promoting alertness, served as an impetus for new light options and educational protocols for Flight Controllers. Additionally, recommendations related to the light emitted from electronic devices such as ISS-grade laptops, I-Pads, and Android devices were provided to the astronaut office this past year. These recommendations were based on an assessment led by NASA's Lighting Environment Test Facility, which included measuring the spectral power distribution, irradiance, and radiance of light emitted from these devices. Evaluations were conducted with and without the use of off-the-shelf screen filters as well as a software application that purports to minimize short-wave length of the visible light emissions. This presentation will focus on the transition for operations process related to built-in, ambient lighting countermeasures in the MCC, as well as the evidence to support recommendations for optimal use of laptops, I-Pads and Android devices during all phases of spaceflight operations.

Learning Objectives:

1. Attendants will learn about transitioning research related to lighting countermeasures, into spaceflight operations.

Tuesday, May 12
S. Hemisphere 2**10:30 A.M.****[XXVIII.] PANEL: A PERSPECTIVE ON THIRD CLASS MEDICAL CERTIFICATION FOR GENERAL AVIATION***Sponsored by the AsMA Aerospace Safety Committee***Co-Chair: Douglas Boyd**
*Houston, TX***Co-Chair: Charles DeJohn**
Oklahoma City, OK

PANEL OVERVIEW: Arguments advanced by several general aviation pilot associations favoring the elimination of the third-class medical certificate for a subset of airmen include (a) financial cost and (b) few accidents in light sport aircraft attributable to medical deficiency. The original exemption would limit the pilot to single-engine, fixed gear aircraft, a maximum of 180 horsepower and four seats. This Panel will discuss various points of view and alternate medical certification approaches in the UK and Canada. AOPA argues that pilots can be taught the significance of key medical parameters (e.g. HDL, blood pressure) via a robust educational program that addresses factual and personalized information towards self-certification. Nevertheless, some aerospace physicians have expressed concern about the negative impact of self-certification on aviation safety. Indeed, an NTSB study noted that fatally injured pilots without current medical certification were more likely to show positive post mortem toxicology than those with medical certification. In the UK the National Private Pilots' License (NPPL) medical standards are based on the Driving Vehicle License Authority medical standards. Applicants with normal vision and without significant previous medical history qualify medically for a NPPL. This application is signed by a GP with access to the airman's medical records. The NPPL is being replaced by the Light Aircraft Pilots License which allows operations across Europe. This requires a stricter medical standard but can be performed by any registered GP again only if there is no significant medical history. A prior medical history warrants assessment by an authorized Aviation Medical Examiner through an examination standard equivalent to the FAA Class 3. Canada provides airmen with an option (Category 4) for a non-ICAO Recreational Pilot Permit via a self-declaration certification process. Operations are restricted to single engine, low performance aircraft (two occupants maximum) in Canadian airspace.

[172] MEDICAL STANDARDS FOR PRIVATE PILOTS

M.F. Hudson

Medical Adviser, Thomas Cook Airlines, Crewe, United Kingdom

INTRODUCTION: Recently in Europe and the USA there is a move to lower the medical standards required for recreational pilots because the medical standards were considered too stringent and more pilots needed encouragement to start flying training. Recreational flying varies from the simplest of micro-light aircraft to more sophisticated twin jet engine private aircraft. In the USA there is a suggestion that private pilots should provide a self-certification statement confirming that there is no significant previous medical history. Concern has arisen particularly among doctors but this may be because of vested financial interests rather than safety concerns. This paper reviews the European situation concerning the UK National Private Pilots Licence (NPPL) and the European Aviation Safety Agency's introduction of the Light Aircraft Pilots Licence (LAPL). NPPL medical standards are based on UK Driving Vehicle Licence Authority (DVLA) driving medical standards. Applicants with no significant previous medical history and normal vision qualify medically for the DVLA Group 2 standard for professional driving and for a NPPL. This application is signed by a GP who must have access to the medical records. If there is a past history of significant illness but the applicant meets the Group 1 standard for private driving the pilot may fly either solo or with a 'safety' pilot. The NPPL only permits flying in UK airspace. The NPPL is being phased out and replaced by the LAPL which permits flying in any EASA state. This requires a stricter medical standard but can be performed by any registered General Practitioner but only if there is no significant previous medical history. Where there is a previous medical history then the applicant has to be assessed by an authorized Aviation Medical Examiner (AME). The medical examination standard is equivalent to the current FAA Class 3.

Learning Objectives:

1. To consider what are appropriate medical standards for recreational pilots.

[173] AOPA/EAA MEDICAL EXEMPTION REQUEST

W.S. Silberman¹ and J.M. Sackier²

¹Aviation Certification Services, LLC, Oklahoma City, OK;

²Department of Surgery, Oxford University, Charlottesville, VA

INTRODUCTION: The original exemption was presented on March 20, 2012 and requested that participating airmen be allowed to exercise privileges of recreational flying while self-attesting that they had no medical condition that would make them unable to operate an aircraft in a safe manner. The exemption would limit the pilot to single-engine, fixed gear aircraft, maximum of 180 horsepower, and no more than four seats. The aircraft would not be operated for compensation or hire or in furtherance of a business. The operations would be made only during Day VFR conditions, below 10,000 ft. msl, and with no more than one passenger. The petition also required periodic participation in an online educational course that would assist the airmen in conducting a self-assessment, would help to identify potential warning signs of pending serious medical conditions, demonstrate appropriate use of medications, and provide an overall better understanding of aeromedical issues and altitude physiology. Following more than two years of delay in responding to the exemption request, the FAA announced in summer 2014 that a Notice of Proposed Rulemaking would be published by late 2014 or early 2015. The NPRM would likely propose non-commercial operations with a valid state driver's license in lieu of a Third Class medical certificate in aircraft with a maximum takeoff weight of no more than 6,000 pounds, that fly no faster than 250 knots at altitudes up to 14,000 ft., and with no more than 5 passengers. Some of the reasons given for the proposal is the cost of the third-class medical certification in terms of money and time required to obtain a response from the FAA, and data from the Aviation Safety Institute study of the light sport aircraft accidents from 2004 - 2011 that has shown very few, if any accidents attributable to pilot medical deficiency.

Learning Objectives:

1. To Define the current AOPA/EAA third-class medical exemption request.
2. Be able to define what the "original" AOPA/EAA medical exemption request was in 2012.

[174] SELF DECLARATION PILOT MEDICAL CERTIFICATION IN CANADA

D.A. Salisbury

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

INTRODUCTION: In the early 1980's Canada instituted a medical self declaration in support of some student pilot permits and what was then called the Private Pilot Licence Ultra-Light Aeroplanes (now referred to as the ultra-light pilot permit). Some time afterwards, there was the introduction of an additional co-signature by a physician (not a designated examiner) required in order to carry a passenger. In the 1990's, a new Recreational Pilot Permit was introduced to allow for low risk VFR flying in light aircraft with a decreased regulatory burden on the pilot. It was decided that the self-declaration plus physician co-signature medical certificate was an appropriate level of medical oversight for this permit as well. The certification process is based on a self declaration via a standardized questionnaire to the regulator plus a physician co-signature. The recreational pilot permit allows for day VFR operation in Canadian air space of a single engine low performance airplane with no more than one passenger. **RESULTS:** There are some 7000 pilots that have been certified under what has now been labelled a Category 4 Medical Certificate. The process also allows for regulatory medicine oversight and issuance of a certificate with operational restrictions if the certificant declares some medical issues. **DISCUSSION:** The self declaration process has been successfully used to medically certify low risk recreational pilots and the category 4 medical certificate can now be used to validate recreational pilot, glider, advanced ultra-light and student pilot permits in Canada.

Learning Objectives:

1. Be able to describe the self declaration process to obtain a category 4 medical certificate in Canada.

[175] NTSB PERSPECTIVE: THE THIRD CLASS MEDICAL CERTIFICATE

M. McKay

National Transportation Safety Board, Washington, DC

INTRODUCTION: For civilian pilots in the U.S., medical certification requirements were included as part of the Air Commerce Act and went into effect on December 31st, 1926. At that time, there were three separate classes of medical certification: transport pilots, industrial pilots, and private pilots. Waivers could be granted, particularly to experienced pilots. The basic concept was and remains that individuals with certain medical conditions or using certain medications are at higher risk of acute incapacitation or impaired performance such as poor judgment or slowed response times and therefore are at higher risk of an accident. Since then, modern medicine has evolved significantly but the issues remain the same. **RESULTS:** Specific accidents involving pilots legally flying without medical certificates will be presented. In addition, results from the NTSB's safety study, Drug Trends in Aviation will be included. In this study, the NTSB noted that fatally injured pilots without current medical certification were more likely to have post mortem toxicology testing, revealing their use of potentially impairing drugs and drugs indicating a potentially impairing condition than those with medical certification; rates were highest among pilots with only a sport pilot certificate. **DISCUSSION:** These results suggest a potential benefit to flight safety related to medical certification. However, the exact safety effects of holding a current medical aeromedical certification have not been adequately studied. The NTSB has recently recommended several further research efforts be undertaken. The need for these studies and further general research on medications and impairment to better inform medical decision making across transportation modes will be outlined.

Learning Objectives:

1. The learner will understand the NTSB's position on the need to collect better information to inform decision making regarding the third class medical certificate.

Tuesday, May 12
S. Hemisphere 3

10:30 A.M.

[XXIX.] PANEL: ADVANCES IN JOINT AEROSPACE PHYSIOLOGY AND TOXICOLOGY

Chair: Lloyd Tripp
Wright-Patterson AFB, OH

PANEL OVERVIEW: In 2010, as a result of the 2005 Base Realignment and Closure Act, the US Air Force and US Navy aeromedical research laboratories were brought together at the new Maj Gen Harry G. Armstrong Center for Aerospace Education, Consultation, and Research at Wright-Patterson Air Force Base. This co-location has resulted in unprecedented levels of aeromedical research collaboration between the services. This panel will discuss recent and ongoing joint research addressing challenges in aerospace physiology and toxicology. Air Force and Navy researchers have recently developed a large program of research to address emerging, and in some cases longstanding but recently appreciated, altitude-related issues related to oxygen delivery, pilot physiology, and cognition in tactical aircraft. Research on hypoxia monitoring, performance effects and recovery will be discussed. Also, joint research on contaminants and toxicants, in life support systems specifically, and in the broader aviation context will be presented.

[176] RECOVERY FROM HYPOXIC EXPOSURE

J.B. Phillips, D. Horning, F.E. Robinson, S. Warner, J. Gomez, D. Geyer, L. Drummond, and M. Funke
Naval Medical Research Unit Dayton, Wright-Patterson AFB, OH

INTRODUCTION: Within minutes after the conclusion of an exposure to hypoxic stress, blood oxygen saturation returns to normal baseline levels. Previous research, however, has identified persistent residual deficits in cognitive performance following hypoxic exposure for up to 24 hours. In that case, participants recovered from exposure on sea-level equivalent oxygen (20.9%). With regard to current practice, supplemental 100% oxygen is administered during an in-flight emergency. The speed at which recovery occurs using this more operationally

valid profile remains unclear. Thus, the goal for the present study was to determine if, after hypoxic exposure, the administration of 100% oxygen would return performance to baseline levels more rapidly than sea-level oxygen. **METHODS:** Eighteen participants were subjected to a placebo condition (sea-level) and either 22K (~9%) or 25K ft (~7%) equivalent oxygen concentration using the Reduced Oxygen Breathing Device. Each altitude was held for 10 min (22K and placebo) or 5 min (25K and placebo) and was immediately followed by a 5 min exposure to 100% oxygen. Participants completed a simple reaction time (SRT) task prior to, during exposure, immediately following, and at 30 min, 1 hour, 2 hours, 3 hours, and 4 hours post-exposure. Physiological data such as blood pressure, heart rate, oxygen saturation at the index finger and the temporal lobe were recorded. **RESULTS:** At both altitudes, 30 min after recovering on 100% oxygen, participants' reaction times had recovered, and in fact, were significantly faster than at baseline. **DISCUSSION:** The aforementioned study in which participants recovered on sea-level oxygen reported that observed cognitive performance deficits persisted through 4 hours of observation. Conversely, the results of the present study suggest that recovery with 100% oxygen rapidly mitigates the effects of hypoxia on performance, with cognitive function recovering and even improving over baseline levels within 5 to 30 min post-exposure.

Learning Objectives:

1. To determine if, after hypoxic exposure, the administration of 100% oxygen would return performance to baseline levels more rapidly than sea-level oxygen.

[177] RODENT MODEL CENTRIFUGE FOR ACCELERATION, +GZ FORCE AND ALTITUDE

D.A. Mahle¹, J.S. Frazey¹, L. Tripp², R. Allnutt³, R.A. James^{4,5}, and M.C. Moulton¹
¹711 HPW/RHDJ, Wright-Patterson AFB, OH; ²Warfighter Interface Division, 711HPW, Wright-Patterson AFB, OH; ³USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; ⁴Camris International, Dayton, OH; ⁵NAMRU-D, Wright Patterson AFB, OH

INTRODUCTION: Human-use centrifuges have been used for experimentation that has provided key information about human physiological responses to acceleration and G force. However, the cellular and molecular effects of acceleration and altitude have not been characterized. Additionally, the impact that these stressors have on the distribution and potential toxicity of an inhaled volatile organic compound (VOC) is unknown and cannot be tested in humans. Therefore, a rodent model centrifuge was designed and produced. **METHODS:** The centrifuge was designed around a Baldor servo motor that provides 8HP to the center shaft. The shaft and arms were custom designed and built from aircraft quality Aluminum 6061-T6. Inhalation exposure and sensor data are passed through a 2-port 28-line rotary union with customized seals to support VOC exposures. A built-to-spec nose only exposure (NOE) system was mounted over the center shaft. Animal restraint modules were inserted into the NOE system and secured to the arms of the centrifuge. **RESULTS:** The centrifuge is operational and capable of replicating a high performance aircraft's +Gz flight profile up to 9 Gs. The onset rate, a key performance characteristic, is 6G/sec, identical to human-use centrifuges. The animal restraint chamber can reach hypobaric levels equivalent to 30,000 ft. The entire system is controlled using custom firmware with integrated feedback utilizing tachometer and accelerometer sensors. A rotating NOE system can be used to replicate most atmospheres. **DISCUSSION:** The goal was to create a system to induce +Gz force, simulate altitude up to 30,000 ft and generate any exposure atmosphere using a rodent model that allows for identification of adverse effects never before achievable with a human centrifuge. Physiological changes at the cellular and molecular level, as well as potential toxic responses influenced by acceleration and altitude can be better described and understood.

Learning Objectives:

1. Describe the cellular and molecular changes caused by acceleration and +Gz.

[178] ALTERNATIVE JET FUEL TOXICITY PROGRAMD. Mattie¹ and K. Mumy²¹RHDDJ, 711 HPW, Wright-Patterson AFB, OH; ²Naval Medical Research Unit Dayton, Wright-Patterson AFB, OH

INTRODUCTION: The Air Force Research Laboratory, 711 Human Performance Wing and the Naval Medical Research Unit Dayton have been collaborating to investigate the toxicity of fuels being developed as alternatives to traditional JP-8 and JP-5. Alternative jet fuels, referred to as synthetic paraffinic kerosenes (SPKs), are engineered to replace or mix 50:50 with the petroleum-derived conventional jet fuels for drop-in operational use. Toxicity research is needed to ensure that the new fuels do not create health problems for airmen exposed during duty.

METHODS: Through a CRADA, an expert Tri-Service review panel of military plus industry toxicologists helped determine the studies needed for alternative fuels toxicity testing. This overarching toxicity protocol, described in DoD Handbook, Aerospace Fuels Certification, MIL-HDBK-510-1A (USAF), includes mutagenicity, genotoxicity (*in vivo* micronucleus), dermal irritation, sensory irritation, and 90-day inhalation studies. The 90-day study was modified to include neurobehavioral tests plus additional screens to indicate potential reproductive effects. **RESULTS:** To date, we have evaluated three classes of SPKs: Fischer Tropsch (FT or S-8), Hydroprocessed Esters and Fatty Acids (HEFA), and Alcohol-to-Jet (ATJ). Assessments of FT, HEFA, and the first ATJ alternative jet fuels showed that they can be handled the same as JP-8 and JP-5. **DISCUSSION:** Assessments are being made for the Tri-Service Alternative Fuels Team. Based on the assessments, operational exposure limits could be established to protect personnel.

Learning Objectives:

1. Understand the process to evaluate the potential toxicity of alternative jet fuels.
2. Know the toxicity and the potential operational exposure limits for the current and alternative jet fuels.

[179] F-22 PILOT HEART RATE RESPONSE TO GZ AND RELATIONSHIP TO PILOT FITNESS USING U.S. AIR FORCE FITNESS TEST SCORESM.M. McIntee², R.S. Mayes¹, B.A. Wright¹, M.J. Kinchen², G. Maupin², E. Ennis², and B. Geier²¹Department of Aeromedical Research, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; ²USAFSAM, Wright-Patterson AFB, OH

INTRODUCTION: Previous works clearly show heart rate (HR) increases in response to Gz exposure due to baroreceptor reflex, the physical work of the anti-G straining maneuver, and the physiologic stress of G exposure. Individual fitness predicts resting HR and corresponding increase in HR in response to exercise. The purpose of this study was to look at U.S. Air Force (USAF) F-22 training sortie data and explore the relative contribution of pilot fitness (using the USAF fitness test components as a proxy for fitness) to the expected increase in HR when experiencing Gz. **METHODS:** Continuous physiologic data as well as sortie profile data from USAF F-22 training environment were recorded. HR data corresponding to sortie Gz profile were sampled from sorties over the course of the year beginning November 2012. Pilot fitness parameters from USAF physical fitness testing (timed 1.5-mi run, pushups, crunches), body mass index, and age were matched to the sampled sorties and put into a de-identified database. Other potential factors were identified such as Gz magnitude, number of Gz events, and elapsed time within sortie of Gz event. These variables were examined using a linear regression model to characterize the relative contribution these variables had on increase in HR over baseline HR obtained at the beginning of the sortie. **RESULTS:** A detailed description of the exposure variables, in particular pilot fitness, and relative contribution of these variables to HR increase in response to Gz exposure will be presented. Preliminary analysis indicates F-22 pilots as a group are very fit individuals, and without a diverse range of fitness levels, we were unable to show a statistically significant effect on HR response to Gz. **DISCUSSION:** This study provides further insight into the expected HR increase in response to Gz.

Learning Objectives:

1. Explore the magnitude of heart rate response to stresses of flight, in particular, the contribution of pilot fitness.

Tuesday, May 12**10:30 A.M.****S. Hemisphere 4****[XXX.] PANEL: USAF RPA ISSUES - SELECTION, RETENTION, SUSTAINMENT, AND RESILIENCY FROM A TOTAL FORCE PERSPECTIVE****Co-Chair: Peter Baldwin**

Wright-Patterson AFB, OH

Co-Chair: Wayne Chappelle

Wright Patterson AFB, OH

PANEL OVERVIEW: The Remotely Piloted Aircraft (RPA) community continues to present challenges to Active Duty, Reserve, and Air National Guard medical operations in the United States Air Force (USAF). Unique demands placed upon RPA aircrews have led to investigation into selection and retention standards for these members as well as how to sustain their operations and keep their force resilient in the face of an ever growing and changing mission. The nature of the aircraft and mission has led to several attempts at finding individuals with the "Right Stuff" to serve as RPA operators with varied results. Likewise, the mission demands placed upon these operators has led to multiple strategies from Aerospace Medicine personnel to maintain medical standards, solve human factors issues, sustain operational mission capability, and bolster crew resiliency. These issues are potentially magnified in the Air Force Reserve and Air National Guard, where different staffing and operations models are in use in both medical and mission aspects. This panel hopes to demonstrate examples of these challenges, attempted and successful solutions, and discussion of "way ahead" in maintaining operations and resiliency from a Total Force perspective inclusive of Active Duty, Air Force Reserve and Air National Guard RPA medical units.

[180] OCCUPATIONAL HEALTH SCREENINGS OF U.S. AIR FORCE REMOTELY PILOTED AIRCRAFT (DRONE) OPERATORSJ. Swearingen⁴, W. Chappelle³, T. Goodman¹, S. Cowper¹, L. Prince², W. Thompson¹, and L.E. Reardon¹¹Neurostat Analytical Solutions, LLC, San Antonio, TX; ²USAF School of Aerospace Medicine, Birmingham, AL; ³Neuropsychiatry, USAFSAM, Wright Patterson AFB, OH; ⁴Medical and Clinical Psychology, Uniformed Services University of the Health Sciences, New Braunfels, TX

INTRODUCTION: Remotely piloted aircraft (RPA) or "drone" operators have critical roles in the U.S. Air Force (USAF), ranging from intelligence, surveillance, and reconnaissance missions to delivering weapons on targets for close air support and precision strike operations. The health and wellness of RPA operators are critical to sustaining performance readiness. As a result, the USAF School of Aerospace Medicine conducted a field survey to assess for general areas of health-related behaviors. **METHODS:** A total of 1,094 MQ-1 Predator/MQ-9 Reaper operators (pilots, sensor operators, and mission intelligence coordinators) from three USAF major commands completed the web-based survey. Statistical analyses were performed to assess for between-group major command differences to quantitative and qualitative items assessing sleep, exercise, tobacco, alcohol and caffeine use, medical conditions worsened by occupational stress, changes in healthcare utilization, and changes in medication utilization. **RESULTS:** RPA operators in this study reported the following: getting less sleep than national averages and sleep patterns that may put them at elevated risk for accidents and/or illness; getting less exercise than recommended standards; and rates of alcohol and tobacco use less than or equal to the American adult population. Increases in medical issues, mental health care utilization, and alternative health care utilization were reported by

14.9%, 7.13%, and 15.17% of RPA operators, respectively. Prescription and over-the-counter medication use increases were endorsed by 102 (9.32%) and 131 (11.97%) operators, respectively. These changes were predominantly attributed to their occupational environment (e.g., shift work, job stress, and ergonomic strain) across all three major commands. **DISCUSSION:** Recommendations are provided for line and medical leadership for optimizing health for RPA operators such as optimizing work hours and shift work schedules, managing the ergonomic strains inherent in the Predator/ Reaper workstations, maintaining sufficient manning for the mission, and embedding mental health providers within line intelligence units.

Learning Objectives:

1. Summarize health behaviors (i.e., sleep, exercise, and substance use) of remotely-piloted aircraft (RPA, "drone") operators as they compare to the general American population.
2. Describe changes in RPA operator behavior related to medical issues, health care utilization, and medication use since engaging in RPA operator responsibilities.
3. Identify leadership interventions and potential changes to the RPA operator occupational environment that may help optimize operator health.

[181] COGNITIVE AND NEUROPSYCHOLOGICAL PREDICTORS OF ELITE U.S. AIR FORCE (USAF) PREDATOR PILOT TRAINING PERFORMANCE

W. Chappelle¹, T. Goodman², and W. Thompson²

¹Neuropsychiatry, USAF School of Aerospace Medicine, Wright Patterson AFB, OH; ²Neurostat Analytical Solutions, LLC, San Antonio, TX

INTRODUCTION: USAF remotely piloted aircraft MQ-1 Predator pilots are a critical asset in a challenging, high-risk, and constantly evolving profession. Although there are numerous empirical studies on the psychological (cognitive and non-cognitive aptitudes) predictors of performance of pilots from manned airframes, there are few empirical studies published on drone pilot training candidates. The purpose of this study was to evaluate the combination of intelligence and neuropsychological aptitudes that reliably distinguish high vs. low training performance among Predator "drone" pilots. Such information is essential for selecting candidates with the "right stuff." **METHODS:** Computer-based intelligence testing (Multiple Dimensional Aptitude Battery-II) and neuropsychological screening (MircoCog) was obtained on USAF pilot training candidates (n = 260) during medical flight screening prior to training. Outcome data (elite vs. low performance) were obtained on each candidate following completion of Predator "drone" Initial Qualification Training. Statistical procedures were implemented to (a) establish normative testing values for Predator pilot trainees, (b) assess for operational significance distinguishing elite performance, and (c) perform a series of regression analyses to determine which aptitudes (e.g., attention/concentration, memory, spatial reasoning/analyses, reaction time, etc.) were predictive of training outcomes. **RESULTS:** Findings reveal a collective combination of cognitive and neuropsychological aptitudes (i.e., speed of information processing, vocabulary, spatial analyses, arithmetic, digit symbol, reasoning/calculation, and general fund of knowledge) distinguish those candidates with elite performance from others selected for this career field. **DISCUSSION:** The results of this study identify psychological aptitudes critical to high levels of performance and adaptation to Predator drone pilot duties. The results are consistent with findings from studies assessing outcomes among pilots of manned airframes. The results of the study may guide aeromedical screening and personnel selection processes for selecting future Predator "drone" pilot training candidates.

Learning Objectives:

1. Identify cognitive and neuropsychological aptitudes of USAF Predator drone pilot training candidates.
2. Identify the collective combination of cognitive and neuropsychological aptitudes that distinguish elite training performance.
3. Identify how USAF Predator drone pilot training candidate test scores compare and contrast with pilot training candidates of manned airframes.

[182] USAF RPA ISSUES - SELECTION, RETENTION, SUSTAINMENT, AND RESILIENCY FROM A TOTAL FORCE PERSPECTIVE

C. Shurlow

178 MDG/CC, Springfield, OH

INTRODUCTION: Exploring the Air National Guard's conversion from manned aircraft to remotely piloted aircraft in response to the growing ISR and weapon strike demands. The experiences of ANG flight surgeons engaged in these unit conversions may provide valuable insight and lessons learned. **METHODS:** Qualitative observations and experiences were collected from multiple Air National Guard flight surgeons to identify themes and issues critical to aeromedical management of aviators going through this transition. **RESULTS:** Observations and experiences were characterized and labeled. Multiple lessons learned were identified. **DISCUSSION:** These lessons learned are critical to current and future conversions.

Learning Objectives:

1. Identify ANG challenges in converting from manned to remotely piloted aircraft.

[183] THE PSYCHOLOGY OF KILLING WITH REMOTELY PILOTED AIRCRAFT

J. Campo

USAF, North Las Vegas, NV

INTRODUCTION: Throughout history, humankind has continually moved itself further and further away from the point of physical engagement during battle, lessening the mental involvement in the act of killing. Remotely Piloted Aircraft (RPA) seem a logical "next evolution" of this process. However, anecdotal evidence indicates RPA aircrew are experiencing unanticipated cognitive, social, and emotional responses to killing others in combat, highlighting a lack of clear understanding regarding the actual psychological responses RPA aircrew are having to weapons engagements. The purpose of this study is to qualitatively and quantitatively characterize the psychological responses RPA aircrew experience from killing. **METHODS:** RPA aircrew who have killed in combat will be anonymously interviewed to document their experiences and resulting social, cognitive, and emotional responses. This study analyzes human, machine, and mission independent variables for differences in psychological response. Additionally, case studies are used to provide heuristic identification of new variables and causal mechanisms. **RESULTS:** Ongoing—scheduled for completion in spring '15. **DISCUSSION:** This study begins with a hypothesis that despite the thousands of miles separating RPA aircrew from their combat engagements, RPA technology is inducing a strong psychological response. If this hypothesis is correct, the level of psychological involvement among the RPA aircrew becomes an important consideration for both the operational and medical community as the USAF continues to engage in modern warfare using this technology. If the hypothesis is proven incorrect, we must then ask if the United States is creating a generation of cold-blooded killers who have no understanding of the reality their weapon system imparts on the world.

Learning Objectives:

1. Provide USAF line and medical professionals with a characterization of the RPA aircrew that are fighting our nation's wars.

[184] CORE MISSION SUPPORT OF INTELLIGENCE, SURVEILLANCE, RECONNAISSANCE (ISR) PERSONNEL: HEALTHCARE AND HEALTH OF THE TELEWARRIOR

P.A. Young

Medical Services, U.S. Air Force, San Antonio, TX

INTRODUCTION: The U.S. Air Force continues to change based on emerging threats to National Security, globalization, budget issues, tech advancements, & warrior job requirements. As a new component to the DoD, the 25th AF (formerly ISR) requires medical support elements to help it face a myriad of challenges. These challenges span across engaging w/various mission sets that include Remotely Piloted Aircraft (RPA), Intel, Language, Signals, Space, & Cyber. As the complexity of the ISR core missions grow

throughout the 5 domains, multiple healthcare & health issues must be addressed to optimize human performance. **METHODS:** Observational & informational data sources: 1 - ISR/RPA surveys - delineate concerns & issues 2 - Commanders' assessments & personnel interviews 3 - Medical Resource analysis 4 - Host Medical Treatment Facility assessments & gap analysis 5 - Medical leadership discussions in local mission areas & general forums 6 - Human performance studies & personality indicators/assessments 7 - Mission assessment & risk mitigation 8 - Disciplinary & administrative actions w/ components related to the work environment 9 - Assessments of lifestyle, diet, exercise, meds/drug, & tobacco usage **RESULTS:** Results will be discussed at the panel's open Q & A period. **DISCUSSION:** Mission demands, tech applications, & warrior demographics of current ISR operations create different challenges than those seen in the past for traditional "aviator care" concepts. Current medical posturing & support on care for this "new force" has been slowly but steadily growing. Field subject matter experts now work at a hectic pace to keep up with this new paradigm that urgently seeks balance between supporting current & future DoD missions. Discussion in this presentation will tie observed findings about the virtual telewarrior w/in the overall panel assessment on the unique operational demands of RPA (& ISR) activities. Overall thoughts will present a detailed look into what issues & concerns have been observed through personal engagements, surveys, site observations, & medical resource employment in various manners. A need for medical contributions that focus on selection, retention, sustainment, resiliency, coping, behavioral modification, etc will be debated

Learning Objectives:

1. Understand the medical challenges involved with healthcare and health for the virtual telewarrior.
2. Link medical support initiatives and strategies involved in optimizing human performance to enhance the cognitive and physical components of the virtual telewarrior.
3. Communicate the need to continue awareness of unique characteristics of the virtual telewarrior; focus on risk reduction/mitigation; and customize preventive measures while dealing with a resource-limited environment.

Tuesday, May 12
S. Hemisphere 5

10:30 A.M.

[XXXI.] PANEL: ADVANCES IN AEROSPACE MEDICINE IN IBEROAMERICA (IN SPANISH)

Sponsored by the Iberoamerican Association of Aerospace Medicine

Chair: Lina Sanchez
Bogota, Colombia

PANEL OVERVIEW: In 2015, the panel sponsored by the Iberoamerican Association of Aerospace Medicine (IAAM) celebrates its 18th year of sharing scientific advances in the Spanish language. Chaired by IAAMs 2nd Vice-president, Dr. Lina Sanchez, of Colombia, and co-chaired by Dr. Karina Flores, of Chile, the panel will commence with the description of an ethylene glycol poisoning case, presented by Dr. Daniel Porras, of Colombia. Next, Dr. Rafael Vasquez, of Colombia, will present results of an epidemiologic study concerning hearing loss in rotary wing aircrew. Dr. Rossana Goette, of Argentina, will then discuss issues encountered in aeromedical certification of pilots, specifically those related to the custom of chewing coca leaves in some regions of South America. The panel will continue with a presentation by Dr. Marcelo Rinaldi, of Argentina, on the advantages offered by the use of a chest band compressor for cardiopulmonary resuscitation in-flight. Dr. Lina Sanchez will complement the session by discussing challenges and opportunities presented by remotely piloted aircraft (RPA) in the Colombian Air Force. Finally, Dr. Flores will conclude the IAAM panel by presenting a case concerning atherothrombotic disease in a 59 year-old airline transport pilot. As always, the panel offers an opportunity to learn from our colleagues and encourages an internationally united environment towards enhancing world aviation safety.

[185] MEDICAL FINDINGS IN AIRCRAFT ACCIDENT INVESTIGATION: ETHYLENE GLYCOL POISONING CASE

D. Porras², M.C. Laverde², E.M. Ricaurte¹, and E.M. Forster¹
¹FAA-CAMI, Oklahoma City, OK; ²National University of Colombia, Bogota, Colombia

INTRODUCTION: Ethylene glycol (EG) is an odorless, colorless, sweet-tasting type of alcohol commonly used as the main component of antifreeze in automobiles and airplanes, de-icing fluids, paint thinner and hydraulic brake fluid. Ingestion can be accidental or related to suicide attempts. EG, itself, has a relatively low degree of toxicity, but its metabolites have significant toxic effects that can lead to death, beginning with central nervous system impairment, followed by cardiovascular compromise secondary to metabolic acidosis, and ending with acute renal failure due to intra-tubular formation of calcium crystals. Because of its central nervous system toxicity, EG has the potential for causing medical incapacitation/impairment to pilots. **RESULTS:** A 64-year-old pilot crashed and was found dead 30 feet away from his aircraft two weeks after the accident. The autopsy reported non-fatal injuries and internal examination revealed meningeal and pulmonary edema. Microscopic examination of his kidneys showed tubular necrosis, interstitial edema and birefringent crystals. Scattered foci of muscular and epicardial hemorrhage were also present. Toxicology tests were positive for antidepressants and mood disorder medications. Renal function tests were consistent with kidney failure (urea nitrogen 287 mg/dl and creatinine 14.1 mg/dl). Based on the autopsy findings, poisoning by ethylene glycol was suspected, though the specific test for its presence was negative. However, the cause of death and the accident were attributed to EG ingestion, although the manner of death was not determined. **DISCUSSION:** The postmortem diagnosis of ethylene glycol poisoning required pathologic analysis because this substance was absent in serological tests, yet there was evidence of its presence in different tissues. On the other hand, the medications detected by forensic analysis suggested that this pilot suffered from a psychiatric disorder that may have been relevant to aviation safety and had not been previously reported to the Federal Aviation Administration.

Learning Objectives:

1. Learn about a case of potentially intended ingestion of ethylene glycol and related forensic issues relevant to accident investigation.

[186] EPIDEMIOLOGY OF HEARING LOSS IN ROTARY-WING STAFF - NATIONAL POLICE OF COLOMBIA

R. Vasquez-Quintero and H.A. Fajardo-Rodriguez
National University of Colombia, Bogota, Colombia

INTRODUCTION: Sensorineural hearing loss is the loss of hearing caused by injury of cochlear neurosensory elements or a cochlear nerve injury due to physical media or other elements in nature within which the noise encountered in a labor environment. The latter has been found to be the cause of 10% of the cases, indicating other factors are at play. The aeronautical environment is a noisy medium both in flight and on land (shops). We conducted research on the prevalence of hearing loss and its associated factors in aeronautical personnel. **METHODS:** A descriptive study was conducted which population sample was obtained from the airline Guaymaral serving the national police of Colombia (rotary wing). Collected information through a questionnaire included the participant, job position, rank, date of admission to the force, pathological and pharmacological history, use of hearing protection, hobbies, target shooting training practices, and hearing parameters at the time of joining the force and current. The information was collected in MS Excel 2010 and analyzed with Epi Info-7, including the use of the Chi Square statistic. **RESULTS:** A total of 139 members were surveyed. All were male with an average age of 33 years (25 to 49). The time spent in the air service was an average of 8 years (2-22). 71% with flight functions and 29% were shop staff. A prevalence of hearing loss of 22% and 40% was found for the respective groups. There was no statistically significant relationship found for the variables considered for the study. **DISCUSSION:** A prevalence of hearing loss greater than the general population (17%) was found in the study sample.

Occupational exposure was found to be greater in shop personnel, likely due to the noise intensity (over 110/120 dB), such as that generated by pneumatic tools.

Learning Objectives:

1. Prevalence of hearing loss in aircrew and ground personnel of the national police of Colombia rotary wing.

[187] BETWEEN REGULATIONS AND CUSTOMS

R. Goette

National Administration of Civil Aviation, Buenos Aires, Argentina

INTRODUCTION: Today the "coqueo" (or the act of chewing coca leaves), old habit in some regions of South America, constitutes a challenge to the Aviation Medical Examiners (AME) when they have to issue the medical certificate which allows airmen to continue working. In Argentina, as Aviation Medical Examiners, we need to comply with both local and international regulations, since their application contributes to a safe development of civil aviation, and, at the same time, we cannot deny old deep-rooted habits that have been used for a long time and that in certain parts of the country are deemed legitimate. Considering these issues, the aviation medical authority of Argentina decided to evaluate how much flexibility they can find in local and international regulations to approve the practice of this old custom (coqueo) at the moment of validating a medical assessment.

METHODS: Both national and international regulations were reviewed, as well as local laws related to the use of coca, and finally the evaluation of key aeromedical cases was also taken into consideration. These cases were the ones that had not met the medical standards to safely exercise the powers of a license, due to the improper use of a psychoactive substance, as the coca leaves are.

RESULTS: From October 2013 to October 2014 we received 359 airmen medical evaluations that did not meet medical standards: 39% were treated by our mental health professionals and of those, 57 % were cases of substance abuse (as confirmed via toxicology testing), 79% of the cases involved male applicants. A total of 28.75% were Class 1, 50% were Class 2, and 8.75 % were Class 3 (ATC). The rest of the cases involved historical licenses. Just 2 key cases of the 39% were rejected (not allowed to perform their functions). **DISCUSSION:** We recommend to the whole aviation medical community to use this paradigm, especially concerning the evaluation of mental health when assessing applicants for medical certification, through both the aeronautical psychology and psychiatry fields.

Learning Objectives:

1. Aeromedical Certification issues concerning the use of coca leaves by airmen.

[188] IMPLEMENTATION OF CARDIOPULMONARY RESUSCITATION (CPR) IN COMMERCIAL FLIGHTS

M.L. Rinaldi, P.V. Oliveri, V. Ciancio, L. De Benedetti, G. DiGiovanni, M. Buzurro, S. Sabelli, L. De la Riva, and M. Oliveri

Sanatorio Modelo Quilmes, La Plata, Argentina

INTRODUCTION: Heart attack is a serious event requiring immediate resuscitation efforts in order to improve survivability. In our experience, CPR conducted in a simulated cruise altitude environment showed that hypobaric hypoxia impacted negatively on both the potential CPR performer and the victim. The latest guidelines (2010 RecAHA) emphasize "the importance of quality" in thoracic compression, early initiation, as well as early defibrillation, as pillars to restore a victim's heart rate to normal. Evaluation of a mechanical CPR device showed a substantial improvement of these parameters in a simulation mannequin. The objective of the study was to evaluate the possible use of a chest load-distributing compression band in commercial aviation conducted in simulated high cabin altitude conditions. **METHODS:** The hypobaric chamber was used to simulate cabin altitude. Other materials included a CPR manikin with oxygen, pressure, and flow sensors;

electronic ergometer; flowmeter; pulse oximeter; and an AutoPulse Non-Invasive Cardiac Support Pump. Parameters evaluated included: maximum power compression and comparison of averages derived from depth (4.8 and 4.5 cm); force (45 and 40 kg); and cephalic progression of fluid volume (average "systolic" measurement in both horizontal and at 105 degrees positions). **RESULTS:** Measurements showed that the force exerted by the human operator (CPR instructor) was 40 kg / 45 kg to produce a displacement of the chest (the simulator) of 4.5 cm / 4.8 cm from the horizontal (1800 angle). The use of the pump generated 43 kg average values obtained to produce the thoracic compression of 4.8 cm. Similar values were obtained at the 105° angular position. Cephalic fluid volume progression was similar for both methods. **DISCUSSION:** Mechanical CPR has advantages over manual CPR, particularly in cramped spaces such as the cabins of commercial aircraft. It doesn't rely on the energy or physical resistance of the rescuer (lessens fatigue) and frees him/her to perform other life-saving activities including oxygen delivery.

Learning Objectives:

1. Learn the advantages of mechanical CPR methods as demonstrated in a manikin.

[189] CHALLENGES AND OPPORTUNITIES IN RPA OPERATIONS IN THE COLOMBIAN AIR FORCE

L. Sanchez and D. Malpica

Air Force, Bogota, Colombia

INTRODUCTION: The incorporation of Remotely Piloted Aircraft (RPA) in the Colombian Air Force has constituted a valuable contribution to the success of flight operations and the effective fulfillment of the assigned missions, generating a great variety of opportunities. However, just like the experience in other countries, this recent technological innovation has also brought different challenges for the people working in aviation, included professionals in aerospace medicine, human factors, and flight safety. In this conference we present the acquired experience from the Colombian Air Force in RPA operations, in which we mention the complex process of adaptation to a new technology and aeronautical culture, the consideration of specific crew selection and aeromedical certification procedures, educational and training requirements for the operative and support staff, the review of standards and procedures, the work in mishap investigation and prevention, the human factor contribution, and the need to optimize human performance in a diminished situational awareness and highly automated environment in sustained operations that has also led to the development of scientific research of the unique challenges in the Colombian territory to improve future technological growth of the human-system integration. The differences and similarities between conventional aviation and RPA and the need to gather a multidisciplinary team to support the effective and safe development of this kind of mission are highlighted.

Learning Objectives:

1. The incorporation of Remotely Piloted Aircraft (RPA) in the Colombian Air Force.

[190] CLINICAL CASE. ATHEROTHROMBOTIC DISEASE IN A 59 YEARS OLD AIRLINE TRANSPORT PILOT.

K.S. Flores¹ and L. Rojas²

¹Chilean Civil Aviation Authority, Santiago, Chile; ²Occupational Medicine Department, Chilean Workers Insurance Hospital, Santiago, Chile

INTRODUCTION: Clinical history: A 59 year old airline transport pilot with medical history of atherothrombotic disease with occlusion of the superior mesenteric artery, occlusion of the origin of the left common carotid artery, occlusion of the left subclavian vein, and pulmonary thromboembolism currently treated with Coumadin; hypertensive disease stage one, currently treated with carvedilol and losartan; dyslipidemia currently treated with rosuvastatin; and hypothyroidism treated with levothyroxine. He obtained his medical

certificate in 2010 under the FAA CAMI special issuance. Since he had no new events, on January 2012 his treating physician decided to suspend oral anticoagulants. On October 2013, he had episodes of disorientation and was diagnosed with multiple cerebral infarcts, without neurological sequels. Oral anticoagulants were restarted. **DISCUSSION:** Analyze if the mentioned pathologies represent a risk for aviation safety.

Learning Objectives:

1. To determine the impact of atherotrombotic pathologies on aviation safety.
2. To analyze risk factors, prevention and treatment of atherotrombotic disease in pilots.

Tuesday, May 12
S. Hemisphere E3

10:30 A.M.

[XXXII.] PANEL: AEROSPACE MEDICINE REVIEW BOARD #2: PREVENTIVE MEDICINE CORE

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. Aerospace Medicine Board Review Series #2: PREVENTIVE MEDICINE CORE. This panel will cover essential elements of the PREVENTIVE MEDICINE CORE in two parts: 1) Neoplastic Diseases (epidemiology, screening, prevention) 2) Major Occupational Health Exposures.

Tuesday, May 12
S. Hemisphere E4

10:30 A.M.

[XXXIII.] PANEL: AEROMEDICAL JEPP-ARDY: PEOPLE YOU SHOULD KNOW

Sponsored by the AsMA History and Archives Committee

Chair: Allen Parmet
Kansas City, MO

PANEL OVERVIEW: This panel presents a "quiz show" format of questions regarding people of historical aeromedical significance. This session will concentrate on the 1910-1938 period. Each panel member will answer the question and present a biography of aeromedical achievements.

[191] ROSCOE TURNER: BARNSTORMER, RECORD SETTER, PIONEER

T.P. Faaborg
AF Human Systems Integration Office, USAF, Washington, DC

INTRODUCTION: "Colonel" Roscoe Turner is perhaps one of the most colorful characters of the Golden Age of aviation, always appearing in his signature uniform and waxed moustache, and often accompanied by his pet lion. This presentation will characterize the record-breaking American aviator who was a three-time winner of the Thompson Trophy air race, a legend Barnstormer, and aviation training pioneer.

Learning Objectives:

1. Understand the life and contributions of a pioneer of aviation's Golden Age, Roscoe Turner.
2. List the contributions Roscoe Turner made to military aviation.

[192] HARRIET QUIMBY - AMERICA'S FIRST WOMAN PILOT

K.A. Heupel
U.S. Air Force, Tijeras, NM

INTRODUCTION: Harriet Quimby is often called "America's First Lady of the Air" because she was America's first licensed woman pilot and the first woman pilot to fly the English Channel. She began her flying career 16 years before Charles Lindbergh flew the Atlantic and 26 years before Amelia Earhart was lost in the Pacific Ocean. She was a strong advocate for Aviation Safety. She wrote several articles in *Leslie's Weekly* magazine where she discussed aviation and described the requirements to be a safe pilot. She believed the greater number of fatalities was due entirely to: reckless flying, over-confidence (flying outside the safe operating window of the airplane) or pure neglect in inspecting the machine before it left the ground. She herself used a pre-flight checklist and never flew without hooking up her seat belt. Unfortunately her life was cut short at age 37 on 1 July 1912 from an aircraft mishap not even 1 year from earning her aviator's license. **METHODS:** This presentation will discuss the accomplishments of this individual and her impact on aviation safety.

Learning Objectives:

1. Review one of the early woman aviators to understand aviation safety lessons from the past.

[193] HUGH DEHAVEN'S MISHAP INVESTIGATION/ CRASHWORTHINESS RESEARCH

C.S. Ramsey
Occupational Medicine, Independent Contractor, Commerce City, CO

INTRODUCTION: A 22-year-old Hugh DeHaven in his final training flight for the Canadian Royal Flying Corps in 1917 was involved in a midair collision. Though he had significant injuries he completed his military service as a clerk, which required collecting human bodies. His interest in injury prevention blossomed as he compared others' injury patterns with his own. It dawned on him that studying accidents might lead to safety improvements. This propelled him into his life's work: studying the epidemiology of accidents. DeHaven believed that statistical analysis would help engineers eliminate hazardous design features. He developed crash injury research into a legitimate science. The Crash Injury Research project (CIR), begun in 1942, studied airplane and related mishaps. In comparison, the Automotive Crash Injury Research project (ACIR) began 1953. Crashworthiness initially was a hard sell, and convincing people that force factors could be quantified across individual accidents and victims was not well-accepted until the late 1940s. Even in 1941 use of seatbelts remained controversial and considered by some to be "highly dangerous". He promoted the need for passive design changes e.g. changing the pitch and padding airplane seatbacks. He lobbied aircraft and automobile manufacturers to improve product safety using data he analyzed. DeHaven's efforts were instrumental in formation of the National Safety Bureau in 1966, with William Haddon in the lead. The National Highway and Traffic Safety Administration was formed four years later. Hugh DeHaven's major contribution was to help transform public attitudes towards safety. His lifetime accomplishments were recognized by the Department of Transportation in 1979 following his death. Ralph Nader summarized, "the scientific and engineering establishment never recognized his signal contributions. After all, he had no advanced degrees, produced little theoretical breakthroughs and did not invent specific products for sale. All he did was to doggedly launch a school of applied engineering which could save lives wherever in the world motor vehicles crash or people strike immovable, man-made objects." **METHODS:** This is a historical presentation.

Learning Objectives:

1. To understand how aviation safety and initiatives to improve it generally were regarded before and after Hugh DeHaven's crashworthiness research.
2. To understand Hugh DeHaven's methods for studying crash injuries.
3. To understand how and what kind of influence Hugh DeHaven had on aviation and highway safety.

[194] MARIE MARVINGT: LA FIANCÉE DU DANGER (FIANCEE OF DANGER)-THE FIRST CERTIFIED FLIGHT NURSE, PIONEERING AVIATOR, AND WORLD WAR I BOMBER PILOT

A.J. Parmet¹ and D. Lam²

¹Aviation Safety & Security, Viterbi School of Engineering, University of Southern California, Kansas City, MO; ²Shaman Medical Consulting, Sitka, AK

INTRODUCTION: Marie Marvingt (20 February 1875 - 14 December 1963) was a French athlete, mountaineer, aviator and journalist. She won numerous prizes for her sporting achievements including those of swimming, cycling, mountain climbing, winter sports, ballooning, flying, riding, gymnastics, athletics, rifle shooting and fencing. She was a record-breaking balloonist, a pioneering aviator and during World War I became the first woman to fly combat missions as a bomber pilot. She was also a qualified surgical nurse, was the first trained and certified Flight Nurse in the world, and worked for the establishment of air ambulance services throughout the world.

METHODS: Marie Marvingt proposed the development of fixed-wing aircraft as air ambulances to the French government as early as 1910. In 1912 she ordered an air ambulance from Deperdussin, but he embezzled the money. In 1914 she disguised herself as a man and, with the connivance of a French infantry lieutenant, served on the front lines as a *Chasseur 2ième Classe* (Soldier, 2nd Class). She later participated in military operations in the Italian Dolomites at the direct request of Marshal Foch. She also served as a Red Cross nurse. In 1915 Marvingt became the first woman in the world to fly combat missions when she became a volunteer pilot flying bombing missions over German-held territory and she received the *Croix de Guerre* (Military Cross) for her aerial bombing of a German military base in Metz.

RESULTS: Marvingt devoted the remainder of her long life to the concept of aeromedical evacuation, giving more than 3000 conferences and seminars on the subject on at least four continents. She was co-founder of the French organisation *Les Amies De L'Aviation Sanitaire* (Friends of Medical Aviation) and was also one of the organizers of the First International Congress on Medical Aviation in 1929. In 1934 she established a civil air ambulance service in Morocco. In 1935 became the first person certified as a Flight Nurse. In 1934 and 1935 she wrote, directed and appeared in two documentary films about the history, development and use of air ambulances. **DISCUSSION:** The annual award given in her memory is sponsored by the French Aviation and Space Medicine Association through the Aerospace Medical Association.

Learning Objectives:

1. Know who first developed the concept of an air ambulance and became the first certified flight nurse.
2. Know who was the first woman to pilot combat missions.

[195] PIONEERING NAVAL FLIGHT SURGEON JOHN POPPEN
W.W. Dalitsch

Captain James A. Lovell Federal Health Care Center, Antioch, IL

INTRODUCTION: Naval Flight Surgeon John Poppen was one of the founding fathers of the Aerospace Medical Association. He led a unique and varied career in aviation medicine, was involved in many "firsts" in the specialty - to include research into spatial disorientation and the effects of G - and made contributions that are still used in aviation today. He served as president of the association, and his career was the basis for a Hollywood movie. This presentation will offer a biographical sketch of Captain John Poppen and his contribu-

tions to aviation medicine within the context of the time in which he lived and practiced.

Learning Objectives:

1. The audience will learn of the accomplishments of pioneering Flight Surgeon John Poppen and how they relate to aerospace medicine today.

[196] PEOPLE YOU SHOULD KNOW: PANCHO BARNES

J.R. Elliott

Central Region, ACE-300, FAA, Lee's Summit, MO

INTRODUCTION: Although perhaps best remembered as the proprietor of the Happy Bottom Riding Club, Pancho Barnes was an accomplished pilot, organizer, and business woman who made numerous contributions to aviation and to flight safety. Her efforts on behalf of motion picture stunt pilots were among some of the earliest contributions to occupational medicine for pilots. This presentation uses the biography of Pancho Barnes to illustrate not only her individual achievements, but to present a historical perspective of the development of aviation and pilots in the early decades of flight.

Learning Objectives:

1. Comprehend the aeronautical achievements of Pancho Barnes as a pilot.
2. Recognize the contributions Pancho Barnes made to flying safety and to occupational health for movie stunt pilots.
3. Explain how the Happy Bottom Riding Club contributed to the success of Air Force Flight Test Operations during the 1940s and early 1950s.

Tuesday, May 12

2:00 P.M.

S. Hemisphere 1

[XXXIV.] SLIDE: NEW & EMERGING TECHNOLOGIES FOR SPACEFLIGHT

Co-chair: Jeff Myers

Merritt Island, FL

Co-chair: Judith Hayes

Houston, TX

2:00 p.m.

[197] EVALUATING THE FUNCTIONALITY AND COST BENEFITS OF A 3D PRINTED THERMOPLASTIC DENTAL INSTRUMENT FOR LONG-DURATION SPACE MISSIONS

J. Wong

Center for Innovative Technologies and Public Health, Toronto, ON, Canada

INTRODUCTION: The Made in Space™ fused deposition modeling (FDM) thermoplastic 3D printer was launched onboard the International Space Station in 2014. Since dental conditions pose a risk for long-duration space missions, the author used 3D design software to create and print an instrument to replace dental fillings. The purpose of this study is to evaluate the function and cost advantage of a FDM 3D printed dental instrument for space missions. **METHODS:** Autodesk Inventor® software was used to create a digital model of a dental instrument that combined the functions of a metal spatula and a double-ended plastic filling instrument. The digital file was uploaded to a ground-based version of the Made in Space™ FDM 3D printer. A physical model weighing approximately 1.0 grams was printed with acrylonitrile butadiene styrene thermoplastic. The difference between the combined mass of the two conventional dental instruments and the mass of the 3D printed instrument was calculated. The function of this instrument was evaluated by a

board-certified dentist through a dental filling replacement simulation using CAVIT™ filling material. **RESULTS:** It is feasible to 3D print a functional dental instrument with the Made in Space™ FDM thermo-plastic 3D printer on Earth. This study showed that replacing two standard dental instruments with a single multi-function 3D printed dental instrument design can reduce inventory mass by approximately 42 g. This could generate cost savings for long-duration space missions. **DISCUSSION:** FDM 3D printing offers the potential advantages of localized, on demand production of reduced cost designs of dental supplies for space missions. Further redesign and cost-benefit analyses of 3D printing for currently flown medical inventory may be warranted.

Learning Objectives:

1. Define fused deposition modeling 3D printing.
2. List the advantages of 3D printing for long-duration space missions.
3. Calculate the cost advantage of reducing mass of medical inventory for long-duration space missions.

2:15 p.m.

[198] INTRODUCING THE FUNCTIONAL READAPTIVE EXERCISE DEVICE WITH POTENTIAL TO REHABILITATE LUMBOPELVIC CHANGES AFTER SPACEFLIGHT

A.J. Winnard¹, N. Caplan¹, M. Wilkinson¹, S.N. Evetts², and D. Debuse¹

¹Sport, Exercise and Rehabilitation, Northumbria University, Newcastle, United Kingdom; ²Wyle GmbH, Cologne, Germany

INTRODUCTION: Lumbopelvic adaptations to microgravity include flexed posture (Buckley 2006), spinal lengthening, increased disc height and deconditioning, altered spinal curvatures (Sayson and Hargens 2008) and atrophy of lumbar multifidus (LM) and transversus abdominis (TrA) (Hides et al. 2011). Astronauts have 68% increased incidence of back pain (Sayson and Hargens 2008) and 4.3 times higher risk of herniated disc than controls (Johnston et al. 2010). A Functional Readaptive Exercise Device (FRED) is being developed to rehabilitate these changes. **METHODS:** FRED exercise is functional, involving an upright posture and sharing important elements with walking. The absence of external resistance requires (and trains) much greater coordination, balance and motor control of the legs and lumbo-pelvic area, than conventional exercise devices. Initial studies investigated recruitment of LM and TrA on FRED compared to traditional therapy (Debuse et al. 2013), lumbopelvic stability on FRED compared to walking (Gibbon, Debuse and Caplan 2013) and tonic contraction of LM and TrA during FRED exercise (Caplan et al. 2014). Ongoing studies are investigating muscle recruitment and acute effects of exercise on sagittal lumbopelvic posture on FRED compared to walking. **RESULTS:** The device recruits LM more than traditional therapy ($p < 0.05$) and causes worthwhile increases in LM and TrA recruitment compared to rest. It increases anterior pelvic tilt ($p < 0.05$), reduces transverse pelvic rotations ($p < 0.05$) and increases lumbar extension (effect size ≥ 0.2) compared with walking. More tonic LM activity is seen during exercise compared to walking ($p < 0.05$). **DISCUSSION:** The studies suggest the device is able to recruit the local muscles of the lumbopelvic region in a tonic fashion during functional activity and produce increased pelvic stability while promoting a more balanced sagittal plane lumbopelvic posture linked with increased activity in the local muscles. The data suggest the potential for FRED to provide a progressive and effective post-mission rehabilitation protocol.

Learning Objectives:

1. Be able to list the lumbopelvic adaptations which occur due to exposure to microgravity during human spaceflight.
2. Be able to identify the local muscles and explain their role in lumbopelvic stability.
3. Develop an understanding of rehabilitation programmes and potential solutions to address lumbopelvic instability problems following human spaceflight.

2:30 p.m.

[199] USE OF A NOVEL EXERCISE DEVICE AND ULTRASOUND MONITORING FOR IMPROVING AND MAINTAINING CERVICAL STRENGTH, ENDURANCE AND RANGE OF MOTION FOR FIGHTER PILOTS AND ASTRONAUTS

J.A. Jones¹, R.A. Scheuring², D. Buckland³, R. Zheng⁴, B. Snyder⁵, and D. Baskin⁶

¹Center for Space Medicine, Baylor College of Medicine, Houston, TX; ²Space Medicine, NASA-Johnson Space Center, Houston, TX; ³MIT, Boston, MA; ⁴Engineering, Boston Univ, Boston, MA; ⁵Harvard Univ, Boston, MA; ⁶Neurosurgery, Methodist Houston Hospital, Houston, TX

INTRODUCTION: Cervicalgia is very common occurring in ~10% of North Americans (30 million), especially in high performance jet aircraft pilots & astronauts after spaceflight. Due to high G forces, helmet & vibratory loads & constant fatigue, fighter & rotary wing pilots have greater risk of developing chronic neck & lumbar problems. Estimates are that >80% DOD pilots suffer cervical or lumbar pain, paresthesias & other sx's. The VA reports high % of HPJA pilots claim cervical disability after they quit flying. Studies show a potential benefit from stretching & exercise pre-flight. No current portable devices designed for cervical exercises exist, so access to cervical exercise may not be possible for deployed. This pilot study tests a lightweight, portable device, Neck-X™ & U/S to assess cervical disc shear forces while exercising. **METHODS:** After IRB approval subjects underwent assessment of cervical strength, (SRM) endurance, (RTF) & range of motion (ROM- measured by goniometry) pre- & post-intervention. The subjects, including 6 F/A-18 pilots, completed a 6 week training program, using Neck-X™ cervical stretching & exercise device bid, 3 X/week. Some subjects had cervical ultrasound during exercise. Compliances & analysis of intervertebral disc deformation (vertebral end plate displacements) were successfully calculated in compression & distraction with U/S. **RESULTS:** 5-10% increases in strength & endurance measures in cervical flexion & extension, with 10-17% gains for lateral bending & rotation. Ultrasound could track longitudinal lengthening & compression of the cervical spine under distraction & loading. **DISCUSSION:** Inter-service DOD, academia & NASA collaboration was used to design the pilot study protocol; it provides initial evidence that Neck-X™, can be utilized to enhance strength, endurance & range of motion in cervical musculature, with objective to reduce the number of med down incidents in aviators and astronauts, & improve airborne performance & enhance mission accomplishment through improved cervical flexibility, endurance, and strength. The authors advocate a broader study population of DOD aviators & potentially International Space Station crew, as a possible countermeasure for observed post-flight cervicalgia & HNP.

Learning Objectives:

1. To understand the incidence of cervicalgia and cervical spine symptomatology in aviators.
2. To discuss the role of cervical exercise as a countermeasure to post-flight symptoms and injury.
3. To understand how ultrasound can be utilized to assess dynamic cervical disk loading and displacement during exercise.

2:45 p.m.

[200] THE VARIABLE VECTOR COUNTERMEASURE SUIT (V2SUIT) FOR SPACE HABITATION AND EXPLORATION

K.R. Duda¹, R. Vasquez¹, A. Middleton¹, M. Hansberry¹, D.J. Newman², S. Jacobs³, and J. West¹

¹Draper Laboratory, Cambridge, MA; ²Massachusetts Institute of Technology, Cambridge, MA; ³David Clark Company, Inc., Worcester, MA

INTRODUCTION: The "Variable Vector Countermeasure Suit (V2Suit)" is a system concept for integrating sensors and actuators with daily intravehicular activities to improve health and performance. The V2Suit uses control moment gyroscopes (CMGs) within a wearable form factor to provide resistance to movements against a specified direction

of “down.” The V2Suit is a countermeasure to the sensorimotor and musculoskeletal adaptation that astronauts experience during long-duration spaceflight and gravitational transitions. **METHODS:** A parameterized simulation of a single V2Suit module was developed to quantify the magnitude of gyroscopic torque that can be generated as a function of CMG configuration, flywheel mass properties, spin rates, and gimbal rates. CMG control was evaluated during simulated arm kinematics to maintain a specified magnitude and direction of gyroscopic resistance in relation to an externally referenced direction of “down.” V2Suit module parameters were down-selected based on these simulations and used as a basis for the mechanical design of a brassboard prototype. **RESULTS:** The simulation enabled a trade space analysis for small form-factor CMG component specifications to generate at least 0.1 N-m torque magnitudes in 3-dimensions. Four single-gimbal CMGs arranged in a pyramidal configuration demonstrated this ability, while accounting for base rate effects due to limb motion. A brassboard prototype was fabricated from commercial-off-the-shelf and custom components to demonstrate “down” tracking using the on-board IMU, as well as actuation of the CMG spin and gimbal motors to provide the torque in response to V2Suit module motion. **DISCUSSION:** A brassboard prototype was developed, based on a detailed simulation trade study, to demonstrate closed-loop control from IMU-based “down” tracking through CMG control. Subsequent human-in-the-loop evaluations in a relevant environment will be required to evaluate and determine the magnitude of perceptible torque. It is envisioned that this type of countermeasure suit will facilitate long-duration space exploration operations following gravitational transitions, including post-flight recovery and rehabilitation. This work was supported by the NASA Innovative Advanced Concepts (NIAC) program.

Learning Objectives:

1. The audience will learn how the properties of control moment gyroscopes can be used to provide a perceptible resistance during movements, and how that resistance can be used as a spaceflight countermeasure.

3:00 p.m.

[201] NONINVASIVE ULTRASOUND-BASED KIDNEY STONE DETECTION AND TREATMENT

J.C. Simon¹, B.W. Cunitz¹, O.A. Sapozhnikov^{1,2}, A.D. Maxwell¹, Y. Wang¹, W. Kreider¹, B. Dunmire¹, J.D. Harper¹, M.D. Sorensen¹, F.C. Lee¹, H. Wessells¹, M. Coburn³, L.A. Crum¹, and M.R. Bailey¹

¹University of Washington, Seattle, WA; ²Moscow State University, Moscow, Russian Federation; ³Baylor College of Medicine, Houston, TX

INTRODUCTION: Astronauts are at an increased risk of forming kidney stones due to the bone demineralization, dehydration, and stasis that occur in space. Current earth-based technologies to detect and treat kidney stones are not suitable for spaceflight. Our team is developing ultrasound-based technologies to address the risk of renal stone formation in space through improved diagnosis and treatment. **METHODS:** The “twinkling artifact” is a rapid color shift that appears inconsistently when imaging kidney stones with color Doppler ultrasound. Using a flexible ultrasound system, we varied the imaging parameters to enhance the consistency and appearance of twinkling for stone detection. Clinical trials are underway to reposition stones using the force generated by long, focused bursts of ultrasound energy. In the laboratory, stones are being fractured into passable fragments using short, low frequency bursts of ultrasound in burst wave lithotripsy (BWL). **RESULTS:** Increasing the ultrasound energy delivered to the stone enhanced twinkling, which led to the development of a stone-specific imaging mode, or S-mode. The first-in-human investigation to reposition stones showed detection and movement of stones with no treatment-related adverse events. Clinically significant results include: 4 of 6 post-lithotripsy subjects passed over 30 fragments (combined) within two days post-treatment, and in 4 subjects, stone repositioning revealed that what appeared as one potentially unpassable stone was actually a collection of small,

passable stones. BWL has fractured all types of human stones *in vitro* in less than 20 minutes, with some cases as fast as 4 seconds. Morphological injury was not observed in a porcine model. **DISCUSSION:** Applications of ultrasound-based stone detection and treatment technologies are not limited to spaceflight and extend to the three million Americans who seek treatment for kidney stones annually. [Work supported by the National Space Biomedical Research Institute through NASA NCC 9-58 and NIH NIDDK grants DK043881 and DK092197]

Learning Objectives:

1. Understand the risk of kidney stones from spaceflight.
2. Determine the role of ultrasound in kidney stone management.

3:15 p.m.

[202] THE ASTRONAUT SEQUENCING PROJECT: ACQUIRED GENOMIC ALTERATIONS FOLLOWING HUMAN SPACEFLIGHT

G.B. Scott^{2,1}, C.A. Shaw³, J.B. Clark^{2,1}, T.L. Johnson¹, and J.W. Belmont³

¹National Space Biomedical Research Institute, Houston, TX; ²Center for Space Medicine, Baylor College of Medicine, Houston, TX; ³Molecular & Human Genetics, Baylor College of Medicine, Houston, TX

INTRODUCTION: The Astro-Omics lab is one of four newly commissioned laboratories located within a Consolidated Research Facility (CRF) that is jointly operated by the National Space Biomedical Research Institute (NSBRI) and the Baylor College of Medicine Center for Space Medicine (BCM-CSM). The CRF is fundamentally transforming the research activities of both NSBRI and the BCM-CSM. In 2008, NASA published a study that reported chromosomal damage in lymphocytes from nineteen astronauts analyzed after their long duration space missions.¹ Understanding the nature of these genomic alterations at the single nucleotide level and the implications of somatic mutations on gene expression are essential if we are to provide individual astronauts with appropriate medical screening, counseling, and precision treatment plans. ¹Cucinotta F.A. *et al*, “Physical and Biological Organ Dosimetry Analysis for ISS Astronauts”, *Radiation Research*, 170(1), 127-138, (2008). **METHODS:** Captured gene sets (comprising oncogenes, cardiovascular [CV] relevant genes, and central nervous system [CNS]) relevant genes) derived from retired U.S. astronaut subjects have been sequenced and analyzed to identify somatic mutations (evidence of mosaicism) that have accumulated over and beyond the entire active flying career of each astronaut subject. This research has been performed by scientists affiliated with, and working within, the Astro-Omics laboratory. **RESULTS:** Analyzed data will be presented detailing and contrasting the frequency distributions of rare genetic mutations detected in the individual genomes of a cohort of retired U.S. Astronauts, as well as a cohort of healthy aged matched controls. **DISCUSSION:** To the best of our knowledge, ours is the first study of any type to sequence large gene sets captured from retired U.S. astronauts. This work is important because the highly unusual environmental exposures that characterize spaceflight, particularly ionizing radiation, microgravity, close confinement and stress, (risk of death) may predispose crew members to increased rates of somatic mutation. The health consequences of somatic mutation are poorly understood, but may include increased risk for cancers, blood dyscrasias, neurological disorders, and other diseases.

Learning Objectives:

1. Describe the broader and long term applicability of omics studies, such as the Astronaut Sequencing Project, to 21st century precision space medicine.
2. Describe the effects that the space environment, and in particular space radiation, may have on the underlying genomes of astronaut crew members.
3. Describe the key principles of omics projects that are now being commissioned by the BCM-CSM, NSBRI, and NASA - such as the Astronaut Sequencing Project, and the Twins Study.

Tuesday, May 12
S. Hemisphere 2

2:00 P.M.

[XXXV.] PANEL: ANTIDEPRESSANT USE IN UNITED STATES AIR FORCE AVIATORS: INTENDED AND UNINTENDED CONSEQUENCES

Chair: Terry Correll
Wright-Patterson AFB, OH

PANEL OVERVIEW: The United States Air Force (USAF) has long made various psychiatric disorders disqualifying for flight duties due to their potential adverse aeromedical impact on aviation safety and flying duties. Cognitive, emotional, and behavioral difficulties secondary to these disorders can lead to observable as well as subtle changes in functioning that negatively affect performance under physically and psychological taxing conditions in aviation. Unidentified, untreated, or undertreated psychiatric conditions may have potentially disastrous consequences. To mitigate such outcomes, the Federal Aviation Administration, Transport Canada, Australia, and the U.S. Army have policies allowing selected aviators to fly while on certain antidepressants. The USAF has followed suit over the last few years allowing select Flying Class II/III personnel to be considered for waivers on the following monotherapies: Zoloft up to 200 mg/day, Celexa up to 40 mg/day, Lexapro up to 20 mg/day, and Wellbutrin SR or XL up to 450 mg/day. While there are aeromedical concerns with the use of psychotropic medications for treatment as well, the USAF has had very positive outcomes to date.

Learning Objective:

1. Examine the use of antidepressant medication to reduce the aeromedical risk associated with psychiatric disorders.

[203] REVIEW OF AVIATORS ON ANTIDEPRESSANTS SEEN AT AEROMEDICAL CONSULTATION SERVICE

J.E. Heaton
Neuropsychiatry Branch, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH

INTRODUCTION: While the United States Air Force (USAF) has allowed personnel in various career fields to operate on antidepressant medication, it has taken more of a conservative approach with pilot and aircrew career fields. It's only been in recent years that the USAF has had limited approved antidepressant use for aircrew and special duty personnel. **METHODS:** The author of this study reviewed records of pilots, aircrew, and special duty personnel evaluated by the ACS for waiver consideration for disqualifying mental health conditions and antidepressant use. **RESULTS:** The author reviewed 16 records of USAF pilot, aircrew, and special duty personnel extensively reviewed and evaluated by the ACS for antidepressant use between 2013 and present. Preliminary results indicate that 13 (81.25%) were granted waiver for SSRI use. In contrast, 3 (18.75%) cases were disqualified secondary to mental health and/or medical diagnoses requiring further treatment/monitoring of symptoms. Results indicate that pilots and aircrew personnel demonstrate stability and low risk for safety concerns while on an antidepressant medication. **DISCUSSION:** The USAF decision to allow pilots and aircrew personnel to perform flying duties while on antidepressants has proven effective and demonstrates a continued commitment to maintaining a healthy and emotionally stable flying force.

Learning Objectives:

1. To demonstrate the proven effectiveness of antidepressant use by pilots, aircrew, and special duty personnel.

[204] U-2 PILOT WITH DECOMPRESSION SICKNESS AND ANXIETY DISORDER TREATED SUCCESSFULLY WITH SELECTIVE SEROTONIN REUPTAKE INHIBITOR (SSRI) AND EXTENSIVE PSYCHOTHERAPY

J. Wood
USAFSAM, Wright-Patterson AFB, OH

INTRODUCTION: While on a high-altitude flight, a U-2 pilot experienced a severe neurologic decompression incident that required hyperbaric therapy treatment. Residual fatigue was prominent for 1 year post-incident, but he was able to return to flying. Subsequently, he developed anxiety while flying consistent with a specific phobia and was able to return to flying status with exposure-based psychotherapy. However, the anxiety then generalized to social situations, such as when giving briefings, and he needed additional treatment. His anxiety was then treated with an SSRI (Zoloft) and 25 sessions of cognitive-behavioral therapy, which resulted in full resolution of symptoms. He continues to be treated with Zoloft 100 mg and wants to continue the treatment regimen. **METHODS:** Three extensive psychiatric evaluations were conducted at the Aeromedical Consultation Service (ACS). These assessments included neuropsychological testing to evaluate cognitive and emotional functioning, interviews with psychiatry/psychology, and review of all medical documents. **RESULTS:** Over a period of 3 years, his symptoms waxed and waned and, of concern, began to generalize to non-flying situations. Fortunately, he was proactive in seeking treatment and received excellent care. Based on interviews and psychological testing, the latest ACS psychiatric evaluation concluded that he was asymptomatic and stable after 3 years of variability in his symptoms. **DISCUSSION:** This case demonstrates that even in the most resilient individual, anxiety can generalize from a one-time traumatic event to other unrelated events in one's life. The first-rate medical care offered to this aviator and his initiative in seeking treatment were paramount to his full recovery. His continued use of an aeromedically approved medication is appropriate, and he will be followed by his local flight surgeon and the ACS as part of the SSRI Study Group.

Learning Objectives:

1. Combination treatment with antidepressant medication and cognitive-behavioral therapy can prove useful when treating aviators.

[205] A FULLY OPERATIONAL MQ-1 PREDATOR PILOT WITH SUSTAINED USE OF A SELECTIVE SEROTONIN REUPTAKE INHIBITOR - A CASE STUDY

W. Chappelle
Neuropsychiatry, USAF School of Aerospace Medicine, Wright Patterson AFB, OH

INTRODUCTION: Following reassignment from a manned airframe to remotely piloted aircraft (RPA) training and a series of significant life stressors, an MQ-1 Predator pilot reported experiencing unmanageable anxiety. The anxiety was significant and interfered with general functioning and his ability to perform pilot duties. He was referred to the installation psychologist for evaluation and treatment. However, his symptoms remained until receiving Zoloft, a selective serotonin reuptake inhibitor (SSRI), to mitigate his chronic anxiety. After returning to "baseline" functioning 6 mo post-treatment, he was referred to the U.S. Air Force School of Aerospace Medicine for an aeromedical evaluation to assess his suitability to return to RPA pilot duties. **METHODS:** The psychiatric/clinical psychological evaluation included 8 hours of clinical interviewing by an aeromedical psychiatrist and clinical psychologist, 4 hours of comprehensive computer-based psychological testing, review of medical and mental health treatment records, and consultation with his line commander. His case was reviewed by a panel of flight medicine physicians for recommendations. **RESULTS:** The results of the evaluation validated the resolution of clinical anxiety. It was discovered such symptoms were due to a combination of preexisting vulnerabilities and corresponding life stressors associated with an abrupt transition as an RPA pilot. The results of testing and interviews revealed he had returned to baseline functioning and adequately adapted to changes in his career path. The concluding diagnosis was generalized anxiety disorder. **DISCUSSION:** The psychiatric/psychological aeromedical evaluation and concurrent use of an SSRI for determining suitability for returning to fly as an RPA pilot are highly complicated issues. Given the increasing use of RPAs in worldwide regions of conflict, flight surgeons will likely be required to evaluate the suitability of pilots with preexisting vulnerabilities and internal conflicts following transition to RPA operations.

Learning Objectives:

1. Understand psychological evaluation techniques for assessing aeromedical readiness to return to fly with aviators currently engaged in SSRI use.
2. Understand the value of objective cognitive and non-cognitive psychological testing as an additional tool for conducting such evaluations.
3. Understand the application of USAF aeromedical policy regarding SSRI use and assessing readiness to fly among USAF RPA pilots.

[206] UNITED STATES AIR FORCE WAIVER GUIDE STANDARDS ON DISORDERS THAT MAY USE ANTIDEPRESSANT MEDICATION TREATMENT IN AVIATORS

M. Hubner

FECN Neuropsychiatry, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH

INTRODUCTION: After more than 10 years of war, the Aeromedical Consult Service is seeing an increasing number of aircrew with mental health diagnoses who may benefit from treatment with antidepressant medication. This increase in patients has raised more questions regarding aeromedical standards and proper utilization of medication. This presentation is part of a larger panel discussion and lays the foundation of the U.S. Air Force Waiver Guide, standards, and rationale.

Learning Objectives:

1. Understand the current U.S. Air Force Waiver Guide standards with respect to possible antidepressant use in aircrew members.

Tuesday, May 12

S. Hemisphere 3

2:00 P.M.

[XXXVI.] PANEL: TOPICS IN HUMAN FACTORS, FATIGUE AND DECISION MAKING-- PAST, PRESENT, AND FUTURE

Sponsored by the Aerospace Human Factors Association

Chair: Dwight Holland

Roanoke, VA

PANEL OVERVIEW: This diverse session will have presentations with regard to Human Factors ranging from analog environments work, to new thinking for developing subjective workload rating scales for the 21st century. We start with a presentation on how yoga and meditation enhance outcomes in analog long-duration space environments. Next, we examine the effects of fatigue on logical processes. Other presentations include new approaches for decision making studies, and retrospective examination of the effects of fatigue on continuous helicopter operations. A presentation on how humans interact with highly automated systems follows. Then, we finish the session with a presentation that highlights some of the problems with the 20th century subjective workload scales, and how we might update them for the 21st century.

[207] A QUALITATIVE STUDY TO ASSESS THE INTEGRATION OF YOGA AND MEDITATION AS COUNTERMEASURE FOR MAINTAINING MENTAL HEALTH AND WELLNESS IN ANALOG ASTRONAUTS

S.I. Jewell

Mars Without Borders, Van Nuys, CA

INTRODUCTION: Living in isolated confined, remote settings like Mars Desert Research Station, MDRS, necessitate development of countermeasures to mitigate problems that could arise under such conditions from increase tensions, anxiety or conflicts within the crew. The objective was to explore the integration of meditation and yoga, as countermeasures into the daily schedule of MarsCrew134 analogue astronauts at MDRS. Seven highly qualified scientists were selected to conduct a Mars analogue simulation. The aim was to develop training

"tools" for maintaining psychological health and wellness of crews living in extreme environments. **METHODS:** An initial baseline status was determined for the crew in two familiarization sessions using remote skype platform. **MEDITATION:** The project used the online pre-programmed Mp3 audio guided meditations from ULCA Mindful Awareness Research Center The daily 20 minute sessions were conducted in the evenings. **YOGA:** A crew member experienced in yoga was assigned to lead the daily morning sessions. Each session lasted 30 minutes. Crewmembers completed daily questionnaires after each session to document subjective feedback and self-evaluation. Separate crew video interview recordings were obtained at the end of the mission for analysis. **RESULTS:** The results obtained demonstrated the positive benefits for integrating yoga and meditation into the Mars analog simulation. The general consensus from all the participants were increase in crew cohesion and interactions, decrease in stress, anxiety and fatigue, and reported improved sleep quality. in two crew participants **DISCUSSION:** The anecdotal observations could provide the basis of future systematic studies in longer duration analogue simulations. The importance for integrating yoga and meditation as mitigation countermeasures into long duration space missions for astronauts psychological health cannot be overemphasized. We must address the components that truly make up the whole person, i.e., Body, Mind and Spirit. Therefore, an integrative approach for space exploration is needed.

Learning Objectives:

1. The integration of yoga and meditation as potential mitigation countermeasures for astronaut training to maintain mental health and well-being is described,

[208] FATIGUE RISK MITIGATION IN AEROSPACE MEDICINE: SIMULATING THE EFFECTS OF FATIGUE ON COGNITIVE PROCESSING

G. Gunzelmann¹, B.Z. Vekslor², M.M. Walsh³, and K.A. Gluck¹

¹Cognitive Models and Agents Branch, Air Force Research Laboratory, Wright Patterson AFB, OH; ²Oak Ridge Institute for Science and Education, Wright Patterson AFB, OH; ³TiER1 Performance Solutions, Wright Patterson AFB, OH

INTRODUCTION: Safety is a major driver of innovation, policy, and operations in both aviation and medicine. One significant threat to safety in both domains is the impact of fatigue on cognitive processing and behavior. Mathematic models and theories have been developed that characterize the dynamic fluctuations in overall cognitive functioning produced by time awake and circadian rhythms. These models have been applied effectively to the development of work/rest schedules that help to mitigate risk in many work environments. In domains like aviation and medicine, however, this approach cannot fully address the problems associated with fatigue, because sometimes operational demands require staying on the job and working in a fatigued state. **METHODS:** The research discussed here uses computational cognitive models to go beyond the capabilities of mathematical models by simulating the information processing activity of the human cognitive system. **RESULTS:** By connecting such models to a simulated task environment, the impact of fatigue on cognition can be simulated as the model performs a complex task, like flying a plane or performing a medical procedure. As fatigue degrades the efficiency and effectiveness of the information processing mechanisms in the model, performance suffers. **DISCUSSION:** The simulations provide evidence regarding the sources, and degree, of risk in the human-machine system as operator fatigue increases. Such information supports a variety of new risk mitigation strategies. For instance, these models can be used to design and evaluate alternative system designs when studies with humans are impractical or impossible. They can also be used to identify training procedures and strategies that are more robust to the deleterious effects of fatigue. Finally, such models can support monitoring technologies that use behavior-based evidence to assess fatigue levels and risk in real time. These potential roles for computational models in fatigue risk management are explored in the context of instrument flight and driving.

[209] ROBUST DECISIONS IN AEROSPACE ENVIRONMENTS WITH FAST & FRUGAL TREES

C. Myers¹, J. Harris¹, K.A. Gluck¹, V. Veksler⁴, T. Mielke⁵, R.E. Boyd², and M.M. Walsh³

¹Air Force Research Laboratory (AFRL), Wright-Patterson AFB, OH;

²Oak Ridge Institute for Science & Education at AFRL; ³TIER1 at AFRL;

⁴Oak Ridge Institute for Science and Education at AFRL; ⁵L3 Link Simulation at AFRL

INTRODUCTION: Medical and military situations within the aerospace domain involve combinations of people, vehicles, and computers that are all information processing components of integrated cyber-physical decision systems. The humans and machines in these aerospace systems engage in decision-making processes that result in actions that have consequences for safety, security, and survivability. An example to illustrate this is an individual presenting with symptoms that suggest myocardial infarction—the decision to be made is whether to send the individual to the Cardiac Care Unit for immediate treatment. We present research toward a principled approach for deriving *fast and frugal tree* decision heuristics (quick, yet robust, decision strategies) in time-critical, life-threatening aeromedical environments in order to track and predict future human performance. The goal is to optimize human-machine teaming by injecting machine-prescribed decision strategies when human strategies are slower and less robust than predicted and calculated alternatives. **METHODS:** We use a combination of machine learning and computational cognitive models to derive predictions of optimal decision strategies and human behavior, respectively. The cognitive models provide predictions of potentially adopted decision strategies. Machine learning techniques provide optimal strategies for decision-making when rewards and penalties are prescribed for different actions. **RESULTS:** We ran the cognitive models and machine learning technique across 4,284 distinct decision environments 50 times each, using massively distributed and high performance computing systems (i.e., MindModeling.org). Environments varied based on disease base rates, reward structure, and symptom prevalence. This analysis enabled us to pinpoint environments where a human is more likely to acquire a fast and frugal tree strategy for decision-making. Results from our cognitive models provide predictions of environments in which humans are capable of performing optimally without machine assistance, when optimal performance wanes, and where one should step in to improve human decision-making.

Learning Objectives:

1. To understand how machine learning, computational cognitive process models, and high-performance computing systems can be leveraged to identify how and when to inject robust decision strategies in time-critical aeromedical decision environments.

[210] WHO WILL FLY IN THE FUTURE: THE HUMAN ROLE IN AUTOMATED FLIGHT SPACES

P. Hancock, T.L. Sanders, T. Kessler, W. Volante, and K. Macarthur

Psychology, University of Central Florida, Orlando, FL

INTRODUCTION: Flight is reaching a watershed threshold in which no human may necessarily be in control of any flying vehicle. Like all technologies, the spectrum of mixed equipment will continue to contain human-in-the-loop control, if only for antique, vestigial, and personal, and show aircraft. Pilots will not disappear from the sky. However, their role in military and commercial operations will be severely curtailed. The empirical question is where in the series of control loops, human intention and human intervention will now appear. The progress excision of human control from the inner loop of control has been accompanied now by a physical expulsion from the cockpit. But this transition has seen critical shortfalls in accompanying feedback which, intrinsic to physical occupancy and hands-on control, is now missing from more modern, sterile vehicles. Now we need to consider not merely the simple and direct replacement of these levels of sensory stimulation and augmented awareness, we have to ask fundamental questions about the nature of flight, its utility, its purpose, and its intended vector of progress. Our paper will address both broad and specific issues in this, apparently unconquerable march of automation.

Learning Objectives:

1. To examine the series of control loops, human intention, and human intervention in manned and unmanned systems.

[211] A LOOK AT A FEW WIDELY USED SUBJECTIVE WORKLOAD DECISION TREE SCALES FROM THE PAST CENTURY, WITH A RATIONALE AND SPECIFIC MODIFICATIONS SUGGESTED TO IMPROVE THEM FOR THE 21ST CENTURY

D.A. Holland

Human Factors Associates, Inc., Roanoke, VA

INTRODUCTION: There are several subjective workload scales that evolved from the Cooper-Harper Flying Handling Qualities Scale in the 1960s at Cornell. These subjective scales are decision tree scales, where the tester— or participant— first decides if the system needs modification/ improvement(s), THEN, chooses which bin inside the pathway chosen is the final answer. Ideally, logic would dictate that you would want the data of many decisions to inform what the outcome is, but this is not necessarily the case with these scales. And, these older scales are non-linear, going from values of 1-10 such that non-parametric statistics need to be used technically to compare results. This generally requires more trials to see a difference between levels of workload, if there is indeed a difference. Linearizing, and updating the Cooper-Harper (FQs), Modified Cooper-Harper (mental workload), and Bedford scales (workload/spare capacity) for the 21st century would enable averaging, ANOVA's, and other more robust approaches to data analysis. **METHODS:** The literature was reviewed in the arena of workload, flight test, RDT&E evaluation, and several scales were targeted for improvement. **DISCUSSION:** Cooper and Harper in the 1960's had little choice but to create workload scales that were decision tree by nature. In those days, metal had to be bent for production lines and controls. As such, decisions needed to be made very early. The modified Cooper-Harper scale, created at Virginia Tech in the 1980's by Cooper-Harper's former graduate student Dr Walt Wierwille (and a mentor of this author) uses a decision tree approach as well to estimate mental workload. Similarly, the classic Bedford spare capacity scale uses this type of approach. This talk questions whether in the 21st century decision tree scales are wise, since now electrons can be moved, displays changed, flight controls altered, and high fidelity simulations can be altered more readily in digital systems than analog ones. Furthermore, adoption of newer linearized scales and replacement the older scales with non-decision tree scales by DoD and RDT&E organizations would result in more accurate answers, theoretically more efficiently, and with less expense/testing required in these workload areas of interest.

Learning Objectives:

1. Understand the Architecture of the Classic Decision Tree Workload scales.
2. What are the different areas that are assessed with the Cooper-Harper, Modified Cooper-Harper, and Bedford subjective workload scales.
3. Understand why newer approaches are required for 21st century decision tree scales.

Tuesday, May 12
S. Hemisphere 4

2:00 P.M.

[XXXVII.] PANEL: ADDRESSING HUMAN PERFORMANCE ISSUES IN UNMANNED AERIAL SYSTEMS

Chair: Tatana Olson
Pensacola, FL

PANEL OVERVIEW: Over the past several years, the U.S. military has experienced a significant increase in the development and acquisition of Unmanned Aerial System (UAS) platforms. This increasing reliance on UASs presents some critical human performance challenges, underscored by the fact that as much as 50% of all UAS mishaps are

attributed to human factors. As UASs, and the missions they execute, become significantly more dynamic and complex, there is a need to ensure the UAS communities are properly supported with valid selection tools for UAS operators and other crew members, effective training systems, and well-designed display and control station interfaces that not only allow for control of a single UAS, but enable a single UAS operator to monitor and supervise multiple UASs simultaneously. Further, there is a need to understand how to best integrate manned and unmanned systems within the same airspace. We have assembled a talented panel of scientists working for the U.S. military who will discuss their work across various UAS human performance domains and the challenges that remain. The panel discussion will be organized around five focus areas: (1) Understanding the skills, abilities, and other characteristics (SAOCs) associated with UAS operators, (2) Integrating these SAOCs within a comprehensive selection system for UAS personnel, (3) Design of UAS control interfaces, (4) Development of UAS training systems, and (6) Issues associated with airspace integration. Additionally, the panelists will highlight the importance of cross-collaboration across research areas and services to ensure a holistic approach to optimizing the UAS human-system relationship.

[212] APTITUDE REQUIREMENTS FOR RPAS OPERATORS

T.R. Carretta¹ and H. Williams²

¹*Air Force Research Laboratory, Wright-Patterson AFB, OH;* ²*Naval Aeromedical Research Unit - Dayton, Wright-Patterson AFB, OH*

INTRODUCTION: In the U.S. Military, early efforts to field Remotely Piloted Aircraft Systems (RPAS) focused on technology development. Manning typically involved retraining manned aircraft pilots to operate RPAS, with the underlying assumption that the two jobs required similar skills. Although this approach usually was adequate, it became too costly and unsustainable as the demand for RPAS capabilities increased. In 2009, the U.S. Air Force established a program to train personnel with little or no prior flying experience to operate RPAS. In the absence of RPAS-specific selection methods, aptitude requirements for manned aircraft training were adopted. Subsequent studies demonstrated these selection requirements had similar predictive validity for manned and RPAS pilot training. Despite this, several efforts were initiated to develop RPAS-specific selection methods. **METHODS:** Subject matter experts with experience in personnel measurement, selection, and human factors reviewed recent military job/task analyses for medium and large RPAS. The goals were to identify critical skills, abilities, and other characteristics (SAOCs), review existing DoD measures, identify measurement gaps, and make recommendations for test development. **RESULTS:** With the exception of psychomotor, SAOC requirements were consistent across RPAS platforms. It was determined that many of the most critical SAOCs could be measured by existing tests. Where measurement gaps were identified, recommendations were made to modify existing test and develop new tests. **DISCUSSION:** As technology matures, RPAS will become more intelligent, automated, and autonomous and more integrated with other manned and unmanned assets in a net-centric environment. These developments may enable a single operator to exert supervisory control over multiple RPAS. Mental and temporal workload will be high. SAOC requirements will focus on higher-order cognitive functioning, decision-making, and management characteristics.

Learning Objectives:

1. Aptitude requirements for Remotely Piloted Aircraft System operators are examined.

[213] OPTIMIZING PERSONNEL SELECTION FOR UNMANNED AERIAL SYSTEMS (UAS)

T.M. Olson

Operational Psychology, Naval Aerospace Medical Institute, Pensacola, FL

INTRODUCTION: As the Navy increases its reliance on UAS, the role of the pilot has evolved from one involving a very direct,

organic connection to the aircraft to one in which there is an increased focus on cognitive and perceptual tasks in information-rich, distributed, and collaborative mission environments. With these changes comes a need to better understand the knowledge, skills, and abilities (KSAs) required by individuals to operate these unmanned platforms safely and effectively, and to develop psychometric tools (or leverage existing tools) to assess these KSAs as part of a standardized and valid UAS personnel selection system. The ability to identify individuals mostly likely to be successful within the UAS environment can result in more qualified UAS personnel and yield significant cost savings in training and mishap avoidance. This presentation will examine a fundamental question to UAS personnel selection - to what extent are tools and techniques used to select pilots for manned aviation platforms generalizable to unmanned aviation? For example, the Aviation Selection Test Battery (ASTB) is the primary tool for selecting pilots and flight officers into naval aviation training. The current version is designed to assess cognitive ability, psychomotor aptitude, and other personal characteristics relevant to aviation. Although the ASTB was designed for manned aviation, recent evidence suggests it assesses many of the KSAs important to unmanned aviation as well. The specific ASTB subtests, their potential applicability to UAS personnel selection, and the gaps in assessment that remain will be discussed. Additionally, this presentation will address challenges to the development of an optimal UAS personnel selection system, such as the diversity of UAS platforms with varying designs, capabilities, and limitations, differences in crew positions, and the range of behaviors association with system operation, as well as key psychometric issues for consideration, to include test administration, standardization, and security.

Learning Objectives:

1. The learner will develop familiarity with psychological constructs relevant to manned and unmanned aviation selection.
2. The learner will gain a basic understanding of the issues and challenges associated with developing a UAS personnel selection system.

[214] MULTI-UAS CONTROL INTERFACE DEVELOPMENT AND EVALUATION

C. Foster

NAWCAD, NAS Patuxent River, MD

INTRODUCTION: One of the key challenges in fully realizing the benefits of Unmanned Air System (UAS) operations is developing the capability to allow human operators to control multiple dissimilar UASs. To date there is limited knowledge on how to accomplish this while ensuring safety of flight. Human error remains the primary cause of most UAS mishaps. Success requires providing the user the capability to track multiple objects, providing meaningful information without overwhelming the user, providing a standardized interface that supports multiple platforms, and integrating the appropriate level of autonomy. This presentation will discuss the approach that the Navy is using to develop and test various human machine interfaces in order to allow (1) a single operator to control multiple UASs and (2) a common control station architecture to manage dissimilar UASs.

Learning Objectives:

1. Understand the challenges associated with developing the capability to allow a single operator to control multiple dissimilar UASs.

[215] TRAINING FOR UNMANNED AERIAL SYSTEMS

B. Olde

ONR, Arlington, VA

INTRODUCTION: Despite the term "unmanned," there is a significant human element involved in operating UAS. The human is critical to safe operations and training is a key component. A one-size-fits-all approach to training and certification is not a

reasonable approach due to the variety in UAS types and mission. For smaller UAVs, some basic training and certification is required, since even small systems can harm people and damage property. While larger UAVs necessitate more extensive training, these systems will likely be transiting in and around the National Air Space (NAS). To address this issue, the Navy has issued policies for UAS training in OPNAVINST 3710.7U Chapter 14 and the Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 3255.01. These documents outline the qualifications required to operate the various UAS Groups (1-5). These requirements range from the Basic Unmanned Qualification Level One (BUQ-I) to operate Group 1 UAS to the BUQ Level Four (BUQ-IV) to operate Group 5 UAS. Current UAS training takes winged Naval aviators and provides platform specific UAS training. For example, the MQ-C Triton will be operated by pilots who have completed P-3 or P-8 training (the Manned Maritime Patrol Aircraft that have a similar mission to Triton). These pilots will have completed one tour and will have experience conducting Maritime Patrol Missions (thus they have most of the Knowledge-Skills-Abilities (KSAs) needed to fly the Triton. They will then receive Triton specific training. Similarly, the MQ-8 Fire Scout will obtain their operators from the existing H-60 community, who already possess many of the require aviation KSAs and thus need very little additional training. In contrast the Army and the Air Force have established UAS training programs that take personnel new to aviation and train them on UAS operations. The Army has its training program in Fort Huachuca, AZ (where Marines receive RQ-7 Shadow training) and the Air Force has their primary training program at Creech AFB, NV.

Learning Objectives:

1. Understand current Navy UAS Training.
2. Discuss current and future training systems.

[216] DEVELOPMENT OF HUMAN BEHAVIOR ALGORITHMS FOR AIRSPACE INTEGRATION (AI) USING SIMULATED UNMANNED AERIAL SYSTEM (UAS)

J.W. Geeseman

Human Systems, NAVAIR, NAS Patuxent River, MD

INTRODUCTION: To support successful airspace integration (AI) we developed human behavior algorithms using simulated unmanned aerial systems (UAS). AI is the process of assimilating unmanned aircraft into manned aircraft airspace. A number of problems, theoretical and tangible, arise when attempting to accomplish this task: human involvement in collision avoidance, sense-and-avoid technology on the UAS, operator performance in high stress or high workload situations, UAS performance as a result of operator input, and so on. The latter two of the previous list are of interest for this project. **METHODS:** The first goal of this project was to develop a series of common (and not-so-common) scenarios of potential mid-air collisions for a simulated UAS. The next goal was to record behavioral and physiological measures of UAS operator participants during these scenarios to identify situations of high stress, high workload, performance degradation, and successful human-machine interactions. **RESULTS:** Once these measures were quantified and analyzed, the final goal was to develop algorithms that informed a MATLAB "plug-and-play" type software packet for UAS test and evaluation (T&E) infrastructure - particularly for the Triton platform. **SPECIFIC RESULTS PENDING DISCUSSION:** During tasks identified as "high workload or high stress," physiological and behavioral measures indicated a decline in performance (e.g., correct decisions, response latencies, inhibition of return). These measures were used to successfully develop a human operator algorithm used to support T&E efforts for UAS platforms.

Learning Objectives:

1. The relationship between high workload/high stress environments on behavioral/physiological measures of UAS operators.
2. Mathematical representation of such relationships.

Tuesday, May 12
S. Hemisphere 5

2:00 P.M.

[XXXVIII.] PANEL: AVIATION CARDIOLOGY CHALLENGES - NATO AVIATION CARDIOLOGY AND EUROPEAN ASSOCIATION OF CARDIOTHORACIC SURGERY WORKING GROUPS

Co-Chair: Eddie Davenport

Wright Patterson AFB, OH

Co-Chair: Ed Nicol

Henlow, Bedfordshire, United Kingdom

PANEL OVERVIEW: Five sessions outlining contemporaneous challenges to the Aviation Cardiology community. These 5 sessions will be presented by members of the respective NATO Cardiology sub-groups and members of the European Association of Cardiothoracic Surgery Aeromedical Working Group and look to address current issues in: 1. Coronary Artery/Ischemic Heart Disease; 2. Electrophysiology; 3. Valvular Heart Disease; 4. Cardiomyopathy and Congenital Abnormalities; 5. Cardiac Surgery.

[217] CONTEMPORANEOUS CHALLENGES IN CORONARY ARTERY DISEASE ASSESSMENT IN AIRCREW

E. Nicol¹, E.D. Davenport², J. d'Arcy¹, T. Syburra³, and G. Gray⁴

¹Clinical Aviation Medicine Service (CAMS), RAF Centre of Aviation Medicine, Henlow, United Kingdom; ²Cardiology, Aviation Consultation Service, Wright Patterson AFB, OH; ³Dept of Cardiothoracic Surgery, University Hospital Geneva, Geneva, Switzerland; ⁴Medicine, CFEME/CMEFC National Defence /Défense nationale, Toronto, ON, Canada

INTRODUCTION: With ever advancing technology to assess CAD and IHD in aircrew this talk will review the current investigations available to assess aircrew who have CAD (whether as an incidental finding, secondary to occupational screening or secondary to the development of symptoms) and address contemporaneous challenges facing the aviation medical practitioner (cardiologist, AME or Flight Surgeon) in risk assessing aircrew with CAD. **METHODS:** A review of international guidelines and evidence from Europe and N. America, highlighting differing approaches to the assessment of patients with incidental findings, as a result of abnormal screening tests and following presentation with symptoms. This session will cover risk assessment both of native coronary artery disease and following PCI with stent or coronary artery bypass surgery. **RESULTS:** There remains significant variation in practice between Nations with regards the assessment of CAD. Many Nations have policies that state the requirement for a stenosis based assessment (either lesion specific or global atheroma burden) but then accept functional based investigations only for risk assessment. **DISCUSSION:** The work of the NATO Cardiology Working Group and European Association of Cardiothoracic Surgeons Aviation Medicine Group aims to explore these variations and agree common consensus on risk assessment of this increasingly prevalent clinical scenario.

Learning Objectives:

1. To be aware of the multitude of investigations available for the clinical assessment of coronary artery disease in aircrew.
2. To be aware of the variation in international guidelines on the assessment, and subsequent risk stratification, of aircrew.
3. To understand the contemporaneous challenges in coronary artery disease assessment in aircrew.

[218] CONTEMPORANEOUS CHALLENGES IN VALVE DISEASE IN AIRCREW

J. d'Arcy¹, E. Nicol¹, E.D. Davenport², G. Gray³, and T. Syburra⁴
¹Clinical Aviation Medicine Service (CAMS), Centre of Aviation Medicine, RAF Henlow, United Kingdom; ²Cardiology, Aviation Consultation Service, Wright Patterson AFB, OH; ³Medicine, CFEME/CMEFC National Defence /Défense nationale, Toronto, ON, Canada; ⁴Cardiothoracic Surgery, University Hospital, Geneva, Switzerland

INTRODUCTION: Valvular Heart Disease is a common finding in aircrew, however individual Nations have different processes for identifying and managing valve disease. This talk will review current imaging techniques for assessing both native valve disease and post valve repair/replacement and address contemporaneous issues with regards risk assessing aircrew with native valve disease, post repair and/or replacement. **METHODS:** A review of international guidelines and evidence from Europe and N. America, highlighting different approaches to the assessment of valve disease (from incidental findings to clinically significant disease) and risk stratification of both native and repaired/replaced cardiac valves. **RESULTS:** There is a difference in the practice of Nations with regards valve disease and in particular the return to flying following surgical valve repair and replacement. In a military context both the flying environment and the operational environment must be considered so issues such as future risk of endocarditis must also be considered. **DISCUSSION:** The work of the NATO Aviation Cardiology and European Association of Cardiothoracic Surgery Aviation Working Groups aim to explore these variations in practice and agree common consensus on risk assessment and occupational guidance for patients with valve disease. This session will link into the cardiothoracic surgery session in the same panel, where the considerations with regards valve surgery and choice of valve will be further explored.

Learning Objectives:

1. To understand the imaging options for the assessment of valvular heart disease and the strengths and limitations of these techniques.
2. To be aware of the literature on, and current National practice in, the assessment and management of aircrew with valvular heart disease.
3. To understand the contemporary challenges of valvular heart disease assessment in aircrew.

[219] CONTEMPORANEOUS ISSUES IN AVIATION CARDIOLOGY: CARDIOMYOPATHY AND CONGENITAL ABNORMALITIES

G. Gray¹, E. Nicol², E.D. Davenport³, J. d'Arcy², and T. Syburra⁴
¹Medicine, CFEME/CMEFC National Defence /Défense nationale, Toronto, ON, Canada; ²Clinical Aviation Medicine Service (CAMS), RAF Centre of Aviation Medicine, Henlow, United Kingdom; ³Cardiology, Aviation Consultation Service, Wright Patterson AFB, OH; ⁴Cardiothoracic Surgery, University Hospital, Geneva, Geneva, Switzerland

INTRODUCTION: Cardiomyopathy and other congenital abnormalities may present or be detected in aircrew; alternatively close relatives of aircrew may suffer a sudden cardiac death and be found to have a congenital abnormality or cardiomyopathy that may be hereditary. This talk will address issues with regards both screening of aircrew and the management of aircrew who are found to have a cardiomyopathy or congenital cardiac abnormalities. **METHODS:** A review of the international guidelines and evidence from North America and Europe. This session will focus on the investigation, management and risk assessment of aircrew with, or at risk from inherited cardiac and congenital abnormalities. This will include imaging and genetic screening. **RESULTS:** National guidelines are far from comprehensive with respects to risk assessment for early cardiomyopathy and congenital heart disease in aircrew. There are few consensus documents. The "normal" physiological findings in some aircrew cause diagnostic challenge as their cardiac dimensions are consistent with early cardiomyopathy. Early detection of cardiomyopathy may result in near normal cardiac measurement and risk assessment can be challenging. Simple congenital abnormalities may be compatible with flying, particularly if repaired in childhood. Congenital abnormalities may affect the coronary arteries, great vessels, valves or cardiac chambers. **DISCUSSION:** There is relatively little

literature to support decision making in early cardiomyopathy in aircrew. Whilst genetic testing may be beneficial it is currently limited. Assessment of arrhythmia risk, endocarditis risk and cardiac function (particularly diastolic dysfunction) are all important in the assessment of aircrew. Congenital heart disease covers a whole spectrum of disease, and at the simpler end may be compatible with flying (albeit often in a restricted multi-crew environment). Operative repair of congenital heart disease is increasingly successful, and risk assessment of these individuals represents a challenge to the aviation medicine practitioner.

Learning Objectives:

1. To be aware of the challenges that congenital heart disease and cardiomyopathy (especially if mild) present to the aviation cardiologist.
2. To be aware of the imaging and genetic investigations that may allow a refinement of the risk assessment of aircrew with congenital heart disease and cardiomyopathy.
3. To understand the contemporary challenges that both congenital heart disease and cardiomyopathy present when risk assessing aircrew.

[220] CONTEMPORANEOUS CHALLENGES IN AVIATION CARDIOLOGY: CARDIOTHORACIC SURGERY

T. Syburra⁴, E. Nicol¹, E.D. Davenport³, J. d'Arcy², and G. Gray⁵
¹Clinical Aviation Medicine Service (CAMS), RAF Centre of Aviation Medicine, Henlow, United Kingdom; ²Royal Air Force, Henlow, United Kingdom; ³Aeromedical Consultation Service, U.S. Air Force School of Aerospace Medicine, Wright Patterson AFB, OH; ⁴Cardiothoracic Surgery, University Hospital, Geneva, Switzerland; ⁵Medicine, CFEME/CMEFC National Defence /Défense nationale, Toronto, ON, Canada

INTRODUCTION: Cardiothoracic surgery in aircrew requires additional considerations compared with non-aircrew. The consideration of revascularization in aircrew must take into account all disease >50%, even if there is no myocardial ischemia in the lesser diseased arteries. Equally the consideration of valve replacement must take into account not only the durability of the valve but also the requirement for subsequent anti-coagulation. This session, delivered by a cardiothoracic surgeon and flight surgeon will address the contemporaneous issues in this area and introduce the European Association of Cardiothoracic Surgeons (EACTS) Aviation Medicine Working Group. **METHODS:** A review of current practice in coronary artery and valve surgery will be considered along with international guidelines for cardiothoracic surgery in aircrew from both North America and Europe. This session will introduce recent guidance being produced by the EACTS Aviation Medicine Working Group and cover both coronary and valve surgery. **RESULTS:** There remains a lack of clear guidance for the cardiothoracic surgeon and aviation medicine practitioners with regards to the most appropriate cardiothoracic surgical techniques for aircrew. The requirement for full revascularization and consideration of the occupational consequences of ongoing anti-coagulation in aircrew requires additional consideration in aircrew requiring cardiothoracic surgery. **DISCUSSION:** The work of the NATO Aviation Cardiology Working Group and EACTS Aviation Medicine Working Groups aims to explore the options available to aircrew undergoing cardiothoracic surgery and advise all aviation medical practitioners as to the available options and pitfalls of cardiothoracic surgery on this population, and allows fully informed discussion with aircrew as to the best option for them, in light of both their clinical disease and occupation.

Learning Objectives:

1. To understand the additional occupational considerations required for aircrew undergoing cardiothoracic surgery.
2. To understand the alternative cardiothoracic surgical options available when considering cardiothoracic surgery in aircrew.
3. To understand the risk/balance of various strategies for cardiothoracic surgery in aircrew, e.g. metallic versus porcine valve replacement for AS secondary to bicuspid aortic valve disease.

[221] CONTEMPORANEOUS ISSUES IN AVIATION CARDIOLOGY: ARRHYTHMIA AND ELECTROPHYSIOLOGYE.D. Davenport², E. Nicol¹, J. d'Arcy¹, G. Gray³, and T. Syburra⁴¹Clinical Aviation Medicine Service (CAMS), RAF Centre of Aviation Medicine, Henlow, United Kingdom; ²Aeromedical Consultation Service, U.S. Air Force School of Aerospace Medicine, Wright Patterson AFB, OH; ³Medicine, CFEME/CMEFC National Defence /Défense nationale, Toronto, ON, Canada; ⁴Cardiac Surgery, University Hospital, Geneva, Switzerland

INTRODUCTION: Palpitations are one of the most common cardiovascular presentations in aircrew and the use of ECG screening detects a significant proportion of ECG abnormalities that may require additional investigation. Additionally, advances in electrophysiology (EP) have led to increasing clinical indications for ablation therapy, often in early disease. For aircrew, where the use of pharmacologic agents may also present additional challenges a clear understanding of the current indications for advanced EP management is essential. **METHODS:** A review of current international guidelines from N America and Europe, highlighting differing approaches to common arrhythmias will be presented. This will include ventricular ectopy, ventricular tachycardia, and supraventricular tachycardias to include Wolf-Parkinson-White, atrial fibrillation, and atrial flutter. It will highlight the generic approach to risk assessment on arrhythmias, the use of common pharmacological agents in arrhythmias, the expanding indication for EP in these clinical scenarios, and subsequent risk assessment and waiver processes. **RESULTS:** With the rapidly expanding indication for ablation for many arrhythmias, including ventricular ectopy, many conditions that previously required pharmacological management now have potential curative ablation options. However, as seen in atrial fibrillation, early optimism about the long-term cure following ablation does not always come to pass. Evidence from various trials in North America and Europe will be presented to highlight the current practice in this complex area. **DISCUSSION:** Understanding the various options in the diagnosis and treatment of a multitude of arrhythmias and evidence to support best clinical practice in each for aviators is increasingly important. As one of the most common presenting cardiovascular complaints, it is essential that the aviation medicine practitioner has a good understanding of the appropriate investigational, pharmacological, and ablative management available for palpitations and arrhythmias.

Learning Objectives:

1. To understand the specific management options for common arrhythmias in aircrew.
2. To understand the appropriateness and limitations of electrophysiology and ablation techniques in aircrew.
3. To have a generic approach to the risk assessment of arrhythmias in aircrew whether treated pharmacologically or with ablation.

Tuesday, May 12

2:00 P.M.

S. Hemisphere E3**[XXXIX.] SLIDE: GLOBAL AE & TRAVEL MEDICINE****Co-Chair: Mary Brueggemeyer**

Bethesda, MD

Co-Chair: Diane Ritter

Biloxi, MS

2:00 p.m.

[222] ASSESSMENT OF AEROMEDICAL EVACUATION TRANSPORT PATIENT OUTCOMES WITH AND WITHOUT CABIN ALTITUDE RESTRICTIONW. Butler, G. Maupin, S. Dukes, and J. Serres
Aeromedical Research Department, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH

INTRODUCTION: Restricting cabin altitude below 8,000 feet is prescribed to mitigate potential altitude-induced complications during aeromedical evacuation (AE). However, cabin altitude restrictions (CARs) appear to add to mission time and fuel expense. Despite much discussion, there is a paucity of evidence-based guidance related to CARs. **METHODS:** A retrospective review of 102 patients was conducted. Patients were matched using ICD-9 codes and points of embarkation/debarkation; 51 were flown with a CAR and 51 without. Patient demographics, inflight status, inflight incident reports, overall outcomes, and mission costs were investigated. **RESULTS:** There were a significantly reduced number of post-flight procedures with CAR patients (CAR = 4.90, non-CAR = 6.08; $p = 0.027$). Similarly, those with CAR/supplemental oxygen had significantly fewer post-flight procedures than those without CAR/supplemental oxygen ($p = 0.029$). Indeed, on regression analysis, CAR and low systolic blood pressure were significant independent predictors of post-flight procedures. Although other outcomes did not reach statistical significance, they trended better with CAR. Patient demographics, inflight status, and inflight incident reports were generally unremarkable. Surprisingly, CAR did not significantly increase flight time and it added only around \$0.81 per mile to the cost of the flight (CAR = \$20.52, non-CAR = \$19.71; $p = 0.68$). **DISCUSSION:** The results suggest the physiological stressors associated with a normal cabin altitude can have a negative patient impact. Further, a CAR may well counter these stressors producing fewer post-flight procedures. This benefit appears to come without serious cost either in flight time or fuel.

Learning Objectives:

1. Recognize the differences in clinical outcomes between critically ill patients who undergo AE transport with and without CAR.
2. Identify cost per air mile of CAR versus non-CAR AE missions.

2:15 p.m.

[223] ROLE OF POINT-OF-CARE ULTRASOUND IN CRITICAL CARE TRANSPORT, AN EARLY EXPERIENCE IN AIR AMBULANCEE. Surakarn and S. Kajornboon
Aviation Medicine Department, Bangkok Hospital Medical Center, Bangkok, Thailand

INTRODUCTION: Ultrasound is a useful diagnostic tool in emergency, trauma and critical care. Its roles also extended to pre-hospital medical service. An advantage is the test result that can be interpreted by visual display and not interfered by noise or vibration in flight environment. As an air ambulance provider, we included the use of portable ultrasound into our critical care transport services, as one of the point-of-care tests both in fixed wing and rotor wing aircrafts. The sonographic findings, subsequent managements and clinical outcomes of patients were studied. **METHODS:** Medical records of patients transferred by air ambulance during Jan 2013 - Sep 2014 were retrospectively reviewed. We reported the sonographic findings, related subsequent treatments and clinical outcomes of 20 patients whose sonographic examination were needed during process of interfacility transfer. **RESULTS:** 38 problems were detected and confirmed by sonographic examinations in 20 patients. The common clinical problems were hypotension, suspected hypovolemia and blunt thoracoabdominal injury. Examinations were performed in both pre-flight and in-flight medical care. Patient's conditions identified by sonography were hypovolemia, hypervolemia, poor cardiac contractility, presence and absence of pneumothorax, hemothorax and free peritoneal fluid. Subsequent treatments related to the findings were fluid resuscitation, inotropic drugs administration, chest tube insertion and serial evaluation. Physiologic parameters of all patients were significantly improved after interventions which were guided by sonographic findings. Some other invasive procedure, such as central venous access for measurement of central venous pressure, can be also omitted. **DISCUSSION:** Our study suggested that point-of-care ultrasound can improve patient safety and feasible in aeromedical transport. Sonographic studies help and facilitate decision making in critical care transport by confirmation of diagnosis, guidance of treatment and re-evaluation.

Learning Objectives:

1. Application of ultrasound in critical care transport by air ambulance can improve clinical outcomes of patients.

2:30 p.m.**[224] UNISTAR AEROMEDICAL TRANSPORT IN PERU**

E. Arevalo

Emergency, Essalud, La Molina, Peru

INTRODUCTION: Unistar Aeromedical Transport is the first operator of aeromedical services in Peru. They specialize in transportation of critical patients and have 13 years of experience. Approximately 700 patients have been transported since 2002. **METHODS:** Descriptions of the aeromedical cases transported by Unistar since 2002 will be presented. Emphasis will be given to the year 2013 with a description of the major diagnoses of patients transported. **RESULTS:** There is a predominance of males (71%) over females (29%). Age: Over 45. The most frequent diagnoses were: Respiratory Failure; High Altitude Sickness; and Trauma. **DISCUSSION:** In Peru, Aeromedical Transport is still a new topic. Peru has important tourist sites such as Machu Picchu, where some tourists suffer from Acute Respiratory Failure and High Altitude Sickness. Some of these patients require Aeromedical Transportation. In Peru, mining is an important activity, therefore some trauma patients are transported from mines.

Learning Objective

1. Introduce aeromedical transportation in Peru to the world community.
2. Share experiences with colleagues.
3. Improving medical transport in Peru.

2:45 p.m.**[225] AVIATION AND EMERGENCY MEDICINE - A POSTGRADUATE COURSE FOR EMERGENCY CARE STUDENTS TAKES FLIGHT**

R.A. Cocks, K. Hung, T. Rainer, and C.A. Graham

Accident & Emergency Medicine Academic Unit, Chinese University of Hong Kong, Hong Kong

INTRODUCTION: Aviation medicine has traditionally been a specialist subject, often regarded as a subspecialty of occupational medicine. In 2005, the Chinese University of Hong Kong introduced a new postgraduate qualification in emergency care, the MSc in Prehospital and Emergency Care, targeted at healthcare professionals from all disciplines. As part of the second year of study, we designed a 3-day course in Aviation Emergencies which explores the close interaction between Aviation Medicine and Emergency Medicine. **METHODS:** A detailed analysis of practical emergency planning and the EMS response to aviation accidents and major incidents, in-flight medical emergencies (including evidence-based aircraft emergency kit design), and transport of emergency patients by air guided the course content and evaluation methods. **RESULTS:** The course occupies three full days and consists of a combination of lectures, practical skills training and coursework. Students are taught on a range of topics including aviation medical fitness (for passengers and for aircrew), approach to inflight medical emergencies, emergency medical kit design, aircraft crash investigation, aviation disaster management and emergency care in the flight environment. A particular highlight is a three hour practical session in the cabin mock-up of a local commercial airline in which authentic scenarios are practiced in the cabin, including cardiac arrest, acute stroke, acute coronary syndromes and obstetric and gynecological emergencies. **DISCUSSION:** There have been seven cohorts with a total of 99 students completing this module of Master of Science in Prehospital Emergency Care course since 2006. Feedback from this discerning and critical group has been overwhelmingly positive. Students enthusiastically participate in the course and they have been challenged by the integration of emergency care knowledge and research with the aviation environment. The course format provides a model that could be usefully integrated into undergraduate medical, nursing or paramedic courses and postgraduate courses in emergency care as a practical introduction to the subject.

Learning Objectives:

1. To examine the many areas of interaction between Emergency Medicine and the aviation environment.
2. To explore the application of Evidence-Based Medicine in formulating a logical response to aviation-related emergencies and disasters.
3. To analyze areas where common gaps in student knowledge and course content can guide future course development.

3:00 p.m.**[226] PROSPECTIVE OBSERVATIONAL STUDY OF INFECTIOUS DISEASES ACQUIRED BY TOURISTS VISITING CARTAGENA CITY, COLOMBIA**M.A. Salamanca¹, G. Conde¹, B. Paternina², M. Ortiz², and S. Orozco²¹*Universidad del Sinu, Cartagena, Colombia;* ²*CURN, Cartagena, Colombia*

INTRODUCTION: Around one billion people travel around the world. Almost two million foreigners arrived to Colombia in 2013, mainly from United States, neighboring South American countries and Spain. Bogota and Cartagena are the major hosting cities. Currently, there are no published studies related to infectious diseases acquired by tourists visiting Cartagena city. **METHODS:** This is a prospective longitudinal cohort study. Foreign tourists 18 years older were interviewed in Cartagena de Indias city, between March 1 and May 1, 2014. They were asked about epidemiological information, travel aspects, accommodation, hygiene habits and the presence of infections. They were subsequently contacted in the fifth, tenth and fiftieth days to inquire for new infections. **RESULTS:** 105 Tourists were interviewed and just 91 were contacted in the second interview. Tourists that were not able to contact at the second interview were excluded. The average age was 33 years, mostly from the America (57%) and Europe (41%), predominantly male (58%). Of the respondents 89% were asymptomatic before arriving Cartagena and 75.8% at the first interview. The cumulative incidence of infectious diseases was 39.6%: mainly gastrointestinal (18.6%) and respiratory (16.4%) infections. Association between gastrointestinal infections found consumption of no bottled water and poor hygiene. **DISCUSSION:** A higher incidence of gastrointestinal and respiratory infectious diseases was found. Because these diseases can be prevented it is advisable to establish policies aimed to travelers, to hosting providers, and to food and beverages handlers in the Cartagena city to prevent the acquisition of infection among travelers without affecting the local economy related to the tourism industry.

Learning Objectives:

1. To estimate infectious diseases incidence among foreign tourists in Cartagena de Indias, Colombia.

3:15 p.m.**[227] FREQUENCY OF MEDICAL EVACUATION FOR ABDOMINAL PAIN FROM ANTARCTICA, 2003 TO 2014: APPLICATION TO RISK ESTIMATES FOR SPACEFLIGHT**D. Reyes¹, E. Kerstman¹, and S. Parazynski²¹*PMCH, UTMB, Galveston, TX;* ²*Center for Polar Medical Operations, UTMB, Galveston, TX*

INTRODUCTION: Emergency medical evacuation (MEDEVAC) is a problem of critical importance for persons such as astronauts, personnel stationed in Antarctica, and others working in remote or austere environments. Abdominal pain presents a unique challenge in an austere environment, in that it is often difficult to separate diagnoses requiring medical or surgical intervention from those that are benign. To help define these risks, MEDEVAC data from the U.S. Antarctic program were reviewed. **METHODS:** The last eleven years of MEDEVAC data from U.S. Antarctic stations (McMurdo, South Pole, and Palmer Stations) were reviewed. The data was scanned for keywords, including "abdominal pain", "appendicitis", and "renal stone". The records that fit these criteria were tabulated and compared to station population to derive the incidence of these diagnoses. **RESULTS:** Of 215 MEDEVACs over the eleven Antarctic seasons from 2003

to 2014, 7 were for abdominal pain (3.26% of total), 9 for appendicitis (4.19%), and 12 for renal stones (5.58%). For the 7 abdominal pain diagnoses, 3 had final diagnoses requiring intervention. Of the 9 appendicitis diagnoses, 7 were treated. For the 12 renal stone patients, 6 had confirmed stones. From 2003 to 2014, there was a 1.8% population risk for MEDEVAC for any cause, and 0.06%, 0.08%, 0.10% risk of MEDEVAC for abdominal pain, appendicitis, and renal stone, respectively. **DISCUSSION:** These diagnoses relied upon the provider's medical opinion in the field, as made without access to advanced diagnostic equipment, such as computed tomography, although ultrasound was available in most cases. The eventual diagnosis at a tertiary facility was often different or inconclusive. The Antarctic MEDEVAC data shows that definitive diagnosis in an austere environment can be difficult. This data may be useful to refine what diagnostic and medical capabilities are needed for deep space missions, and to help refine pre-mission screening requirements.

Learning Objectives:

1. MEDEVAC data from Antarctic provides excellent data that can be used to help determine risk estimates for mission-threatening medical events during spaceflight.

Tuesday, May 12
S. Hemisphere E4

2:00 P.M.

[XL.] PANEL: EVIDENCE-BASED HUMAN PERFORMANCE, PART 1

Sponsored by the Science and Technology Committee, the Aerospace Human Factors Association, and the Aerospace Physiology Society

Chair: Valerie Martindale
Beavercreek, OH

PANEL OVERVIEW: Background: Evidence-based decision making has been improving the quality and cost-effectiveness of medicine since its introduction in 1972. The evidence-based approach involves five steps: (1) framing an answerable question, (2) retrieval of evidence, (3) critical evaluation of evidence, (4) application of results in practice, and (5) evaluation of outcomes. This double panel examines the initial stages in applying the evidence-based decision making process to selected topics in the field of human performance relevant to US Air Force (USAF) operational needs. Panel speakers will discuss the first three steps, conducted as an adaptation of the process used in evidence-based clinical preventive services. **Methods:** The work presented here was conducted as a proof-of-concept for demonstration within the USAF. It is based on the Electronic Topic Guide created and maintained by the U.S. Preventive Services Task Force (USPSTF). The USPSTF procedural manual was used as a starting point for process development and a model for the final product. The product is intended to support the human performance practitioner, which for this proof-of-concept was chosen to be the Aerospace Physiologist. **Results and Conclusions:** Panel speakers will discuss 1) the evaluation process, including conceptual development and practical limitations, 2) four examples of specific human performance topics evaluated by this process, including practice and research recommendations determined for each, 3) the electronic tool for maintaining and presenting results for use by practitioners, and 4) future directions. The second panel will conclude with open discussion.

[228] PROCESS DEVELOPMENT FOR EVIDENCE-BASED DECISION MAKING IN HUMAN PERFORMANCE

M. Aldag¹ and V.E. Martindale²
¹Booz Allen Hamilton, Rockville, MD; ²Booz Allen Hamilton, Beavercreek, OH

INTRODUCTION: Evidence-based decision making is a new endeavor in human performance, where a repeatable, traceable, documented process is needed to produce reliable recommendations that can be accessed and used in the field. This evidence evaluation process was adapted from the U.S.

Preventive Services Task Force (USPSTF) procedural manual. **METHODS:** A scoping workshop composed of individuals reflecting the intended audience of the evidence-based recommendations (e.g., Aerospace Physiologists) identified and prioritized a list of current human performance challenges as topics for evaluation. Additionally, participants provided guidance on topic scope and populations of interest. Scientific and medical literature describing studies relevant to each topic were identified using predetermined inclusion and exclusion criteria. Individual studies were evaluated systematically by a panel of reviewers using a set of defined criteria, with periodic discussions conducted among reviewers as necessary. Individual reviewer evaluations were consolidated into a single summary evaluation for each study. **RESULTS:** Reviewers considered summary evaluations for all studies within a topic to determine practice recommendations, associated evidence grade, and recommendations for future research. The process and its development will be presented with special reference to where it differs from the USPSTF process, and where it can be improved in future.

Learning Objectives:

1. Develop evidence-based recommendations for human performance.

[229] LIMITATIONS OF THE EVIDENCE-BASED PROCESS AND MODEL

V.E. Martindale² and M. Aldag¹
¹Booz Allen Hamilton, Rockville, MD; ²Booz Allen Hamilton, Beavercreek, OH

INTRODUCTION: To develop an evidence base for human performance, the authors created a proof-of-concept database with recommendations, analogous to evidence based medicine recommendations, and a software platform to allow navigation of human performance recommendations. During the development of the proof-of-concept recommendations and platform, a number of limitations became apparent, to be discussed here. **METHODS:** This presentation will introduce limitations of evidence evaluation and recommendation formulation identified during this work and how they can be addressed in practice. The primary limitations follow, which should be borne in mind when interpreting recommendations. **RESULTS:** (1) Framing a study question for investigation of the evidence base results in a carefully defined area of knowledge on which to gather evidence, and recommendations must be interpreted in this context and then tailored to operational use. (2) For a given topic, there may not be sufficient evidence (i.e., scientific or medical studies) to support a recommendation. (3) Studies in human performance cannot always be blinded, randomized, or placebo controlled. (4) The definition and measurement of performance is highly variable and not always generalizable. (5) Recommendations are specific and narrow by design, but as a consequence, they cannot be comprehensive. **DISCUSSION:** To mitigate the limitations presented, several practices are needed. Practitioners need to be able to interpret and adapt recommendations for specific cases, without losing the essential value of the evidence-based process. The process must be robust enough to work despite the biases of individual reviewers. Finally, the evaluation process described here is still in development: application of recommendations in practice and measurement of real-world outcomes are the final steps that will complete the cycle and ultimately determine the value of each evidence-based recommendation.

Learning Objectives:

1. The evidence base process provides an objective view of the value of a practice or intervention.
2. Some expertise in the area and some familiarity with the role of the evidence base are needed to apply recommendations correctly in practice.

[230] THE EVIDENCE BASE FOR FUNCTIONAL MOVEMENT SCREENING™

S. Williams¹ and V.E. Martindale²
¹Physiology, USAF, APO AE; ²Booz Allen Hamilton, Kettering, OH

INTRODUCTION: Musculoskeletal injuries result in significant cost to the Air Force, and a means of predicting and preventing injury would be valuable. Functional Movement Screening™ (FMS) is a test intended to

predict susceptibility to injury and/or physical performance by evaluating body movement symmetry and range of motion in a simple, easily applied set of steps. Reviewers set out to evaluate the evidence supporting this use of the screening test. **METHODS:** Of eighteen abstracts meeting initial inclusion criteria screening, nine met all inclusion and exclusion criteria. These nine papers were each evaluated by four reviewers, and graded on five criteria for internal validity. **RESULTS:** Reviewers determined that there is insufficient evidence to support a recommendation for or against the use of FMS as a predictor of injury and/or physical performance in the population of interest. Further research is recommended to establish links between FMS and performance measures, evaluate specific subpopulations, and determine potential utility of complementary screening methods. The implications of a statement of insufficient evidence will be covered, and some considerations on how the evidence-based process is useful in this context.

Learning Objectives:

1. How does the Air Force define musculoskeletal injuries?

[231] THE EVIDENCE BASE FOR USE OF MODAFINIL TO MITIGATE FATIGUE

L. Caldwell

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

INTRODUCTION: Modafinil is approved by the U.S. FDA for the treatment of narcolepsy, obstructive sleep apnea, shift work disorder, and is used by select aircrew for fatigue mitigation. Therefore consideration of modafinil to mitigate fatigue presented an opportunity for a positive control case in development and testing of the evidence-base process for human performance sustainment. **METHODS:** Of 25 abstracts meeting initial inclusion criteria, nine studies were found to meet all inclusion and exclusion criteria, and were evaluated by three reviewers. Each study was graded on five internal validity criteria as a measure of quality. **RESULTS:** Existing evidence strongly supports the use of modafinil to mitigate fatigue. Further research is recommended, particularly to determine whether the longer-acting armodafinil may be a good alternative to modafinil to mitigate fatigue for long missions. The recommendation statement of this proof-of-concept product is tailored to the intended audience that will include individuals that do not have prescription authority.

Learning Objectives:

1. Understand the proper use of modafinil in military operations.

Tuesday, May 12
Americas Seminar

2:30 P.M.

[XLI.] POSTER: COSMIC CLINICAL CONSIDERATIONS

Co-chair: John Darwood

Kennedy Space Center, FL

Co-chair: Royden Marsh

San Antonio, TX

[232] THE VALUE OF SOME NEW INFLAMMATORY MARKERS FOR FOLLOW-UP IN DIABETIC FOOT PATIENTS RECEIVING HYPERBARIC OXYGENATION THERAPY

S. Metin¹, C. Ozturk², A. Akin¹, T. Cakmak¹, S. Balta³, A. Sen⁴, and M. Aparci⁵

¹*Aerospace Medicine, Gulhane Military Medical Academy, Eskisehir, Turkey;* ²*Gulhane Military Medical Faculty, Ankara, Turkey;* ³*Cardiology, Eskisehir Military Hospital, Eskisehir, Turkey;* ⁴*Aerospace Medicine, Turkish Air Force Aeromedical Research and Training Center, Eskisehir, Turkey;* ⁵*Cardiology, Etimesgut Military Hospital, Ankara, Turkey*

INTRODUCTION: Atherosclerosis and inflammation play important roles in the etiopathogenesis of diabetic foot. Some new inflammatory markers have been studied as new predictors for inflammation. We aimed to investigate and compare the changing in neutrophil/ lymphocyte ratio (N/L ratio), platelet/ lymphocyte ratio (P/L ratio), red cell distribution width/ lymphocyte ratio (R/L ratio) and other inflammatory markers in patients with diabetic foot before and after hyperbaric oxygenation therapy (HBOT). **METHODS:** The medical records of 16 diabetic foot and known multiple atherosclerotic patients who admitted for adjunctive treatment with HBOT to our hospital were included in this study. N/L ratio, P/L ratio, R/L ratio and other inflammatory markers were measured as parts of the automated complete blood count. Statistical analyses were done by using SPSS 16.0 software. Values of $p < 0.05$ were considered to indicate statistically significant differences. **RESULTS:** Mean ages of the patients were 61.50 ± 10 and mean number of HBOT sessions were 21.50 ± 8.36 . There were statistically significant differences in some blood count parameters in diabetic foot patients before and after HBOT. Platelet counts were $270 \times 10^3 / \mu\text{l}$; $239 \times 10^3 / \mu\text{l}$ ($p: 0.004$, $Z: 2.846$), mean platelet volumes (MPV) were 8.95 fl ; 9.15 fl ($p: 0.031$, $Z: 2.163$) and platecrit values were 0.24% ; 0.217% ($p: 0.030$, $Z: 2.132$) before and after HBOT, respectively. N/L ratio were 1.95 ; 2.06 ($p: 0.836$, $Z: 0.207$), R/L ratio were 5.16 ; 5.81 ($p: 0.326$, $Z: 0.982$), P/L ratio 108.73 ; 97.81 ($p: 0.255$, $Z: 1.138$) before and after HBOT, respectively. **DISCUSSION:** The treatment with HBO improved the rate of healing and improved the platelet counts and platecrit values but increased in MPV in patients with diabetic foot. The new inflammatory markers-N/L ratio, P/L ratio and R/L ratio did not change. We need further large series studies to obtain optimal results about the effects of HBOT on specific inflammatory markers.

Learning Objectives:

1. To find a successful follow-up marker in monitoring diabetic foot patients before and after hyperbaric oxygenation therapy.

[233] RECIPIENT SITE NECROSIS IN HAIR TRANSPLANTATION AND HYPERBARIC OXYGEN TREATMENT

D. Alhan², E. Ercan¹, and D. Yildiz³

¹*Department of Hyperbaric Medicine, Eskisehir Military Hospital, Eskisehir, Turkey;* ²*Department of Plastic, Reconstructive & Aesthetic Surgery, Eskisehir Military Hospital, Eskisehir, Turkey;* ³*Department of Dermatology, Eskisehir Military Hospital, Eskisehir, Turkey*

INTRODUCTION: Follicular unit extraction (FUE), one of the types of hair transplantation surgery (HTS), is widely accepted hair-restoration technique and complications are uncommon in the literature. We used Hyperbaric Oxygen Treatment (HBOT) in order to restrict necrosis area in length and depth, and increase wound healing in our patient. A 33-year-old man has suffered hair loss localized to the frontal and vertex area was diagnosed with androgenic alopecia, Norwood grade III. He underwent to HTS with FUE technique. **METHODS:** The ring block was administered in the frontal and occipital scalp (2% prilocaine hydrochloride with 1:100.000 adrenaline) and preceding tumescent saline solution with adrenaline was injected in the entire recipient site to make it turgid. Grafts were harvested and were transplanted to the frontal site. **RESULTS:** Patient suffered from a pain in the recipient site and a cyanosis was revealed after three hours. The cutaneous lesion then rapidly evolved into the necrotic appearance. The patient was referred to our hospital for HBOT in the first day of operation. On the examination, dark purple lesions with irregular borders were observed especially at the frontal region. He does not smoke. The laboratory tests were normal. The patient was given 10 sessions of HBOT (2.4 ATA) and topical wound care was administered. Dry, dark and leathery eschar was totally debrided after 3 weeks. **DISCUSSION:** Adrenaline has potential side effects. Therefore its use must be carefully considered in patients. Our case shows that the necrosis of recipient site owing to exaggerated vasoconstrictor response to adrenaline in tumescent infiltration. Thus, the patient's previous response to epinephrine or adrenaline must be elucidated in order to avoid ischemia or necrosis of scalp. HBOT which involves the inhalation of pure oxygen at higher atmospheric pressures is suggested to have anti-hypoxic, anti-edema, and anti-infective properties. Urgent HBOT is needed in ischemia to prevent necrosis or decreasing necrotic tissue size

in length and depth. We concluded that necrosis is very rare but serious problem in follicular unit transplantation surgery. Dermatologists and plastic surgeons must be aware of this risk.

Learning Objectives:

- 1- Hyperbaric Oxygen Treatment (HBOT) may be beneficial to restrict necrosis area in length and depth.

[234] EFFECTS OF NIFEDIPINE ON CEREBRAL PERFUSION DURING +GZ EXPOSURE IN SPONTANEOUSLY HYPERTENSIVE RATS

S. Maruyama¹, M. Fujita¹, A. Kobayashi¹, N. Yamada², and Y. Nishida³

¹Second Division, Aeromedical Laboratory, Tachikawa, Japan;

²Aeromedical Laboratory, Sayama, Japan; ³Physiology, National Defense Medical College, Tokorozawa, Japan

INTRODUCTION: Some pilots in the Japan Air Self-Defense Force (JASDF) are diagnosed as hypertensive. Calcium channel blocker (CCB) might reduce +Gz tolerance of the fighter pilot but the effect of CCB to cardiovascular system is still elusive. We investigated the effects of nifedipine (one of the CCB), on the cerebral perfusion in spontaneous hypertensive rats (SHR). **METHODS:** We used 10-week-old male spontaneously hypertensive rats (SHR) and Wistar-Kyoto (WKY) rats. Eight SHR and WKY rats were fed a normal diet for 2 weeks; namely nSHR and nWKY, respectively. Eight SHR and WKY rats were fed a diet that contained 0.1 % nifedipine for 2 weeks; namely tSHR and tWKY, respectively. Rats were exposed to 4.5 Gz for 5 sec using our centrifuge system for small animals. Arterial pressure at the level of the brain (APLB) and heart rate (HR) were continuously monitored. **RESULTS:** The resting APLB was significantly higher in nSHR and tSHR than in nWKY rats before centrifugation, and the resting APLB was lower in tSHR than in nSHR rats. No significant differences were found between nWKY and tWKY rats. During +4.5 Gz exposure, the average decline in the APLB was significantly greater in nSHR than in tSHR and nWKY rats. However, no significant differences were observed in the rate of decline in the APLB in tSHR, nWKY, and tWKY rats. No significant differences were observed in the HR among these groups. **DISCUSSION:** Our results suggest that hypertension may reduce +Gz tolerance with regard to cerebral perfusion. However, nifedipine may eliminate this reduced cerebral perfusion in hypertensive rats; thus, hypertension treatment may be beneficial from the aspect of cerebral perfusion.

Learning Objectives:

1. Our centrifuge system for small animals is introduced.
2. Reduced cerebral perfusion of hypertensive rats is introduced.
3. Nifedipine treatment may be beneficial from the aspect of cerebral perfusion.

[235] HYPERTENSION-DIAGNOSIS AND INCIDENCE IN U.S. ARMED FORCES PILOTS

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INTRODUCTION: Hypertension is a common medical problem that most flight surgeons have encountered in aircrews. The publishing of the JCN 8 AMA hypertension guidelines in the U.S. in 2014 and the CHEP 2014 guidelines in Canada have indicated new blood pressure levels for both diagnosis and treatment of hypertension. It is therefore important that military aviation medicine keeps abreast of these new diagnostic criteria and updates its own guidelines accordingly. This primary objective of this study is to compare the current aviation waiver guidelines in the U.S. armed forces and the Royal Canadian Air Force to existing civilian guideline. Secondary objectives are to determine rates of hypertension amongst U.S. military pilots. **METHODS:** The waiver guides of The U.S. Navy, U.S. Air Force, U.S. Army and the Royal Canadian Air Force were examined and compared to JCN 8 and CHEP guidelines respectively. Additionally, we utilized the (DoD) Armed Forces Health Surveillance Center's (AFHSC) Defense Medical Surveillance System (DMSS) from 2008 to 2013, querying ICD codes related to hypertension 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 hypertension by person years of specific platforms or service. Hypertension related to secondary causes such as polycystic kidney disease, OSA, autoimmune, or congenital were also included. **RESULTS:** The JNC 8 guidelines use the blood pressure of 140/90 for diagnosis and treatment of hypertension in under 60 years. The U.S. Navy, Us Air Force and U.S. Army all use the 140/90 cut off for diagnosis. The RCAF does not have a separate flight surgeon guideline for hypertension. The DMED results are not yet available. **DISCUSSION:** Further discussion is pending DMED results.

Learning Objectives:

1. The eventual formulation of a new hypertension flight surgeon guideline for the RCAF.

[236] THE INFLUENCE OF TRANSCRANIAL MICRO-ELECTRIC CURRENT PHYSIOLOGICAL TRAINING ON CEREBRAL FUNCTION UNDER ALTITUDE HYPOXIA

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INTRODUCTION: Cerebral function can be impacted by hypoxia during flight training in altitude, and some symptoms of headache, insomnia, depression and low cognitive ability would appear. Transcranial micro-electric current physiological training (TMCPT) is to directly guide microcurrent (strength: microampere; μV) into the brain through simulating brain wave with surface electrode on the scalp, and regulates central nervous system, improve emotional state and elevate cognitive ability. **METHODS:** Forty healthy volunteers served as subjects, who took flight to the altitude and were trained by TMCPT in the condition of altitude hypoxia (3,700 m above sea level). Current intensity of TMCPT was limited within safe physiological range. Subjects were trained twice per day (one in the morning and the other in the afternoon), each for 5 minutes. Neurobehavioral ability index was separately observed in rush entry phase (first 10 days after entry) and in various resident phases (resided in altitude for 1, 2, and 3 months). Self-evaluating questionnaire and Pittsburgh Sleep Quality Index were used to evaluate sleep quality in different phases. **RESULTS:** (1) In rush entry phase: digital scan, memory scan, simple visual reaction time, complex visual reaction time, pursuit aiming and consecutive performance were significantly increased at 10 days after TMCPT training ($t=1.982-4.412$, $P < 0.05$) as compared with those at 1 day. (2) Resident phase: compared to neurobehavioral ability index at 1 month, only digital scan, memory scan and simple visual reaction time were significantly increased at 3 months after TMCPT ($t=3.744-5.812$, $P < 0.05$) as compared with those at 1 month. (3) Sleep quality evaluation: sleep quality indexes had a significant reduction after TMCPT as compared with rush entry phase ($t=1.833-3.552$, $P < 0.05$). **DISCUSSION:** The four topics of the paper were discussed, including: (1) Promoting the effect of feedback training of β frequency brainwave band. (2) Promoting effect of feedback training of a frequency brainwave band on sleep. (3) TMCPT can maintain cognitive ability. (4) Significance of cognitive training for flight in altitude.

Learning Objectives:

1. The participant will learn the value of feedback training for altitude hypoxia.

[237] MODULATION OF THE VENTILATORY RESPONSE DURING EXERCISE: ARE THERE GENDER DIFFERENCES?

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INTRODUCTION: During exercise, ventilation is regulated to maintain isocapnia. Current studies demonstrate the importance of respiratory adaptive strategies (modulation) during exercise. Short term modulation (STM) of the ventilatory response (serotonin dependent

modulator) maintains blood gas homeostasis while breathing added deadspace (hypercapnia); however, it is unknown if STM is affected by gender. **METHODS:** STM of the ventilatory response was measured in men (n=10; age= 25.9±5.7 yrs; ht=69.4±3.0 in; wt=172±32.1 lbs.) and women (n=6; 23.0±1.7 yrs; ht=66.6±1.4 in; wt=133.8±10.2 lbs) on a cycle ergometer. Ventilation was measured at rest and during exercise at 30, 50 and 75% of peak oxygen consumption while breathing 0 (control), 400, 600, and 800 ml of external deadspace. Minute ventilation (V_E) and tidal volume (V_t) were corrected for body weight. A two-way ANOVA with RM was used to test for differences in all ventilatory variables. Multiple comparison procedures were performed using the Holm-Sidak method. **RESULTS:** Significant gender differences in V_E ($p<0.001$) and V_t ($p=0.003$) were seen at rest while breathing external deadspace. STM of the exercise ventilatory response was not different between men and women. **DISCUSSION:** The differences in STM at rest, based on gender, were eliminated during exercise. Thus, STM may be a strategy to preserve exercise capacity. Gender differences in ventilation at rest and during exercise are important to everyday life because common physiological changes (i.e. obstructive lung disease, obesity, and sleep apnea) or different environmental situations (i.e. altitude, or imposed breathing apparatus used by pilots and divers) are constantly encountered.

Learning Objectives:

1. Determine the effect of gender on short term modulation at rest and during exercise.

[238] PHARMACOKINETICS AND EFFICACY OF INTRANASAL SCOPOLAMINE SPRAY

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INTRODUCTION: Motion sickness (MS) is a problem for the modern military across the Services. The anticholinergic scopolamine is one of the most efficacious anti-MS medications, though its most common routes of administration (transdermal and oral) have drawbacks that often compromise utility, including delayed onset of action and dose-related side effects. A 2011 pilot study of a low-dose (0.2 mg) aqueous spray formulation of intranasal scopolamine (INSCOP) suggested rapid absorption with no significant side effects. We expanded upon the pilot study to identify the full pharmacokinetics (PK), efficacy, and side effect profile of the aqueous spray formulation. **METHODS:** We performed a preliminary study divided into two phases: PK (n=6) and Efficacy (n=4). In both phases, bioavailability, peak plasma concentration, absorption rates, and side effects profiles were analyzed. Cognitive performance was measured via the Automated Neuropsychological Assessment Metrics® batteries, and subjective alertness was measured via the Karolinska Sleepiness Scale. In the Efficacy phase, a within subjects, double-blind study design was used. Subjects underwent two separate sessions of mechanical rotation receiving either placebo or INSCOP (active medication) on each rotation. Subjects experienced Coriolis cross-coupling in a staircase progression until moderate stomach awareness was achieved. MS symptoms were reported according to a symptom profile derived from the Pensacola Motion Sickness Questionnaire. **RESULTS:** Preliminary results suggest that the aqueous INSCOP spray may provide fast onset of action with consistent drug delivery at a lower than normal dose without significant side effects, potentially providing "just-in-time" treatment in fast-changing, dynamic, operational settings. **DISCUSSION:** The preliminary results support the need to perform a more powerful study, PK (n=12) and Efficacy (n=32), which is currently on-going. The complete study will provide a clearer picture of the efficacy and utility of using INSCOP in dynamic operational environments. Having an effective, fast-acting, MS countermeasure, one without untoward side effects, would enable our warfighters to perform at optimal levels without compromising their mission readiness and performance.

Learning Objectives:

1. To examine the efficacy and side effects of intranasal scopolamine as an anti-motion sickness medication.

[239] BACK PAIN ASSESSMENT IN THE ARMY AVIATION COMMUNITY

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INTRODUCTION: Previous studies indicate that back pain occurs in more than 50% of military helicopter pilots. Suggested causal factors of back pain in military aviators include poor posture, cockpit vibration, and inadequate lumbar support of aircraft seating. Despite these earlier reports, it remains unclear whether modifications to aircraft design could potentially alleviate back pain and/or improve long-term musculoskeletal outcomes in rotary wing pilots and other crewmembers. The current study was designed to obtain timely crewmember feedback on operational and personal issues that may correlate with the occurrence of back pain, which may then help shape future studies to explore practical and effective back pain countermeasures. **METHODS:** Human subject volunteers completed an anonymous, written survey consisting of 20 questions. The survey included feedback on crewmember demographics, flight experience, history of back pain, approaches to managing back pain, and possible non-operational confounders of back pain. Correlations among these factors were then calculated, in an effort to discern potential key associations. Also, subjects were asked to provide narrative feedback on their perceptions of aircraft seating and quality of cockpit ergonomics. **RESULTS:** The incidence of back pain was found to be associated with crewmember perceptions of lumbar support quality, seating material, and wearing combat gear. Moreover, approximately 90% of respondents with experience flying in UH-60, AH-64, and/or CH-47 aircraft indicated that their occupational duties likely contributed to back pain. **DISCUSSION:** These findings have focused our attention upon specific aspects of cockpit design and operational practices that are closely linked to the development of crewmember back pain. Future studies will assess the effectiveness of alternative approaches to aircraft engineering that may allow for improved human musculoskeletal outcomes while still meeting platform airworthiness standards.

Learning Objectives:

1. To discern potential correlations with crewmember back pain, and to provide a foundation for exploring back pain countermeasures.

[240] PREVALENCE AND FEATURES OF HEPATIC STEATOSIS AND INCIDENTAL THYROID NODULES IN AVIATORS DETECTED BY ABDOMINAL AND THYROID ULTRASONOGRAPHY

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INTRODUCTION: Ultrasonography is a valuable noninvasive method using in annual examination of aviators. We evaluated the correlation of prevalence of hepatic steatosis (HS) and incidental thyroid nodules among aviators and its relationship with clinical features. **METHODS:** A cross-sectional study was conducted and we retrospectively analyzed the medical records of 300 aviators who were examined by abdominal and thyroid ultrasonography during annual periodical examination between May 2014 and September 2014. Demographic features (age, BMI, and etc.), TSH and liver function test results of consecutive aviators who had hepatic steatosis and thyroid nodules were compared, separately. The frequency and coincidence of thyroid nodules and hepatic steatosis were also described. **RESULTS:** Three-hundred consecutive aviators were enrolled. Retrospective analysis of medical records showed that the prevalence of hepatic steatosis and the incidental thyroid nodules were 20% for both pathology. The mean age was 30.9+10.69 years. Coincidence frequency of hepatic steatosis with incidental thyroid nodules were calculated 8%. Serum TSH levels were low in aviators with hepatic steatosis. Older age and high BMI were abnormally increased in aviators with hepatic steatosis. Serum levels of liver enzymes depending on ultrasonographic grading of steatosis were also elevated in those subjects. **DISCUSSION:** Current retrospective study is a first report relevant to the prevalence of hepatic steatosis and Incidental thyroid nodules in aviators. The hepatic steatosis was significantly associated with higher body mass index and waist circumference in present study. Despite the fact

that many studies have reported the association of hepatic steatosis and metabolic risk factors, most metabolic and anthropometric parameters were normal in present study. Hepatic steatosis prevalence was found in 20% and its presence was not associated with central obesity. Although incidental thyroid nodules were also common, the prevalence of thyroid nodules for flight crew was not found higher than population based studies. Ideal physical activity, weight loss, diet balance and life modifications could be the initial preventive measures especially for senior aviators.

Learning Objectives:

1. Hepatic steatosis can often be related to other diseases and conditions such as thyroid diseases. Therefore it is crucial to perform abdominal sonography accompanied by thyroid ultrasonography in annual examination of flight crew, particularly for whom it may be an increased risk factor.

[241] ASSOCIATION OF CAROTID ARTERY INTIMA-MEDIA THICKNESS AND NON-ALCOHOLIC FATTY LIVER DISEASE IN MILITARY AIRCREW

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INTRODUCTION: Recent studies suggest that the severity of liver histology in non-alcoholic fatty liver disease (NAFLD) is associated with markers of early atherosclerosis. We aimed to investigate the prevalence of NAFLD and its association with carotid artery intima-media thickness (IMT), an indicator of subclinical atherosclerosis, in military aircrew who are repeatedly exposed to occupational stressors of flight. **METHODS:** Military aircrew who applied for annual periodical medical examination was included in this study. Besides routine medical screening tests, measurement of carotid artery IMT was also performed. Ultrasonographic hepatic assessments were carried out by 3.5-MHz convex array transducer and B-mode measurement of carotid IMT were performed by 7-MHz, high-frequency linear array transducer. Sonographic contrast between the liver and right renal cortex in the midaxillary line were used to diagnose steatosis. Carotid artery IMT measurements were captured in a longitudinal view and 3 measurements were recorded on both right and left sides at possible areas of common carotid artery, bulbs and internal carotid artery. **RESULTS:** 127 asymptomatic military aircrews with a mean age of 32.5±5.4 years (23-48) and a body mass index of 25.4±2.4 kg/m² were enrolled in the study. All of them were male. 38 (29.9%) were jet pilots, 31 (24.4%) were helicopter or training pilots, 24 (18.9%) were transport aircraft pilots, and 34 (26.7%) were ground aircrew. 40 (31.5%) had grade 1 and 10 (7.9%) had grade 2 NAFLD. There was no significant difference in carotid artery IMT in relation to the degree of NAFLD. **DISCUSSION:** We couldn't find any relation between NAFLD and carotid artery IMT. This may be due to the young age of the subjects which is insufficient to develop a thickened carotid artery wall.

Learning Objectives:

1. To learn the association of carotid artery intima-media thickness and non-alcoholic fatty liver disease in military aircrew and whether it can be used as a predictor for cardiovascular risk or not.

[242] POTENTIAL USE OF CAROTID ARTERY INTIMA-MEDIA THICKNESS FOR AEROMEDICAL RISK ASSESSMENT IN MILITARY AIRCREW

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INTRODUCTION: Carotid artery intima media thickness (IMT) is a marker of subclinical atherosclerosis, and its association with cardiovascular risk factors has been described. We aimed to investigate the potential use of carotid artery IMT measurement for cardiovascular risk assessment and clinical aeromedical decision-making. **METHODS:** A total of 127 military aircrews applied to our center for annual periodic medical examination were divided into jet (n=38) and non-jet aircrew (n=89). Demographic features including smoking habit, total flight time, flight time of last six months period, mean, arterial and diastolic blood pressures, body mass index (BMI), and waist circumference were recorded. After obtaining their medical history, they underwent routine medical examination and carotid artery IMT measurements. B-mode measurement of carotid IMT were performed by 7-MHz, high-frequency linear array transducer. Three measurements were recorded of both right and left sides at possible areas of common carotid artery, bulbs and internal carotid artery. Additionally, diameter of aortic annulus, ascending aortic diameter at end-diastole and end-systole, blood flow velocity in the ascending and descending aorta measurements were also made by using two-dimensional transthoracic echocardiography. **RESULTS:** Mean age of the total group was 32.54±5.46 years (23-48) and their BMI was 25.4±2.4 kg/m². Smokers among jet pilots (15.7%) were significantly less compared to non-jet aircrew smokers (65.1%). Linear regression analysis of aortic dimensions and blood flow velocities that may affect carotid IMT did not show any significance. Jet pilots had significantly lower left ICA measurements compared to other aircrew members (0.47 vs. 0.55 cm, p=0.001). There was no significant difference in other parameters. **DISCUSSION:** Carotid artery IMT measurement failed to show usefulness in predicting cardiovascular risk probably due to the younger age and healthy nature of our study group. The higher percentage of smoking habit in non-jet aircrew group might have accelerated the thickening process of carotid artery wall.

Learning Objectives:

1. To learn the association of carotid artery intima-media thickness with aortic dimensions and blood flow velocities in aorta in military aircrew.

[243] EOSINOPHILIC ESOPHAGITIS PRESENTING AS FOOD IMPACTION OR DYSPHAGIA IN THE AVIATION COMMUNITY

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INTRODUCTION: Eosinophilic esophagitis (EoE) is an emerging esophageal disease associated with dysphagia and food impaction. Practice guidelines have only recently been developed. It affects 1/2500 individuals, predominantly young adult males. As this demographic represents a substantial portion of the military aviation population, aerospace medicine clinicians should be familiar with this diagnosis when evaluating dysphagia or impactions. **CASE REPORT:** A 23-year-old Caucasian male, U.S. Air Force air traffic controller, presented to Flight Medicine following an episode of food impaction, requiring evaluation in the local emergency department. The patient reported a five-year history of recurrent episodes of food lodging in his throat, requiring fluid and body repositioning for resolution. Medical history was significant for eczema. Upper endoscopy revealed an abnormal esophagus with macroscopic features of EoE and biopsies were also consistent with EoE. After further work-up, the patient was diagnosed with EoE and treated. Complete remission of symptoms was noted after two months of therapy. **DISCUSSION:** This case outlines the evaluation of food impaction as well as the diagnostic criteria for EoE which is a disease that affects patients with demographics common to the military aviation community. As the diagnostic and treatment guidelines for EoE are relatively new, it may easily be overlooked by the primary care physician causing a delay in subspecialist consultation, thus delaying treatment. EoE is a condition with symptoms that pose high risk to the performance of aircrew duties, therefore, flight surgeons must be familiar with the aeromedical standards that accompany this diagnosis.

Learning Objectives:

1. Recognize eosinophilic esophagitis as a common cause of dysphagia in the military aviation community.

**[244] AIR FORCE AEROSPACE MEDICINE ENTERPRISE
LABORATORY MEDICAL CARE SURVEY**G. Maupin¹ and A.P. Tvaryanas²¹USAFSAM - FHC, 711th Human Performance Wing, Wright-Patterson AFB, OH; ²HP, 711th Human Performance Wing, Wright-Patterson AFB, OH

INTRODUCTION: The purpose of this study was to gather, analyze, and disseminate information about the in-garrison health care. This report describes the patient population and the broad range of health care services delivered in the permanent, continuously operating U.S. Air Force Flight and Operational Medicine Clinics (FOMC). This report includes information regarding patient characteristics, services provided, clinic utilization, and trend estimates. **METHODS:** A cross sectional analysis was performed on the retrospective cohort of 714,157 patients who received care (4,829,626 encounters) at a FOMC during 2003-2012. Patient demographic and healthcare data were obtained from the Military Health System (MHS) data Mart (M2). **RESULTS:** The 77 FOMCs served an average of 180,996 patients annually across 11 major commands. Overall these patients were majority male (71.0%), and USAF service members or their dependents (80.6%). The largest age categories were 18-25 year olds (45.0%), followed by 31- to 40-year-olds (20.7%). Acute visits were the most common type of health encounter (33.6%) across the study period. The two most common primary diagnoses were Administrative/social admissions (489,182) and ICD-9 V70.5 Aviation Exams (468,341). The most prevalent procedure across the study period was for ophthalmologic and otologic treatment (65.8). The number of annual health encounters declined noticeably among USAF dependents and retirees over the course of the study period. **DISCUSSION:** Patient population characteristics were primarily USAF, male, ages 18-25 years, working in the career area of logistics. The primary healthcare services being provided were acute care with a primary diagnosis of health exam (V70.5) associated with the most common procedures performed ophthalmologic and otologic treatment. Non-V70.5 primary diagnosis most commonly included a medical examination/evaluation procedure. Frequency of care for all individuals had a median of 2 annual visits. Trend analysis revealed nine subpopulations that exhibited an increase or decrease in annual visits of at least 25% from 2003-2012.

Learning Objectives:

1. The typical users of FOMC are USAF men between the ages of 18-25 working in logistics are seeking acute care for ophthalmologic and otologic treatment on a biannual basis.
2. Subpopulations of higher/lower users of FOMC exist.

**[245] AIRWAY OBSTRUCTION IN YOUNG ADULTS WITH
BRONCHIECTASIS**E. Demirel¹, H. Cermik², E. Balci², H. Umudum², and A. Oysul²¹Department of Pulmonary Medicine, GATA Haydarpaşa Training Hospital, Istanbul, Turkey; ²Etimesgut Military Hospital, Ankara, Turkey

INTRODUCTION: Bronchiectasis is defined as an irreversible abnormal dilatation of one or more bronchi due to chronic airway inflammation with chronic sputum production, recurrent lung infections and airway obstruction. The aim of this study is to define airway obstruction rate in bronchiectasis patients. **METHODS:** In this study we investigate localization of bronchiectasis with high-resolution computed tomography (HRCT). All cases underwent physical examination in Air Force Hospital. The asthma and emphysema rates in the study group is given by illness history, physical examination, spirometry and HRCT. **RESULTS:** We investigate 65 male bronchiectasis cases with mean age of 21.8±2.8 (19-30 years). Eighteen cases (28%) had right, 17 cases (26%) had left, 30 cases (46%) had bilateral bronchiectasis in lungs. Eleven cases (17%) had asthma, 7 cases (11%) had emphysema. HRCT examination of bronchiectasis localization showed 65% cystic, 25% tubular, 6% traction, 4% both cystic and tubular type. The localization of lesions in both lungs is as follows: %11 right upper, %19 right middle, 21% right lower, 7% left upper,

11% left lingula, 30% left lower lobes. **DISCUSSION:** This study which evaluates lesions in young patients with bronchiectasis showed 50% lower lobe localization. Asthma and/or emphysema rate in bronchiectasis was found nearly 30%.

Learning Objectives:

1. Bronchiectasis can be complicated by respiratory conditions like chronic bronchitis, asthma, and emphysema.

**[246] BIOMARKERS AND SENSITIVE EVALUATION OF RETINAL
LASER LESIONS**K. Schuster¹, R. Vincelette¹, A. Shingledecker¹, J. Bixler², B. Rockwell², and W. Kinerk²¹TASC, Inc, JBSA Fort Sam Houston, TX; ²711 HPW/RHDO, Air Force Research Laboratory, JBSA-Fort Sam Houston, TX

INTRODUCTION: Advanced imaging techniques and proteomic technology continue to push the boundaries for diagnosing and understanding retinal laser exposures. **METHODS:** We conducted retinal imaging in the rhesus macaque to compare the appearance of suprathermal laser lesions in the macula (five-by-five grid) from both photothermal (532 nm, 100 ms) and photomechanical (532 nm, 9 ns) insult using five different imaging systems: three clinically approved systems; Heidelberg Spectralis SD-OCT-SLO, Heidelberg HRT3 cSLO and Topcon Fundus camera and two experimental systems; multispectral, using a fundus camera, and hyperspectral detection, using a PSI Inc. LSLO. In addition to imaging, blood plasma samples were acquired prior to laser exposure, at 6 hrs, and 24 hrs, to search for biomarkers occurring from the different laser damage mechanisms. **RESULTS:** These exposures produced lesions within minutes after exposure. Photomechanical lesions damage the retinal tissue by creating a shockwave that rips through the surrounding cell structure. Photothermal lesions occur when energy is absorbed faster than thermal relaxation. This leads to the exposed tissue heating up to cause denaturation or coagulation. Due to these damage properties, photomechanical lesions were smaller and generally harder to image compared to the photothermal lesions. **DISCUSSION:** The two imaging modalities that provided the best diagnosis of retinal damage from laser exposures were the color fundus camera and the Spectralis SD-OCT with autofluorescence. The two experimental imaging systems provided some observational evidence that lesion identification may be aided by spectral-reflectance information, but these systems were not fully optimized. Imaging data from this study suggest that if a person is suspected of having a laser exposure, it would likely be very difficult to gather medical surveillance information without two key pieces of data: 1) previous retinal images for baseline and 2) images of a lesion in the observational window from hours to days after the exposure.

Learning Objectives:

1. Determine the optimal imaging systems to diagnose laser eye injury.

**[247] CURRENT CIRCUMSTANCE OF THE UPPER AGE LIMIT OF
PROFESSIONAL PILOTS IN JAPAN**H. Hayashi¹, H. Gomi², K. Takazoe², and Y. Miyagawa¹¹Aviation Safety and Security Department, Civil Aviation Bureau, Japan, Tokyo, Japan; ²Japan Aeromedical Research Center, Tokyo, Japan

INTRODUCTION: Japan has extended age limit of professional pilots for class 1 to under 65 years old in 2004. For those aging pilots, the additional aviation medical examination (additional examination) system has been introduced to be performed at the age of 60 and of 63 besides regular aviation medical examination. Additional examination include medical interview with blood pressure measurement, rest electrocardiogram (ECG), respiratory function test, blood lipid test, Holter ECG, echocardiogram, treadmill exercise ECG and brain MRI. The results of additional examination revealed that some aging pilots have asymptomatic cerebral infarction and circulatory system disease such as arrhythmia. However, there were only few cases that would

link with incapacitation. Furthermore, pilots without abnormality in blood lipid test, rest ECG and blood pressure had no such findings as above. Therefore, from December in 2013, the screening test system has been established consisting of medical interview, blood lipid test, rest ECG and blood pressure. Pilots who meet the standard of each item can be exempted from additional examination. **METHODS:** We reviewed the results of the additional aero medical examinations from 2010 to 2014 and the screening tests in 2014. **RESULTS:** There are 6791 professional pilots in total and 465 pilots aged 60 or over in Japan. From 2010 to 2013, 775 pilots underwent the additional aero medical examinations and 757 were passed it. The additional aero medical examinations have found several cases of asymptomatic cerebral infarction and non-life-threatening arrhythmia. There has been no in-flight incapacitation in Japanese commercial airlines since the cases of cerebellar hemorrhage in 2000 and acute pancreatitis in 2004. **DISCUSSION:** The significance of the additional examination and the screening test system is discussed. Considering the aspects of both medical qualification and maintenance of competence as a pilot, extending age limit to 65 or over is discussed.

Learning Objectives:

1. The retirement age limit of pilots in Japan and the additional aviation medical examination system for pilots at the age of 60 and 63 are described.
2. Our study in consideration to extending the retirement age for pilots is described.

[248] PROTEOMIC AND METABOLOMIC STUDIES IN A RAT HYPOBARIC EXPOSURE MODEL

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INTRODUCTION: U-2 pilots and altitude chamber technicians show increased incidence of leukoariosis or white matter hyperintensities (WMH) in T2 weighted magnetic resonance imaging (MRI), indicative of hypodensities linked to neuronal loss, demyelination and gliotic scarring. It has been hypothesized that exposure to extreme hypobaria, excess oxygen, or a combination of both stressors, irrespective of decompression sickness, is the primary causative factor for these WMH. However, the exact etiology and underlying mechanisms are unknown. **METHODS:** Rats will be exposed to pressures corresponding to 30,000ft above sea level and 100% oxygen for 3 hr/day for 3 days. At the end of the final exposure brains will be collected. Proteomic characterization of proteins and pathways will be developed using high resolution LTQ-Orbitrap Velos mass spectrometer and SEAQUEST algorithms for protein identification and quantitation. High resolution ¹H and proton-decoupled ³¹P and ¹³C nuclear magnetic resonance spectroscopy will be used to characterize lipid and small molecule profiles. **RESULTS:** Preliminary data from thalamus from rats exposed to 20,000 ft identified modulation of proteins involved with DNA damage repair, calcium signaling, lipid metabolism and microtubule organization. Exposure to 20,000 ft also down-regulated calcium dependent blood vessel homeostasis. **DISCUSSION:** WMH may be caused by hypobaric exposure or oxygen toxicity. Proteomic and metabolomic analyses can provide knowledge of the mechanistic basis of the adverse effects of hypobaria and hyperoxia that can set the foundation for understanding the pathophysiological changes associated with these exposures. The potential payoff of the knowledge gained from these studies is a better approach to mitigating or preventing operational risks and long term adverse health outcomes associated with high altitude flight.

Learning Objectives:

1. Describe the relationship between hypobaric and hyperoxic exposure and metabolic and protein profiles in brain.

[249] DIFFERENCES IN POSTMORTAL ALCOHOL FORMATION IN TWO VICTIMS FROM THE SAME AIRCRAFT ACCIDENT.

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INTRODUCTION: Both pilots of a sporting aircraft died immediately after their plane crashed following an in-flight collision. Emergency services arrived on the crash site within minutes. After a few hours of crash site investigation the bodies were stored at 4 degrees centigrade. Autopsy was carried out 42 hours after the crash. At this time, the bodies showed limited signs of decomposition, e.g. circumscribed discoloration of the abdominal skin. **METHODS:** Blood samples were taken from the first victim's femoral veins for blood alcohol analysis. Muscle tissue from the second victim was used for this investigation. **RESULTS:** In the first victim a blood alcohol concentration of 0.30 ‰ was found along with 13 mg/l of acetaldehyde. Butanol-1 or propanol-1 was not detected. In the second victim 1.02 ‰ and 1.04 ‰ of alcohol were found in the muscle tissue using gas chromatography. Furthermore, 2 mg/kg acetaldehyde, 6 mg/kg ethyl methyl ketone and 743 mg/kg butanol-1 were detected. **DISCUSSION:** In the first but not in the second victim a forensically relevant blood alcohol concentration of 0.30 ‰ was demonstrated for the time of the accident. The finding of a significant level of butanol-1 in the muscle tissue of the second victim indicated decomposition as the origin of alcohol in his body. The present case shows that decomposition can lead to different levels of alcohol formation in bodies with identical time of death and identical storage conditions.

Learning Objectives:

1. Knowing the principles of forensic alcohol analysis in aircraft accident investigation including confounding factors such as decomposition of the body.

Tuesday, May 12

4:00 P.M.

S. Hemisphere 1

[XLII.] SLIDE: PHARMACOLOGICAL & PSYCHOLOGICAL CONSIDERATIONS IN SPACEFLIGHT

Co-Chair: Mark Campbell
 Paris, TX

Co-Chair: Derek Nusbaum
 Houston, TX

4:00 p.m.

[250] MECHANISMS AND MITIGATING FACTORS FOR THE IMPLICATIONS OF THE EARLY DEGRADATION OF MEDICATIONS IN LONG-DURATION SPACEFLIGHT

R. Zucker¹ and K.R. Lehnhardt²
¹Biology, George Washington University, Stamford, CT; ²Department of Emergency Medicine, School of Medicine and Health Sciences, George Washington University, Washington, DC

INTRODUCTION: Currently, it is known that some medications have a tendency to degrade faster than others in long duration spaceflight. As long duration spaceflight missions are being planned, particularly human missions to Mars, any discussion must include how to provide appropriate medical care and how to prevent medications from expiring before they are needed. While International Space Station missions in low Earth orbit can be resupplied relatively easily and regularly, long distance missions cannot and may need to carry extra stores of medications or be able to synthesize their own. There is a paucity of research in the space medicine community in this area, as there are few opportunities for rigorous scientific testing in flight. Current efforts to address this concern by attempting to simulate

space-like conditions on Earth are limited. While the exact mechanism for reduced drug stability in space is still not known, most theories focus on an increase in exposure to space radiation or inappropriate storage for the spaceflight environment. Working with these theories as the starting point, one can begin to design systems that may be used to mitigate the problem. These systems range from new methods of storing drugs to increased radiation shielding to bioreactors that are designed for in-flight drug production using genetically modified bacteria. This paper discusses the variety of proposed methods that could be used to help ensure drug efficacy and availability in long duration spaceflight.

Learning Objectives:

1. Identify which techniques may be used during mission planning for prolonging medication shelf-life during spaceflight.
2. Examine possible mechanisms for the premature expiration of medications in spaceflight.

4:15 p.m.

[251] POST-VOID RESIDUAL URINE VOLUME DURING SPACEFLIGHT

R. Cole^{2,3}, K. Garcia¹, A.E. Sargsyan¹, and D. Ebert¹

¹Wyle Science, Technology and Engineering Group, Houston, TX;

²University of Texas Medical Branch, Galveston, TX; ³University of Texas at Houston Medical School, Houston, TX

INTRODUCTION: Urinary retention has occurred during spaceflight on several occasions. An increased post-void residual (PVR) has been clinically associated with an increased rate of urinary tract infections in the terrestrial setting. The supine position decreases the voiding dynamics in men and may predispose bed rest participants to urinary tract infections (Riehmman, M, Bayer, WH, et al. Position-Related Changes in Voiding Dynamics in Men. *Adult Urology*, 52 (4), 1998). The effect of spaceflight on PVR is unclear; we compared the preflight, in-flight, and postflight PVR of one asymptomatic individual. **METHODS:** Pre-void and post-void ultrasound images of the urinary bladder were acquired on L-78, FD 39, FD 33, and R+3 using a Vivid q portable ultrasound unit (General Electric, Milwaukee, WI), a curved array (C3-RS) probe, and the factory abdominal preset. An additional image set was obtained immediately after a second void on L+39. Two orthogonal cine-loops were acquired: a sagittal or long axis of the bladder, and an axial or transverse bladder. Analysis was performed on selected frames in the cine-loops using off-line DICOM software (Fujifilm America). **RESULTS:** Estimated pre-void bladder volume measurements were 146 mL (L-78), 581 mL (FD 39), 248 mL (FD 133), and 380 mL (R+3). Estimated Post-void residual measurements were 15 mL (L-78), 472 mL (L+39), 45 mL (L+133), and 14 mL (R+3). The bladder volume estimate was 230 mL after the second void on L+39. **DISCUSSION:** Our study showed an increased PVR during spaceflight relative to before and after flight. Although there is no standard definition of normal PVR, a PVR of less than 100 mL is generally considered normal in adults. A prolonged distended bladder may have contributed to the large PVR seen on L+39. Although this study is limited to a single individual, our data suggest the need for further in-flight investigation.

Learning Objectives:

1. The implications of spaceflight on post-void residuals in the urinary bladder will be discussed.

4:30 p.m.

[252] EFFECT OF THE HYBRID TRAINING METHOD ON THE DISUSE ATROPHY OF THE MUSCULOSKELETAL SYSTEM OF THE ASTRONAUTS

N. Shiba¹, H. Matsuse¹, Y. Takano², M. Omoto¹, A. Narita¹, S. Yamada³, H. Ohshima³, and Y. Tagawa⁴

¹Department of Orthopedics, Kurume University, Kurume, Japan;

²Department of Physical Therapy School of Health Sciences at Fukuoka, International University Health and Welfare, Okawa, Japan; ³Human Space Technology and Astronauts Department,

Japan Aerospace Exploration Agency, Tsukuba, Japan; ⁴Department of Mechanical and Control Engineering, Kyushu Institute of Technology, Tobata-ku, Japan

INTRODUCTION: It is well known that atrophy of the musculoskeletal system due to disuse occurs among astronauts. We developed a "hybrid training system" (HTS) that is designed to maintain the musculoskeletal system of astronauts by using an electrically stimulated antagonist to resist the volitional contraction of agonist muscles in weightlessness. In other words, electrical stimulation generates a resistive force instead of gravity. This approach consists of a compact device, produces a minimum of inertial reaction forces and has the advantage of minimizing the need for external stabilization that is currently necessary during exercise in weightless conditions. HTS has several features. These include; 1) a simple device, 2) requiring minimal external stabilization of the subjects, 3) simultaneous contractions of both agonist and antagonist musculature, 4) volitional contraction of deep layers of muscle, 5) longitudinal bone force loads. In the experiment of ISS Increments 38/39, we have completed tests of the HTS device in JEM for one of an astronaut's upper limbs (the non-dominant arm) for four weeks. HTS training consisted of elbow curls: flexion 2 sec and extension 2 sec, 1set: 10 elbow curls, 10 sets of 10 elbow curls with 1 minute rest interval between sets (15 minutes 40 seconds/ training). We evaluated the subject's muscular strength and bulk on ISS, and his/her muscular strength, bulk, and bone mineral density on the ground to compare them to those of the non-HTS arm (the dominant arm). All the training and evaluations on ISS were performed as scheduled and we established its usability. We are going to show results from this experiment. We think that HTS will become a useful back-up for the standard training device in the ISS, or a useful training device in small space ships for the exploration of the Moon and Mars.

Learning Objectives:

1. To evaluate the exercise method on the disuse atrophy of the musculoskeletal system of the astronauts staying in the international space station for a long term.

4:45 p.m.

[253] CEREBRAL HEMODYNAMICS IN HYPERGRAVITY AND MICROGRAVITY: IMPLICATIONS FOR SPACEFLIGHT AND NAVAL AVIATION

V. Ivkovic¹, G. Spielmann³, D.M. DiPasquale¹, G. Hu¹, Q. Zhang¹, and G. Strangman^{1,2}

¹Psychiatry, Harvard Medical School, Charlestown, MA; ²Center for Space Medicine, Baylor College of Medicine, Houston, TX; ³Health and Human Performance, University of Houston, Houston, TX

INTRODUCTION: The effects of changing gravity loads experienced by astronauts and naval aviators on cerebral hemodynamics are insufficiently understood. In addition, effects of carrier takeoffs and landings on the brain have not been investigated. The mechanical shock associated with such maneuvers can reach 9g, and occur in excess of 500 times during a flight career, raising concerns about (repetitive) brain injury. Currently no non-invasive method exists for detecting and characterizing brain oxygenation and movement inside the skull during mechanical shock. Our group has developed a wearable brain monitoring technology called NINscan based on near-infrared spectroscopy (NIRS) that allows non-invasive detection of brain oxygenation and motion inside the skull. In a parabolic flight study we investigated these parameters associated with gravitational transitions from 0-2g. **METHODS:** During 4 NASA parabolic flights, and in baseline tests on the ground, 9 subjects (5 females) aged 31.0±4.1 years completed three tasks: quiet rest, Valsalva and Mueller maneuvers. Brain and scalp oxygenation and perfusion were recorded by an optical sensor over prefrontal cortex. A tri-axial accelerometer measured head orientation and changes in acceleration vectors. The subjects were loosely strapped to their seats during data collection. **RESULTS:** Consistent cerebral perfusion changes were observed in all 9 subjects during gravitational

modulations. Larger hemodynamic changes were recorded in cerebral than in scalp tissue. In scalp, oxy- and deoxy-Hb signals fluctuated in-phase, whereas they were out of phase in cerebral tissue. Valsalva and Mueller maneuvers during freefall generated similar hemodynamic responses as on the ground. **DISCUSSION:** We observed apparent cephalic fluid shifts associated with altering gravitational conditions. Hemoglobin fluctuations differed in scalp vs. cerebral tissues, suggesting autoregulatory mechanisms may be affecting cerebral hemodynamic responses to changing gravity conditions. Similar responses to Valsalva and Mueller maneuvers in flight and on the ground suggest that forced fluid flow can overwhelm passive fluid shifts associated with gravitational transitions and hence may influence the visual impairment and intracranial pressure syndrome.

Learning Objectives:

1. Outline the sources of potential neurologic injuries for astronauts and naval aviators exposed to extreme changes in gravitational loadings.

5:00 p.m.

[254] STUDY OF SIMULATED MICROGRAVITY ON IMMUNOLOGICAL PARAMETERS

P. Kinra¹, A. Narayanamoorthi², P. Tyagi³, and V. Dutta⁴
¹Classified Pathologist & GI Pathologist, Command Hospital Air Force, Bangalore, Bangalore, India; ²MMS Holdings Inc, International Medical Scientist, Canton, MI; ³Director Healthcare SAMECS, Bangalore, India; ⁴Pathology, Army Hospital R&R, New Delhi, India

INTRODUCTION: The possible mechanisms by which spaceflight induces immunosuppression include (i) direct and indirect effects on cells responsible for immune responses; (ii) stress induced by spaceflight; (iii) changes in circadian rhythm/ nutritional intake and (iv) radiation encountered during spaceflight. Studies have shown impairment of cell mediated, humoral and innate immunity variables in blood samples of astronauts who have flown a space mission. The present study examined the objective immunological parameters on healthy adults before and after simulated microgravity. **METHODS:** 20 healthy adult male volunteer subjects were subjected to simulated microgravity for 6 hours using dry floatation tank. The immunological parameters were analyzed using the blood sample taken pre and post exposure to simulated microgravity. The parameters included: total leukocyte count, differential leukocyte count, CD4 count, CD8 count, CD4/CD8 ratio, serum IL-2 (adaptive immune cytokine) and TNF- α (innate immunity cytokine) levels. **RESULTS:** There was no statistically significant change in the CD4 count, CD8 count or CD4/CD8 ratio ($p=0.449, 0.122, 0.151$). However there was significant reduction in values of serum TNF- α ($p=0.004$) and IL-2 ($p=0.0258$). One-tailed paired t-test was used in the parameters that passed the normality test. **DISCUSSION:** Though the change of CD4/CD8 ratio was not significant in our study however there was a downward trend. This can be explained by the probable low microgravity time exposure as compared to literature studies where the simulation has been as long as 120 days in continuation. A likely explanation for altered counts is the enhanced release of corticosteroids that can induce alterations in the lymphocyte subpopulations of CD4⁺ and CD8⁺ cells. The decrease in TNF in our study can be explained by increase in adrenocorticotrophic hormone and catecholamines subsequent to microgravity that upregulates TH2 cytokine production via stimulation of the glucocorticoid and β_2 -adrenergic receptors. Low IL-2 production capacity could compromise immune defenses not only against infectious agents but also against neoplastic cells during extended space missions thereby leading to infections and possible neoplasms.

Learning Objectives:

1. Understanding the immunopathogenesis of spaceflight alterations in immunity.
2. Developing countermeasures to avoid clinical consequences of immunosuppression.
3. How to systematically investigate a pilot having signs of immunosuppression.

5:15 p.m.

[255] DIETARY SUPPLEMENTS: SAFE OR STUPID?

C. Bird¹ and M. Coppini²
¹325 MDG, Tyndall AFB, FL; ²366 MDG, Mountain Home, ID

INTRODUCTION: Supplements are generally easy to obtain and are commonly used in today's society. Supplements can be helpful to the body, but others carry inherent risks, especially when used in extreme conditions such as a deployed desert environment. This can present a problem when individuals are making rather uninformed decisions on which supplements they use and can become harmful when they begin to "stack" supplements. The presenters were recently deployed to a hot, desert climate and witnessed a service member who developed hepatitis from stacking various supplements. He eventually needed to be air evacuated out of the theater of operation. We intend to present this as a case study to demonstrate the perils of uninformed and unregulated supplement use. After this case, Team Aerospace at the deployed location put together a series of interventions in order to train the deployed service members on smart decision making with supplements. We will highlight the techniques and tools that we used in order to avert further injuries and loss of personnel.

Learning Objectives:

1. To provide education on the hazards of taking dietary supplements in extreme environments.
2. To inform military personnel how to make smart choices when they do choose to take dietary supplements.
3. To present a case study that shows the effects of stacking supplements in a deployed location.

Tuesday, May 12

4:00 P.M.

S. Hemisphere 2

[XLIII.] PANEL: FROM REGULATION TO PRACTICE: MAKING A DIFFERENCE IN AEROSPACE MEDICINE IN THE UNITED KINGDOM

Chair: David McLoughlin

RAF Henlow, Bedfordshire, United Kingdom

PANEL OVERVIEW: There have been significant changes and improvements in the regulation and practice of aviation medicine in the United Kingdom. The panel will outline the new regulatory environment before presenting on contemporary areas of aviation medicine practice that will be of interest to the worldwide aerospace medicine community. One significant development has been the introduction of a Military Aviation Authority that regulates all aspects of flying in the United Kingdom. The implications for aviation medicine will be analyzed. A practical example of making a difference was the aeromedical evacuation of a British aid worker with Ebola Virus Disease from Sierra Leone to London using an Air Transportable Isolator in August 2014. The patient arrived at the High Level Infectious Unit at the Royal Free hospital London in under 36 hours from the point of activation. Subsequently they made a full recovery. The use of modern technology has resulted in advances in the clinical care of aircrew. However, there can be challenges in interpreting investigations in an aircrew population. The use of advanced cardiac imaging, including cardiac CT and cardiovascular MRI in military aircrew will be discussed. Asthma prevalence is increasing and asthmatics experience a high frequency of attacks and working time lost. Therefore careful consideration is required in the selection of asthmatics for military service in order to maintain combat effectiveness. The results and implications of a large cross sectional survey of all Royal Air Force asthmatics will be presented. In the UK reservists are entitled to occupational but not primary care, whilst civilian contractors receive no medical care. In order to assure the fitness to fly of aircrew not receiving military primary care a Medical Attendant Report was introduced in 2010. This is completed by the individual's usual medical provider and has been subject to annual audit for discrepancies between self-declared illness and that documented by the medical provider. Successive annual audits have documented a reduction in discrepancies that could have impacted on fitness to fly.

[256] INTRODUCTION OF A MILITARY AVIATION REGULATOR: IMPLICATIONS FOR AVIATION MEDICINE IN THE UNITED KINGDOM

D. McLoughlin

RAF Centre of Aviation Medicine, RAF Henlow, United Kingdom

INTRODUCTION: The Military Aviation Authority (MAA) was established in 2010 in response to the recommendations made by Mr. Justice Haddon-Cave in his Nimrod review. This review into the broader issues surrounding the loss of a Royal Air Force Nimrod aircraft in Afghanistan called for a radical overhaul of military airworthiness regulation. **RESULTS:** The MAA is an independent and autonomous organization responsible for the regulation, surveillance, inspection and assurance of the air operating and technical domains. As the single authority responsible for regulating all aspects of Air Safety across UK Defence, the MAA has full oversight of all Defence aviation activity, including aviation medicine. **DISCUSSION:** This presentation will outline the changes associated with the formation of the MAA. These include the introduction of the duty holder concept, the open reporting of dangerous occurrences and a focus on reducing risk to aircrew life. These changes have raised the profile of aviation medicine, delivered significant increases in funding for aviation medicine related training equipment, and improved flight safety. However, the introduction of the MAA has also led to an increase in requests for specialist advice. Meeting these demands, while aligning with the future needs of Defence, will enable aerospace medicine to continue to make a difference in the United Kingdom.

Learning Objectives:

1. To analyze the impact of the formation of a military aviation regulator in the United Kingdom.

[257] UK AIR TRANSPORTABLE ISOLATOR (ATI) MISSION TO REPATRIATE BRITISH AID WORKER WITH EBOLA VIRUS DISEASE (EVD)

B. Mollan

Infection Prevention and Control, Royal Air Force Brize Norton, Oxfordshire, United Kingdom

INTRODUCTION: EVD is a contagious and life threatening disease. Potential intercontinental transfer of EVD remains a worldwide concern. Assistance provided in West Africa to contain the current outbreak places international personnel at risk. On 23 Aug 14 the UK government was notified of a British aid worker with PCR-positive (confirmed) EVD in Kenema, Sierra Leone; the RAF conducted the secure movement of the infected patient with an ATI Team to the Royal Free Hospital in London. **METHODS:** Following the activation of the Aeromedical Evacuation (AE) service, a specially commissioned C-17 aircraft with the UK ATI was tasked to undertake the mission. A direct oceanic flight plan was mandated due to International Health Regulations and the available diplomatic clearances. The patient was transferred into the ATI at Lungi International Airport, Freetown and the AE Team undertook a decontamination procedure. The patient was subsequently transferred to London. Post mission health surveillance of all personnel was conducted. Consequent detailed analysis of the mission was undertaken to refine and improve future procedures. **RESULTS:** Under 36 hours from the point of activation, the patient arrived at the High Level Infectious Unit at the Royal Free Hospital, London. Subsequently making a full recovery, the patient was discharged from hospital 10 days following admission. Post mission 21 day health surveillance of aircrew and AE Team, the mission was declared a success as the virus had been contained. **DISCUSSION:** The UK ATI was initially commissioned by the Department of Health and the RAF in the 1970s and has undergone several revisions. Currently, several other aeromedical isolation capabilities exist. Following post-mission review, the ATI and procedures remain fit for purpose. The swift response and ability to provide quality care in the air is aided by the regular exercising of the capability. Whilst the transfer of EVD patients remains controversial, the availability of specialist AE isolation units allows a mechanism for the safe repatriation of exposed or infected personnel.

Learning Objectives:

1. To understand the aeromedical factors in the global air transportation of patients with EVD.

[258] ASTHMA IN THE ROYAL AIR FORCE (RAF) AIRCREW: CROSS-SECTIONAL SURVEY OF SEVERITY AND CONTROL

I.A. Mollan¹, J. Szram^{2,3}, S. Schofield^{3,2}, G. Davies^{1,4}, D.L. Bruce⁵, and P. Cullinan^{3,2}

¹RAF Centre of Aviation Medicine, Royal Air Force, RAF Henlow, United Kingdom; ²Department of Occupational and Environmental Medicine, Royal Brompton and Harefield NHS Foundation Trust, London, United Kingdom; ³Occupational and Environmental Respiratory Disease, National Heart and Lung Institute, Imperial College London, London, United Kingdom; ⁴Respiratory Medicine, Chelsea and Westminster Hospital, London, United Kingdom; ⁵Royal Air Force Brize Norton, Regional Occupational Medical Department, Carterton, United Kingdom

INTRODUCTION: Asthma prevalence is increasing and asthmatics experience a high frequency of attacks and working time lost. In order to maintain combat effectiveness, careful consideration is required in the selection of asthmatics for military Service, particularly aircrew. There is little literature examining the effect of asthma on military aircrew Service. **METHODS:** A cross-sectional survey of all RAF asthmatics and a matched case-control analysis of non-asthmatics was undertaken by questionnaire designed for self-completion. Characteristics of asthmatics were stratified according to current Step of treatment being taken as classified by the British Thoracic Society. Job classification, ability to perform military tasks, employability and deployability factors were examined. The aircrew component of this cross-sectional survey was examined. **RESULTS:** The RAF population comprised 807 asthmatics, of whom 24 (3%) were aircrew. On the 1005 responders, a total of 92 (9%) were aircrew, 17 (1.7%) of whom were asthmatic. Across stratified treatment groups, there was no statistically significant difference in those with aircrew status ($p=0.927$). In the RAF asthmatic population as a whole there was statistically significant trend of increasing median Asthma Control Questionnaire (ACQ) score with increasing Step of treatment taken ($p<0.001$); however, when stratified according to aircrew status, 15 (93.8%) of aircrew were well controlled as defined by having an ACQ score < 1.0 . **DISCUSSION:** This large study was comprehensive in its inclusion of RAF personnel with asthma, as all asthmatics were given an opportunity to participate. It was the largest investigation of asthma undertaken in the UK military ever, and the largest investigation within an Air Force population globally to date. RAF asthmatic personnel had relatively mild disease, controlled on a minimum amount of pharmacotherapy. While aircrew reported taking current treatments which included Step 3-5 medications, the overwhelming majority (93.8%) were well controlled with an ACQ < 1.0 . A full analysis of the whole RAF population was undertaken and is described elsewhere; however due to the relatively small number of aircrew a separate fully stratification was not undertaken.

Learning Objectives:

1. To recognize that asthma prevalence is increasing.
2. To recognize that careful selection of asthmatic aircrew recruits is required to maintain the combat effectiveness of the Air Force.

[259] THE USE OF ADVANCED CARDIOVASCULAR IMAGING IN THE ASSESSMENT OF MILITARY AIRCREW IN THE UNITED KINGDOM

R. Chamley, J. d'Arcy, and E. Nicol

Clinical Aviation Medicine Service (CAMS), RAF Centre of Aviation Medicine, Henlow, United Kingdom

INTRODUCTION: Over the last three years, the Royal Air Force Clinical Aviation Medicine Service (CAMS) has provided occupational and clinical cardiovascular assessment of aircrew from across UK Defence. The use of advanced imaging techniques in these assessments plays a significant role, which will be outlined in this presentation. **METHODS:** The use of advanced cardiovascular imaging techniques, in particular cardiac computed tomography (CCT) and cardiovascular magnetic resonance imaging (CMR), in

UK military aircrew seen by the CAMS, from 2011 to the present, was examined. The indications for the use of such techniques, and the outcomes of these investigations were ascertained. **RESULTS:** Between 2011 and the present, the use of advanced cardiovascular imaging techniques for the assessment of aircrew in the UK Armed Forces has increased. The use of these imaging modalities has allowed the identification of significant pathology across the spectrum of cardiology in a population which is generally considered to be fit and healthy; it also has a role in excluding significant cardiac disease in selected cases. The results of these tests impacts on the aeromedical disposition of patients, and may also cause significant diagnostic difficulties. **DISCUSSION:** Evolving techniques in cardiovascular imaging have an important role to play in the risk assessment of the aviation population, and appropriate use should be made of these technologies. Management and disposal dilemmas may arise when the significance of imaging findings in a relatively unstudied population is unclear.

Learning Objectives:

1. To understand the indications for advanced cardiovascular imaging in military aircrew in the United Kingdom.
2. To understand the breadth of cardiovascular pathology detected by advanced cardiovascular imaging in military aircrew in the United Kingdom.
3. To understand the use of advanced cardiovascular imaging in risk assessment of military aircrew in the United Kingdom.

[260] ENSURING AIRCREW TELL THE AME THE TRUTH

D.G. Harper

Centre of Aviation Medicine, RAF, Henlow, United Kingdom

INTRODUCTION: Only regular servicemen obtain both primary care and occupational medicine from UK military sources. Part-time reservists are entitled to occupational but not primary care, whilst civilian contractors receive no military primary care or occupational medicine. To assure the self-declaration of illness by those not entitled to military primary care, in 2010 a Medical Attendant's Report (MAR) was introduced. This is completed by the applicant's usual medical provider and has been subject to annual audit. **METHODS:** RAF medical centers were asked to complete an annual template return. This reported the total number of MAR received, whether there were any discrepancies between self-declared illness and that documented by the medical providers and whether that discrepancy affected the fitness to fly. **RESULTS:** In the first year of introduction there was a 6.97% discrepancy rate between self-declared illness and that documented on the MAR; 3.59% were significant enough to affect fitness to fly. Every subsequent year has demonstrated a continuing fall in the total number of discrepancies and their significance: in 2014 there was a 0.59% discrepancy rate between aircrew and their medical provider, none of which affected fitness to fly. **DISCUSSION:** The MAR has resulted in a significant reduction in the amount of unreported medical conditions.

Learning Objectives:

1. The value of an objective medical report from an aircrew's usual medical provider is demonstrated.

Tuesday, May 12

S. Hemisphere 3

4:00 P.M.

[XLIV.] PANEL: ADVANCED FLIGHT AND SITUATIONAL AWARENESS DISPLAYS

Sponsored by the International Association of Military Flight Surgeon Pilots

Co-Chair: William Mueller

Cibolo, TX

Co-Chair: William Agerton

NAWS China Lake, CA

PANEL OVERVIEW: Recent developments in military aviation have resulted in a myriad of displays to maintain aircrew's situational awareness. The traditional 'instrument T-check' is no longer the foundation for monitoring an aircraft's position in space. Advances in piloted aircraft technology and the utilization of remotely piloted aircraft has resulted in a wide assortment of Primary Flight and Situational Awareness Displays that have inherent strengths and weaknesses which must be understood by the aerospace medicine community. The International Association of Military Flight Surgeon Pilots (IAMFSP) is a charter organization within ASMA whose members are able to provide unique, cross-domain perspective on operational and aeromedical issues. This IAMFSP-sponsored panel will draw from the experiences of our members to highlight challenges and opportunities related to advanced situational awareness displays in current civilian and military piloted and remotely piloted aircraft.

[261] ADVANCEMENTS IN SYNTHETIC VISION

C. Borchardt

USAF, Langley AFB, VA

INTRODUCTION: Maintaining aircraft attitude awareness in adverse weather conditions is vital to safe aircraft operation and enables sustained airfield operations during periods of low visibility. Advances in cockpit displays, traditional head up displays, and helmet mounted displays will be discussed. Various methods of displaying flight paths and terrain using infrared cameras and synthetic representations utilizing mapping databases will be highlighted. Current concepts in situational awareness will be addressed throughout the presentation. **DISCUSSION:** Advancing technological possibilities, mishap trends and FAA NextGen initiatives point toward enhancements in flight crew awareness that will improve aircraft safety and operations efficiency. This presentation will focus primarily on the advancements in Synthetic Vision and how that broad concept is being implemented in a variety of ways. Where appropriate there will be discussions of runway and taxiway awareness as well as the generalized trends toward aircraft rather than centrally controlled navigation and traffic coordination as the FAA moves toward implementation of NextGen goals.

Learning Objectives:

1. Knowledge and understanding of advancements in Synthetic Vision as it applies to flight crew aircraft attitude and situational awareness in the air and on the ground.

[262] INTEGRATING 5TH GENERATION TECHNOLOGY INTO A 20TH CENTURY AIRFRAME

D. Prakash

U.S. Air Force, Bossier City, LA

INTRODUCTION: As legacy aircraft undergo upgrades and modifications to fly in the modern battlespace, there is always the potential for negative transfer. Usually training and experience rid pilots of old habits. But new upgrades do not always eliminate legacy systems. Both systems may need to be employed simultaneously. The B-52H is undergoing the most transformational upgrade in its storied 60 year history with a program called Combat Network Communications Technology (CONNECT). Human factors and negative transfer will be discussed as it relates to the design of CONNECT and simultaneous employment of these systems. **DISCUSSION:** The CONNECT display integrates navigation, targeting and threat information as well as locations of air and ground forces. The CONNECT multi-function color display does not replace the legacy monochrome display. Current operational testing reveals the need for one pilot to display the legacy display while the other pilot displays the CONNECT screen in order to successfully prosecute the target. During weapons employment, the pilot must monitor both screens cross-cockpit. Subtle discrepancies in scale and symbology between the two displays have the potential to create negative transfer, and the pilot must consider these discrepancies while maneuvering the aircraft. This presentation will use the B-52H CONNECT display as an example of how the aerospace medicine community can contribute to understanding the human-centric strengths and limitations as 3rd generation aircraft are upgraded to fly in a 5th-generation battlespace.

Learning Objectives:

1. Understand how subtle design differences in pilot cueing systems create negative transfer and how these negative transfers are reinforced when new upgrades augment rather than replace legacy systems.

[263] GLOBAL DECISION SUPPORT SYSTEM (GDSS) AS A DISPLAY ENHANCING SITUATIONAL AWARENESS AS EXEMPLIFIED BY USE IN AEROMEDICAL EVACUATION VIA OPPORTUNE AIRLIFT

C.E. Backus
USAF, Anchorage, AK

INTRODUCTION: Aeromedical Evacuation is one factor contributing to the lowest "died-of-wounds" rates in recent conflicts despite the last dedicated USAF aeromedical evacuation platform retiring in 2003. Opportune airlift has filled this need and Global Decision Support System provides situational awareness to allow visibility of these assets. **DISCUSSION:** Multiple airframes can be utilized for opportune airlift. Time required from "realization of need" to "aircraft presence on station" can be decreased to less than that required for dedicated aeromedical evacuation platforms since no positioning leg is required. The large volume of airlift typically needed to support routine logistics in an ongoing conflict is leveraged to support aeromedical evacuation needs by re-tasking existing already-scheduled missions. However, re-tasking presents challenges to situational awareness. The precise locations of assets, fuel states, cargo capacity, crew duty day remaining, priority of existing mission, and operating characteristics such as cruise speed and ceiling among other factors impact the decision and influence which missions can be re-tasked. A decision support tool, such as GDSS, can aid situational awareness for opportune aeromedical evacuation while keeping other airframes and aircrews dedicated to their originally tasked missions.

Learning Objectives:

1. Instill awareness of GDSS as a display enhancing situational awareness.
2. Anticipating multiple presentations on cockpit displays, contrast ground positioned displays that contribute to situational awareness, increasing understanding of situational awareness and other components of crew resource management as including more than just airborne assets.

[264] F-35 DAS HEAD MOUNTED DISPLAY TACTICAL VISION RESEARCH

S.C. Hadley^{1,2}

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

INTRODUCTION: A fifth generation fighter, the F-35, will be first aircraft to use a Head-Mounted Display System (HMDS) as primary flight instrument. The F-35 HMDS is a bi-ocular (both eyes view the same imagery), monochrome design that presents symbology, as well as thermal and night vision imagery using the distributed aperture system (DAS) and the Night Vision Camera (NVC). The DAS uses multiple IR cameras integrated into aircraft structure with a head-tracking system to determine pilot head location/orientation and the DAS sensor imagery that aligns with that orientation. The DAS allows pilot view through aircraft structure (e.g. through bottom of fuselage). **DISCUSSION:** The F-35 DAS Head Mounted Display system has induced spatial disorientation, diplopia, two separate eye Symbology display, green glow after image, jitter and variable canopy issues. Initial research of these issues will be presented and mitigation strategies will be presented.

Learning Objectives:

1. Describe the F-35 visual display system.
2. Explain the ocular demands of the F-35 dual see-through helmet mounted display system.
3. Discuss USAF aeromedical impact on pilots selected to fly the F-35.

Tuesday, May 12
S. Hemisphere 4

4:00 P.M.

[XLV.] PANEL: NAVAIR HUMAN SYSTEMS DEPARTMENT RESEARCH IN UNMANNED AERIAL SYSTEMS

Chair: David Rozovski
Orlando, FL

PANEL OVERVIEW: Since the introduction of the first Military Unmanned Aerial Systems (UAS), there has been an ongoing debate as to not only what the proper selection criteria are for UAS operators but how to design control stations and interfaces for them. The inherent challenges UAS operations present - compounded by ever increasing mission criteria, information relay latency, and a variety of other human factors issues - create a challenging environment often requiring periods of alternating vigilance and high workload (Tvaryanas et al., 2008) in which accident rates themselves are 1.5 to 2 times higher than in manned aircraft (McGarry, 2012). While there is a large body of work, and standards and design criteria that exist for surface, sub-surface, and air selection, the UAS environment's characteristics require new directions in research to explore questions unique to this environment. This panel will highlight ongoing research in Unmanned Aerial Systems (UAS) within the Naval Air Systems Command (NAVAIR) 4.6 Human Systems Department, and how these efforts advance our understanding of UAS design, utilization, manning, and performance assessment. Panelists will discuss work in UAS performance metric development, operator population differences, validation efforts for performance-based selection assessments, techniques for helping operators maintain situational awareness during high workload, conditions under which operator spatial disorientation during airborne control of UASs can be minimized, and methods of consolidating information to help operators make more effective decisions. The views expressed herein are those of the author and do not necessarily reflect the official position of the DoD or its components.

[265] UNMANNED AERIAL SYSTEM (UAS) SELECTION: CONSTRUCT VALIDATING THE PERFORMANCE BASED MEASUREMENT (PBM) BATTERY

J. Pagan, R. Astwood, and H.L. Phillips
NAWCTSD, Orlando, FL

INTRODUCTION: The high number of Unmanned Aerial System (UAS) mishaps associated with human error (over 50% [Williams, 2004]) has sparked interest in methods that can mitigate these safety issues. One strategy that has proven effective for manned aviation is the implementation of standardized validated selection tools. For example, research on the Navy's Aviation Selection Test Battery (ASTB) indicates that applicants with higher ASTB scores have improved safety and performance compared to those who score lower on the ASTB (Grubb & Phillips, 2011). In addition to promoting safety and mitigating mishaps, the ASTB yields an estimated savings of over \$35 million a year by improving the quality of training accessions, reducing the flight hours needed to meet wing requirements, and lowering trainee attrition (Naval Aerospace Medical Institute, 2011). Providing a similar tool validated for UAS platforms could provide equivalent benefits by supporting the selection of those individuals who are most likely to succeed in training. Although numerous validated selection tools exist for manned aviation (e.g., Performance Based Measurement [PBM]), few exist for unmanned aviation (e.g., Computer Based Performance Test [CBPT]). While tests developed for legacy UAS have shown high predictive validity in the past (Phillips, Arnold, & Fatolitis, 2003), platform relevance and applicability to current UAS technologies limit their utility, as a successful test must be validated and updated to reflect the new skill sets needed to operate emerging UAS technologies. While no test currently meets this requirement, the domains measured by the Performance Based Measurement (PBM) selection battery (developed for manned aviation) significantly overlap with those measured by the CBPT, making the PBM a prime candidate for establishing validity for the UAS

population. Thus, this presentation will describe construct validation results from the second of three validation studies investigating the utility of the PBM for the UAS community. The views expressed herein are those of the author and do not necessarily reflect the official position of the Department of Defense or its components.

Learning Objectives:

1. Attendees will achieve a basic understanding of the process of construct validation.
2. Attendees will achieve broad awareness of naval manned aviation selection tools and procedures.

[266] IDENTIFICATION AND DEFINITION OF UNMANNED AERIAL SYSTEM (UAS) AIR VEHICLE OPERATOR (AVO) PERFORMANCE METRICS

C. Foster¹ and H.L. Phillips²

¹4.6, NAWCAD, NAS Patuxent River, MD; ²46T, NAWCTSD, Orlando, FL

INTRODUCTION: UAS AVO selection and training systems currently lack useful criteria for performance measurement and validation. Current efforts investigating UAS AVO performance metrics focus primarily on those that can be gathered automatically. Attention must also be placed on those metrics which will be captured and recorded by trained observers, instructors, or other crew members. The UAS AVO performance metrics study is a three year program that will identify, develop, validate, and transition UAS AVO performance metrics. The current presentation will focus on the job task analysis (JTA) and subject matter expert (SME) interviews conducted to identify key performance domains and discuss how these data are decomposed to develop performance metrics.

Learning Objectives:

1. Develop an understanding of the process used to develop and validate performance metrics.

[267] MULTIMODAL INTERFACE DESIGN FOR UNMANNED SYSTEMS (MIDUS)

T. Alicia

NAWCTSD, Orlando, FL

INTRODUCTION: In a complex environment such as the operator station of an Unmanned Aerial System (UAS), a faster reaction time to an alert may mark the difference between mission success and failure. One significant design consideration for a UAS interface is how to map critical alerts to an appropriate sensory modality (e.g., visual or auditory). If an alarm is presented in a modality already highly taxed or overloaded during a mission, reaction times will be lengthened. To combat this performance decrement, an alert could be presented in a less heavily loaded channel; however, abruptly switching modalities between channels results in an even further increase in reaction times due to an emergent phenomenon called the Modality Shifting Effect (MSE) (Gherri & Eimer, 2011). The objective of this effort is to test a technique called bridging, which transitions the incoming alert from one modality to another while simultaneously counteracting the MSE. Using a simulated UAS operator station, participants performed either a challenging visual or auditory task, depending on condition, while remaining vigilant for visual or auditory alarms. The alarm modality switched between visual and auditory either abruptly or via a bridged transition. This study is currently collecting data to test the hypothesis that participants in the bridging technique condition will show reduced reaction times compared to participants in the abrupt condition. The views expressed herein are those of the author and do not necessarily reflect the official position of the Department of Defense or its components.

Learning Objectives:

1. Attendees will understand the application of Multiple Resource Theory in a UAS context.
2. Attendees will understand a technique to mitigate the modality shifting effect.

[268] DECISION MAKING SUPPORT FOR HUMAN-MACHINE COLLABORATION IN COMPLEX ENVIRONMENTS: A COGNITIVE TASK ANALYSIS

J. Pagan, K. Kaste, and T. Alicia

NAWCTSD, Orlando, FL

INTRODUCTION: In order for autonomous systems to navigate from waypoint to waypoint, they must employ a multitude of sensor combinations (e.g., Light Detection and Ranging, Millimeter Wave Radar, Stereovision, Electro-Optical/Infrared, Sonar) that allow for perception of the environment and aid sensor uncertainty (Chao & Chen, 2012). While research has identified the most effective sensor combinations for various platforms, the question of how best to translate this myriad of disparate sensor data sources into actionable operator information remains an area for research (e.g., Jang & Liccardo, 2007). Consequently, the need exists to investigate how to effectively combine large amounts of disparate data into a manageable format that enhances operator performance. This format must support the quick synthesis and transformation of data into actionable information that aids operator decision-making in complex environments. To understand how to combine this type of data, it is important to first understand decision-making strategies used by existing expert operators, mission specific information processing requirements, task demands, and other characteristics associated with interpreting such data. This presentation will discuss methods and preliminary findings from a cognitive task analysis conducted to determine such requirements. The views expressed herein are those of the author and do not necessarily reflect the official position of the Department of Defense or its components.

Learning Objectives:

1. Attendees will develop an understanding of data management strategies applicable to optimizing UAS operator effectiveness.
2. Attendees will develop an understanding of operator decision-making strategies and characteristics that affect task-specific information processing requirements.

[269] THE IMPACT OF CONFLICTING SPATIAL REPRESENTATIONS IN AIRBORNE UAS CONTROL

W. Wells, J.W. Geeseman, and J. Patrey

Human Systems, NAVAIR, NAS Patuxent River, MD

INTRODUCTION: Emerging concept of operations (CONOPs) for Unmanned Aerial System (UAS) employment call for the potential control of UAS while airborne, such as controlling a broad area maritime surveillance (BAMS) UAS from an airborne P-8A. While there are numerous differences from classic aviation tasks, one of particular concern is that of the conflicting spatial representations between own position (seat configuration), aircraft position, UAS position and sensor position in dynamic, six degrees of freedom space. The first five degrees of freedom, previously mentioned, are the Cartesian plane (forward/backward and left/right), elevation, pitch and yaw of the aircraft. The sixth degree of freedom is the angle of which the simulated camera is pointed. For example, an aircraft could be banking left and descending, while the UAS being controlled could be banking right and ascending, while the camera is slewing left and ascending, for a person in a starboard seat configuration creating great discord between these spatial representations along with their critical, relevant sensory inputs. This creates the likelihood not only of noteworthy momentary performance lapses until these spatial discrepancies are reconciled, but also pervasive and sustained fatigue and motion sickness and the consequent creation of significant safety risks. **METHODS:** In this study, participants assumed the role of a sensor operator for an unmanned aerial vehicle (UAV) simulation while riding in the fuselage of an airborne P-3. The P-3 flew a flight profile of intermittent ascending, descending, and turning profiles (in strict accordance with an emphasis on safety of flight) to induce a maximum level of spatial discordance to the sensor operator screen where the participant tracked simulated targets. **RESULTS:** The multiple frames of reference for the participant induced spatial discordance and an overall decrease in tracking performance compared to trials during straight and level flight and ground baseline trials. **DISCUSSION:** The results of this study will be used in the continuing development of the common control station (CCS) and to inform decisions on the future development of Naval Air Training and Operating Procedures Standardization (NATOPS) for UAV operators.

Learning Objectives:

1. The impact of spatial discordance on performance metrics while operating UAS sensors in an airborne environment.
2. Consequences of motion sickness and spatial discordance found during UAS sensor operation while airborne.

[270] ADAPTIVE, GENERATIVE AND MODULAR AGENTS FOR LVC AND OTHER TRAINING APPLICATIONSC. Foster¹, D. Schmorow³, and J.V. Cohn²¹4.6, NAWCAD, NAS Patuxent River, MD; ²OASD (R&E), Office of Secretary of Defense, Silver Spring, MD; ³Soar Technology, Vienna, VA

INTRODUCTION: In this talk we provide a vision, based on our combined 30+ years of developing training and education technologies, for the next stage in training system content development. We envision an automated capability to generate new, context appropriate, training content with limited human supervision, based on integrating training system authoring tools with expert system technologies. **METHODS:** A critical enabler of this approach is the ability to deliver training through student interactions with one or more agents. These student - agent interactions will provide the basis for both implicit and explicit - or experiential - training. We envision agents that will have the ability to assess student performance against a set of training goals and objectives, and that can adapt their behaviors to assist the student in optimizing their training experience. **RESULTS:** Importantly, these agents will be able to generate new and appropriate behaviors based on their assessment of an individual student's needs, and the available curriculum content. This will replace hand-coded rule sets, automatically generating new and appropriate agent behaviors from one or more data sources including data: captured during live exercises; captured from experts operating their systems within a simulated environment; or provided in a script-like format. On the basis of one or more of these initial data sets, it is then possible to reproduce the behaviors, to model them for more general uses, and to extend those models to provide new behaviors in a training environment. **DISCUSSION:** This approach will require integrating cognitive modeling approaches with AI techniques to generate tactically authentic behaviors. Cognitive models provide a means of formally representing the underlying behaviors of interest. AI techniques provide a wide range of inductive approaches to generalize modeled behaviors to new missions and contexts. Training objectives, doctrine and tactics, techniques and procedures (TTPs) bound the initial cognitive models and subsequent machine learning generalization to ensure that new behaviors are tactically authentic and also responsive to training needs. The resultant behaviors can then be validated as part of a new training scenario.

Learning Objectives:

1. Participants will be able to describe how agents have the ability to assess student performance against a set of training goals and objectives as well as describe how they can adapt their behaviors to assist the student in optimizing their training experience.
2. Become familiar with the overall methods for developing adaptive training.
3. Recognize different potential applications for advanced training technologies.

Tuesday, May 12
S. Hemisphere 5

4:00 P.M.

**[XLVI.] PANEL: AEROSPACE MEDICINE
CERTIFICATION: INTERNATIONAL
PERSPECTIVES**

Chair: David Salisbury
Ottawa, Ontario, Canada

PANEL OVERVIEW: There is a need for specialists in aerospace medicine (or aviation & space medicine) to have undergone an approved program of recognized higher professional medical training in their country of registration (licensure) and for that training to be

afforded the same standing as for any other medical specialty. Practitioners in aviation & space medicine may have come from a variety of medical backgrounds including internal medicine, anaesthetics, preventive or occupational medicine. Several nations have had recent changes in the formal recognition of the specialist training such practitioners undertake. The purpose of this panel will be to present international perspectives on certification in aerospace medicine and outline the needs for training programs and maintenance of certification. Presenters will outline the process for aerospace medicine certification in their countries and outline training and post certification maintenance of competence requirements.

[271] AEROSPACE MEDICINE CERTIFICATION IN CANADA: A NEW ERA

D.A. Salisbury

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

INTRODUCTION: Historically Canadians wishing to specialize in Aerospace Medicine have gone to the U.S. or to the UK and been certified by the American Board of Preventive Medicine or the Royal College of Physicians of London (UK). **METHODS:** In 2011 The Royal College of Physicians and Surgeons of Canada announced several new forms of specialty training recognition including a Diploma in an Area of Focused Competence.(AFC) This route was chosen by a group of current Aerospace Medicine practitioners as the best fit for the discipline of Aerospace Medicine and a formal application was made to the Royal College to initiate recognition as an AFC. **RESULTS:** A working group was struck and the parameters of practice were outlined, the training requirements specified and the method(s) for demonstrating competence selected. AFCs were specifically requested to avoid the traditional examination process in assessing competence. A new assessment methodology was adopted, requiring the candidate seeking the Diploma to provide the Royal College with a portfolio of documents demonstrating experience, training and competence that together would constitute eligibility for certification. The requirements for the portfolio will be presented and the ongoing maintenance of competence program will be outlined.

Learning Objectives:

1. Be able to describe the Royal College of Physicians and Surgeons of Canada certification process for Aerospace Medicine.

[272] AVIATION & SPACE MEDICINE: THE DEVELOPMENT OF A NEW CURRICULUM IN THE UKD. Gradwell¹ and S. Evans²¹*Physiology, King's College London, London, United Kingdom;*²*Medical, Civil Aviation Authority, Gatwick, United Kingdom*

INTRODUCTION: Specialist UK practitioners of aviation medicine have had very varied training backgrounds. Few are identified on the national General Medical Council register as being specifically trained in aviation and space medicine. Increasingly constrained training pathways and shortened programs have made it essential that trainees can fulfil the requirements for specialist accreditation as rapidly as possible while ensuring their training is robust and comprehensive. **METHODS:** A Specialist Advisory Committee was established by the Joint Colleges of Physicians' Training Board with wide representation from aeromedical practitioners in academia, military services, aviation regulators, air traffic services, airlines, aeromedical retrieval, space medicine and AMEs. Lay representation has been welcomed, as have trainees. **RESULTS:** A comprehensive curriculum has been developed, identifying core and additional training elements. Trainees holding a post-graduate medical Royal College qualification are selected competitively and progress assessed annually. A matrix of training providers, with reciprocal arrangements between them, allows trainees to access expertise and facilities that may not be available within their own unit. Trainees, thus, will have opportunities to work in a range of areas. Although training provision for Aviation & Space Medicine is not provided within the National Health Service extensive clinical training has been emphasized. The importance of the specialty to the UK medical capability has been

underlined in parliamentary and governmental reports. **DISCUSSION:** Although not a new specialty, curriculum approval procedures treat this program as if it is. There is a two-stage process requiring initial agreement by the four national Health Departments and then the General Medical Council. The Secretary of State for Health is then asked to approve the program. The first stage has been achieved and work is advancing on completion of the second.

Learning Objectives:

1. To familiarize attendees with progress in specialty training for aerospace medicine in the UK.

[273] USAF SCHOOL OF AEROSPACE MEDICINE

P.R. Storms

FEEG, USAFSAM, Dayton, OH

INTRODUCTION: The United States Air Force School of Aerospace Medicine (USAFSAM) has been training aerospace medicine specialists since 1950. The training location, curriculum, and training methodologies have evolved over the years in response to operational and organizational needs. **METHODS:** Explore the history, development, challenges, and successes of USAFSAM in the training of aerospace medicine specialists. **RESULTS:** Review and discuss school history and development through the years, current curriculum and oversight, and a look to the future. **DISCUSSION:** USAFSAM has been training aerospace medicine specialists for 65 years. With a robust history, strong operational links, and flexible and responsive curriculum, the school is prepared to continue training specialists far into the future.

Learning Objectives:

1. Appreciate the history of the USAF School of Aerospace Medicine.
2. Understand how operational requirements drive changes to the curriculum and how the school adapts to new and changing regulatory requirements.
3. Understand the board certification process for graduating residents in aerospace medicine.

[273a] THE REBIRTH OF THE ARMY SPONSORED AEROSPACE MEDICINE GRADUATE MEDICAL EDUCATION

S. A. Salmon, J. Houk, and K. Wilson

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

INTRODUCTION: From 1917-1948 the Army Air Corps was the preeminent US organization providing aviation medicine science, services and practices. Through the end of World War II and starting again with the Vietnam Campaign, the greatest number of US military aviators and combat aircraft were assigned to the Army. In contrast to our historical roots and operational needs, the US Army has never sponsored an Aerospace Medicine Residency. **METHODS:** On July 1, 2015 the US Army School of Aviation Medicine at Ft Rucker, Alabama will matriculate its inaugural class into the Army's first Aerospace Medicine Program. Already home to the largest fleet of military aircraft and aviators in the world, Ft Rucker will now unite Army initial and advanced flight training with a permanent and accredited Aerospace Medicine Graduate Medical Education (GME) program. Co-location with the US Army's Aeromedical Activity, Research Laboratory, Safety Center, and the Center for Aviation Excellence greatly enhances the spectrum of experiences for residents and allows Army Aerospace Medicine to better weather the fiscal pressures on our specialty's GME. The philosophical and programmatic marriage of the existing Occupational Medicine Residency with the new Aerospace Medicine Residency ensures new Army Aeromedical Specialists are capable of providing quality comprehensive primary, preventive and deployment health care to the Army Aviation enterprise. **RESULTS:** From conception and approval through resourcing and accreditation, birthing a new residency takes considerable time and effort. Changing practices, advancing technology and evolving risk assessments call for a nimble and responsive Aerospace Medical educational paradigm. The 2015

opening of the Army Aerospace Medicine Residency is the latest step in that evolution representing a 20% expansion in the number of US based Aerospace Medicine programs. After familiarizing attendees with the program this panel will encourage discussion and seek audience feedback the direct, indirect, and "intangible" benefits and challenges relating to curriculum, integration of GME into an Aviation Solider Patient Centered Medical Home and of co-locating Aerospace Medicine GME with the Home of Army Aviation.

Learning Objectives:

1. Understand the newly formed Army Aerospace Medicine Residency.
2. Describe noted advantages and disadvantages to a combined Army Occupational Medicine and Aerospace Medicine Residency program in Ft Rucker, AL.

Tuesday, May 12

S. Hemisphere E3

4:00 P.M.

[XLVII.] SLIDE: HEALTH CONCERNS IN COMMERCIAL AIR TRAVEL

Co-Chair: Nora Johnson

Austin, TX

Co-Chair: Mary Brueggemeyer

Bethesda, MD

4:00 p.m.

[274] NEW EUROPEAN REGULATIONS FOR ON-BOARD EMERGENCY EQUIPMENT

J. Siedenburg

Lufthansa Medical Service, Uetersen, Germany

INTRODUCTION: Civil carriers transport more than three billion passengers annually. Increasing size of aircraft, duration of flight and growing numbers of passengers of old age or with pre-existing disease contribute to a significant number of in-flight medical events. Even though most emergencies are minor some emergencies may require sophisticated medical support to prevent fatal outcomes. The industry has responded by varying standards for flight travel fitness, medical training for cabin crew and by providing medical equipment for use by passenger doctors or other medically trained personnel. **RESULTS:** ICAO recommends carrying first-aid kits (FAK) and emergency medical kits (EMK). Based on these recommendations, a European working group on air passenger health issues started working on European requirements, which manifested in recommendations of ECAC (European Civil Aviation Conference). A working group of the Joint Aviation Authorities drafted the pertinent requirements for flight operations. However, due to political discussions and the transition from national requirements to common European requirements it took almost 10 years until the drafts could be implemented as so-called Acceptable Means of Compliance to EASA-OPS. After a 2-year opt-out option ended in October 2014 all member states of EASA had to implement EASA-OPS and these requirements. **DISCUSSION:** The presentation gives a brief introduction to the required emergency equipment supplies. The concept of first aid kits (number depending on the number of passengers carried) and emergency medical kit has been kept. However, technical equipment and medications are much more elaborated. Carriage of an AED depends on the risk assessment of the individual airline. Nevertheless, most well-known big European quality carriers carry much more supplies than required by law.

Learning Objectives:

1. Understanding the need for on-board medical equipment.
2. Understanding the regulatory background for on-board medical equipment.
3. Understanding that the regulation provides minimum standards.

4:15 p.m.

[275] PROPOSED GUIDELINES FOR ASSESSING FITNESS TO FLY IN SICKLE CELL DISEASE PATIENTSF. Wood¹, J. Howard², and D. Gradwell¹¹Aviation Medicine, King's College London, Watlington, United Kingdom; ²Haematology, Guy's and St Thomas' Hospital, London, United Kingdom

INTRODUCTION: Sickle Cell Disease (SCD) affects 12-15,000 people in the UK. It is associated with anemia and cardiorespiratory disease which mean that even the mildly hypoxic environment of a commercial airliner cabin can pose a potential risk to SCD patients leading to an increased risk of acute pain crisis and acute chest syndrome. Despite this, current guidance to use supplemental oxygen is not routinely followed in practice. A review of current data was followed by the development of new guidelines to assess fitness to fly. **METHODS:** A Medline search of the published literature yielded information about potential risks. This was corroborated by reference to the Guy's Hospital SCD clinic. A clinical guideline to identify those SCD patients that require fitness to fly assessment using pre-flight procedures which may be acceptable in clinical use was produced. **RESULTS:** For many SCD patients the risk of experiencing a sickling crisis related to a commercial flight is low and unpredictable but current guidance (e.g. from AsMA and the Civil Aviation Authority) advocates the universal use of supplementary oxygen. Commonly, this guidance is not followed and many may fly without supplementary oxygen until they encounter problems. There is currently no means to assess which patients should use supplemental oxygen. **DISCUSSION:** Since the first occurrence of air travel related complications is potentially fatal, vulnerable patients may be put at an unacceptable level of risk. A potential guideline, which provides an algorithm for clinicians to identify at-risk SCD patients, a framework to assess fitness to fly and consider if other steps are available to mitigate the risk, will be presented for discussion. There is a need for further work to derive a consensus regarding their specificity and effectiveness.

Learning Objectives:

1. Practical advice for assessing fitness to fly in SCD patients.
2. An appreciation of the further work required in this area.

4:30 p.m.

[276] EFFECT OF AGE ON THE PULMONARY ARTERY PRESSURE RESPONSE TO SIMULATED AIR TRAVELB.E. Turner¹, P.D. Hodkinson², A.C. Timperley², and T.G. Smith³¹Stanford University, Stanford, CA; ²Royal Air Force Centre of Aviation Medicine, RAF Henlow, United Kingdom; ³University of Oxford, Oxford, United Kingdom

INTRODUCTION: Hypoxia-induced elevation in pulmonary artery pressure during air travel may contribute to the worldwide burden of in-flight medical emergencies. The pulmonary artery pressure response may be greater in older passengers, who are more likely to require flight diversion due to a medical event. Understanding these effects may ultimately improve the safety of air travel. **METHODS:** Sixteen healthy volunteers were studied, consisting of a younger group (aged < 25 years) and an older group (aged > 60 years). Using a hypobaric chamber, subjects undertook a two-hour simulated flight at the maximum cabin pressure altitude for commercial airline flights (8,000 ft/2,438 m). Higher and lower altitudes within the aeromedical range were also explored. Systolic pulmonary artery pressure (sPAP) was assessed by Doppler echocardiography. **RESULTS:** There was a progressive increase in sPAP which appeared to be biphasic, with a small initial increase and a larger subsequent rise. Overall, sPAP increased by 5 ± 1 mmHg from baseline to 35 ± 1 mmHg at 8,000 ft ($P = 0.002$). Over two hours at 8,000 ft, sPAP increased by 19% in the older group compared with an 8% increase in the younger group ($P = 0.024$). **DISCUSSION:** This study confirms that pulmonary artery pressure increases during simulated air travel, and provides preliminary evidence

that this response is greater in older people. Advancing age may increase in-flight susceptibility to adverse pulmonary vascular responses in passengers, aircrew and aeromedical patients. Until further evidence is forthcoming, it may be prudent to consider using supplementary oxygen routinely in elderly air ambulance patients, at least for longer flights.

Learning Objectives:

1. To gain greater understanding of the physiological effects of aircraft cabin hypoxia, particularly the pulmonary vascular response.

4:45 p.m.

[277] PULMONARY HYPERTENSION IN AIRLINE PASSENGERS: A LARGE CASE SERIES FROM OCEANIAL. Brown¹, P. Prasad³, T.G. Smith², and B. Johnston³¹University of Auckland, Auckland, New Zealand; ²University of Oxford, Oxford, United Kingdom; ³Flight Operations and Safety, Auckland, New Zealand

INTRODUCTION: The current guidelines available to the medical community to assess a patient's fitness to fly with pulmonary hypertension are less than ideal. The evidence for the guidelines from bodies such as the British Thoracic Society have been inferred from animal studies or from patients with primary cardiac disease and have significant room for error in interpretation. The current guidelines stratify patients based on symptoms from classes developed from the NYHA and WHO. The assessment from the aviation physician is to decide on the patients' need for oxygen in-flight, further investigation with a hypoxic altitude simulation test (HAST) or advised not to fly. An airline operating in Oceania has had a significant number of patients present with pulmonary hypertension for assessment for fitness to fly. The aim of this paper is to present these cases with discussion around the difficulty of the current guidelines. **METHODS:** A retrospective review was undertaken of patients presenting for assessment for fitness to fly with pulmonary hypertension from May 2014 - current. Patient's medical background and physician decision making around the case was sourced. **RESULTS:** A total of 14 patients were assessed. Of these, 9 were approved to fly, with 5 declined. Patients were generally approved based on good functional class and declined due to co-morbidities. There was heterogeneity in decision making between physicians which reflected the ambiguity of the current guidelines. **DISCUSSION:** Pulmonary hypertension is a serious disease for aviation physicians to understand. The current guidelines are ambiguous and further investigation is required to develop more appropriate guidelines.

Learning Objectives:

1. To appraise the current guidelines for assessing patients fitness to fly with pulmonary hypertension.

5:00 p.m.

[278] IN-FLIGHT MEDICAL EVENTS AND FLIGHT DIVERSIONS: SIX AIRLINES EXPERIENCE IN IRAN FROM 2006 - 2013K. soleimani¹ and N. Mercado²¹Air Medical Section, Civil Aviation Organization & Mahan Airline, Tehran, Iran; ²Centro de Hematologia y Medicina Interna de Puebla, Clinica Ruiz, Mexico., Universidad Popular Autonoma del Estado de Puebla, Mexico

INTRODUCTION: Commercial aviation in-flight emergencies are relatively common. Flight diversion due to medical emergency transport incurs a significant financial and legal cost. An aging population combined with the increasing mobility of people with acute and chronic illnesses could make an increase in the frequency of in-flight medical events aboard commercial aircraft likely. The aim of this study is to determine the incidence of each type of in-flight medical illness, the appropriateness of medical equipment in flight, which factors lead to aircraft diversion, and which factors affect the suitability of the decision to divert. **METHODS:** A review of in-flight

medical emergencies reported by six airlines from 2006 to 2013 including (8 years) was done. The frequency of aircraft diversion was related to finding fault and medical assistance provided. The suitability of the decision to divert was determined as a function of hospital admission rates. **RESULTS:** Over the 8 years, 186.3 million passengers traveled domestic and international and there were 525 medical emergencies and 35 (6.7%) diversions. During this period there were 6 deaths recorded, which is a rate of 1 per 30,550,000 passengers and 0.032 deaths per 1 million passengers. **DISCUSSION:** Medical conditions most commonly leading to diversion were cardiac, chest pain, respiratory disorders, gastrointestinal, faint, neurological and psychological. All in-flight medical complaints could likely have been adequately treated with the contents of the ICAO mandated medical kits. Physician participation in decisions to divert aircraft should be requested as it is associated with more appropriate divert decisions. **Keywords:** In-flight medical emergencies, in-flight death, in-flight medical care, medical flight diversions, in-flight medical kit, aircraft emergencies equipment and supplies.

Learning Objectives:

1. The aim of this study is to determine the incidence of each type of in-flight medical illness, the appropriateness of medical equipment in flight, which factors lead to aircraft diversion, and which factors effect the suitability of the decision to divert.

5:15 p.m.

[279] COSMIC RAYS AND CARI SOFTWARE: RECENT DEVELOPMENTS

K.A. Copeland

Protection and Survival Laboratory, CAMI, Oklahoma City, OK

INTRODUCTION: Aircrews of commercial aircraft are exposed to higher doses of ionizing radiation than members of the general population in most parts of the world. The principal ionizing radiation to which aircrews are exposed is galactic cosmic radiation, which is thought to come primarily from supernovae. Among the most enigmatic particles present in the primary galactic cosmic radiation spectrum are the so-called *heavy ions*. These are atoms of lithium and heavier elements stripped of all their electrons and traveling near the speed of light. Along with relativistic alpha particles, these ions cause unique biological damage that is still poorly understood, resulting in some controversy about their handling in dosimetry. While of no importance at present commercial aviation altitudes, they are increasingly important as flight altitude increases above 60,000 feet. They become the dominant source of effective dose as one approaches the edge of space, where long-duration manned commercial balloon flights are already being offered to the public. The FAA Office of Aerospace Medicine, through the Numerical Sciences Research Team at the Civil Aerospace Medical Institute, develops and freely provides to science, industry, and interested members of the public software, advice and educational materials on the health risks associated with exposure to ionizing radiation while flying. Previously developed software, CARI-6 (and earlier versions), is inaccurate at altitudes where heavy ions are important--above 60,000 feet. To address this shortcoming, two new version of CARI based on different radiation transport methods have been developed: CARI-NAIRAS and CARI-7. CARI-NAIRAS uses tables of dose rates generated by the National Aeronautics and Space Administration's (NASA) NAIRAS (Nowcast of Atmospheric Ionizing Radiation for Aviation Safety) program, which uses the NASA's deterministic radiation transport program HZETRN, developed at NASA's Langley Research Center. CARI-7 uses a library of cosmic ray shower simulations made on CAMI's HiPARCoS HPC using the Monte Carlo radiation transport software package MCNPX 2.7.0, developed at Los Alamos National Laboratory. Results of these two new programs are compared and contrasted.

Learning Objectives:

1. Ionizing radiation flight doses calculated by CARI-7 and CARI-NAIRAS are superior to those calculated by CARI-6 at high altitudes.

Tuesday, May 12

S. Hemisphere E4

4:00 P.M.

[XLVIII.] PANEL: EVIDENCE-BASED HUMAN PERFORMANCE, PART 2

Sponsored by the AsMA Science and Technology Committee, the Aerospace Human Factors Association, and the Aerospace Physiology Society

Chair: Valerie Martindale

Beavercreek, OH

PANEL OVERVIEW: This second set of talks on the subject of evidence-based human performance will present two more examples of specific evidence evaluation and recommendations. We will also demonstrate a searchable database of the recommendations, created for use by human performance practitioners. The database can be expanded as new human performance interventions are evaluated. The session will end with consideration of future topics for evaluation and open discussion. Questions from the audience are welcome.

[280] THE EVIDENCE BASE FOR USE OF CAFFEINE TO MITIGATE FATIGUE

K. Dowd³, A. Cooks¹, V.E. Martindale¹, and M. Aldag²

¹Booz Allen Hamilton, Beavercreek, OH; ²Booz Allen Hamilton, Rockville, MD; ³U.S. Air Force, Pensacola, FL

INTRODUCTION: Fatigue is prevalent in today's 24/7 aerospace operations. Caffeine is widely used to mitigate fatigue, and has the advantages of being easily available and controlled by the individual.

METHODS: Of 17 abstracts meeting initial inclusion criteria, seven studies were found to meet all inclusion and exclusion criteria, and were evaluated by three reviewers. Each study was graded according to five internal validity criteria as a measure of quality.

Learning Objectives:

1. The Evidence Based supports that caffeine mitigates fatigue.

[281] THE EVIDENCE BASE FOR SHIFT WORK SCHEDULING PRACTICES TO OPTIMIZE PERFORMANCE

V. Kumar

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INTRODUCTION: Many jobs, in and out of the military, require 24 hour, seven-day coverage, including aerospace operations such as air traffic control, security, and aircraft maintenance. Questions persist as to how shift work can be arranged to maximize performance, safety, and health while achieving requisite coverage. **METHODS:** Inclusion and exclusion criteria for studies to be evaluated were carefully considered (studies including transmeridian travel were excluded), to scope an addressable topic question. Of 81 abstracts meeting initial inclusion criteria, 26 studies were found to meet all inclusion and exclusion criteria. Because of the large number of studies and limited time, each was evaluated by three reviewers, but all four reviewers participate in each discussion. Each study was graded according to five internal validity criteria as a measure of quality. **RESULTS:** The evaluation process identified a high degree of methodological variability across studies, as well as numerous uncontrolled study variables within single studies. Reviewers determined that the fundamental determination of 8-hour versus 12-hour shifts has little influence on performance, but additional scheduling factors can be taken into account to maximize performance. Several evaluated studies assessed safety, health, sleep quality, morale, and absenteeism as side-effects for consideration. This topic highlighted the difficulty of crafting a recommendation statement for a complex topic while still providing guidance to the practitioner in the field who must make a determination on how to schedule shifts

Learning Objectives:

1. Many jobs, in and out of the military, require 24 hour, seven-day coverage, including aerospace operations such as air traffic control, security, and aircraft maintenance. Questions persist as to how shift work can be arranged to maximize performance, safety, and health while achieving requisite coverage.

[282] THE HUMAN PERFORMANCE SUSTAINMENT ELECTRONIC TOPIC GUIDE: PROOF-OF-CONCEPT DEMONSTRATIONJ.W. Lasswell² and V.E. Martindale¹¹Booz Allen Hamilton, Beavercreek, OH; ²US Air Force, Fairfax, VA

INTRODUCTION: In order for evidence-based decision making to have an impact on human performance, there must be a mechanism for collecting and disseminating the evidence-based recommendations for use in the field. The Human Performance Sustainment Electronic Topic Guide (HPS ETG) was designed for storing, managing, and presenting evidence-based practice recommendations and associated information for use by Department of Defense (DoD) human performance practitioners. **METHODS:** This proof-of-concept demonstration was modeled after the U.S. Preventive Services Task Force (USPSTF) electronic topic guide hosted on the Agency for Healthcare Research and Quality (AHRQ) website. The DoD Human Factors Analysis and Classification System (HFACS), which provides a widely-used system for organizing information related to human performance, was selected as the entry portal and primary information organization method for the HPS ETG. **RESULTS:** Consultation with the human performance practitioners resulted in several methods for organization and retrieval of information. The primary access to HPS ETG topics is through categorization by the DoD HFACS. Topics are also searchable by intervention, performance decrement, and free text query. The platform includes material to support transparency and traceability, and allows for updating as new evidence becomes available. The initial proof-of-concept runs on a DVD, but is envisioned to become web-based. **DISCUSSION:** The Human Performance Sustainment Electronic Topic Guide is proven in concept as achievable and valuable to advance the practice of human performance.

Learning Objectives:

1. The audience will be familiar with the purpose and basic structure of the HPS ETG.

Wednesday, May 13**8:30 A.M.****S. Hemisphere 1****[XLIX.] SLIDE: UNDER PRESSURE...OR NOT!****Chair: Diane Ritter***Biloxi, MS***8:30 a.m.****[283] EBULLISM IN SPACE: FACT VS. FICTION**

T. Swaffield, D. Buckland, R. Slivka, and K.R. Lehnhardt

The George Washington University Hospital School of Medicine and Health Sciences, Washington, DC

INTRODUCTION: Popular movies that are based in space frequently portray inaccurate events, such as that which would occur in a decompression event. This misinforms the public and skews our understanding of the seriousness of just such an emergency. Decompression in space could lead to ebullism, which is the spontaneous evaporation of water from liquid to gas at a pressure of 47 mmHg or less. This process occurs at any altitude above 63,000 ft, which is a relative boundary known as "Armstrong's line." Above this altitude, a pressurized suit or spacecraft is necessary for human survival. In this project, we analyzed how scenes from popular science fiction movies misrepresent the physiological dangers of ebullism.

METHODS: The movies "Europa Report" (ER), "Guardians of the Galaxy" (GG), "Star Trek Into Darkness" (ST) and "Star Wars Revenge of the Sith" (SW) were selected. We chose appropriate scenes from each movie and analyzed

the duration of exposure, noticeable symptoms of those affected, apparent recovery (if applicable), and relevant information that is incorporated into the movie surrounding the decompression event. This information was then compared to available literature outlining the known pathophysiology and treatment of ebullism and validated for accuracy. **RESULTS:** The characters in ER and GG had longer exposures at >120 seconds. The characters in ST and SW had shorter exposures being ~9 seconds and ~15 seconds respectively. All characters survived exposure with minimal or no symptoms. **DISCUSSION:** It is possible that all individuals would have survived their exposures, just as the movies portray. However, the possibility of recovery depends largely on the length of exposure and the extent of cardiac/pulmonary damage. It was found that the selected movies improperly depicted the resulting effects of rapid decompression, which misrepresents the seriousness of this type of off-nominal event.

Learning Objectives:

1. To educate both physicians and the public alike about ebullism and its risks, given that science fiction movies frequently misrepresent the physiological effects of decompression in space.

8:30 a.m.**[284] IMPLICATIONS OF FIGHTER COCKPIT PRESSURIZATION RATES IN MODERN AIRCRAFT - SYNTHESIZING ENGINEERING AND AEROMEDICAL PERSPECTIVES**P. Lipinski¹, R. Jager³, and R.M. Monberg²¹Air Force Flight Test Center, Lancaster, CA; ²USAF, North Pole, AK;³JSF-ITF, USAF, Edwards AFB, CA

INTRODUCTION: Evaluating the modern military aircraft cockpit pressurization environment requires engineering and clinical perspectives across numerous engineering subsystems and disciplines. This presents a case study demonstrating the importance of maintaining this interdisciplinary mindset in complex aeromedical systems, examining a series of overpressurization events in a modern military fighter aircraft, from the initial discovery of the off-schedule events to the resulting reporting on the potential physiological consequences. **METHODS:** A series of over-pressurization events were observed in specific flight envelope and aircraft configuration combinations. Analysis of the pressurization subsystem, cockpit pressurization schedules, and rates of exposure were performed on data collected on the affected flights, and clinical assessment of the absolutes and rates of pressurization was performed alongside the engineering investigation. **RESULTS:** Over-pressurization was found to be related to specific aerodynamic conditions surrounding one of the cockpit pressurization valves, and rates of over-pressurization were found to be excessive. Aeromedical and life support reporting on the deficiency followed a previous environmental control systems report that had focused on the absolute value of pressure, not on the excessive rates. **DISCUSSION:** In complex aerospace systems, maintaining multiple perspectives is essential to fielding safe and reliable platforms for aircrew, and this case study serves as a demonstration of the real-world application of this mindset. An overview of over-pressurization absolutes and rates supplements the systems-level discussion.

Learning Objectives:

1. Understand the need for an interdisciplinary approach in evaluating human vehicle interface system deficiencies.
2. Understand the implications of excessive pressurization rates and levels in a modern fighter.

8:30 a.m.**[285] VALIDATION OF A METHOD ADAPTING AN AVIATOR'S MASK TO US CIVILIAN EMERGENCY MEDICAL SERVICES SYSTEMS**

R.C. Kipp

U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH

INTRODUCTION: U.S. Air Force (USAF) guidance for the initial treatment of simple altitude-induced decompression sickness requires administration of 100% surface level oxygen. The current preferred method of delivery is a tight-fitting aviator's mask. As more USAF bases