

including misunderstandings about the reporting policy, or fear of losing their flying status. While safety culture should be negatively related to safety incidents overall, we hypothesize that aspects of safety culture will be positively related to the reporting of those physiological incidents that could potentially go unreported. This abstract contributes to the Air Force Safety Center's research using the Air Force Combined Mishap Reduction System (AFCMRS) and Air Force Safety Automated System (AFSAS).

METHODS: We analyzed US Air Force aviation, physiological incidents from Fiscal Years 2010 – 2019 in squadrons that fly fighter/attack aircraft. A subject matter expert categorized incidents by whether or not they could go unreported. Safety culture was measured with an anonymous, web-based survey. Regressions were used to determine the effect of various aspects of safety culture on reporting, controlling for overall level of safety incidents. **RESULTS:** The direction of the relationship between safety culture and reporting depends on the aspect of safety culture being measured, and on the other variables that are controlled for in the model. The pattern of relationships provides insight about the underlying reasons for non-reporting of physiological incidents in fighter aircrew. **DISCUSSION:** Not only does safety culture predict the occurrence of safety incidents, but also reporting of those incidents. Accurate analysis of safety incident data for mishap prevention purposes requires complete, accurate, and unbiased reporting. This study provides insights into the underlying reasons for non-reporting of incidents that may be used to target educational measures to most effectively ensure accurate reporting and improve safety.

Learning Objective

1. The audience will understand the aspects of safety culture that relate to reporting of physiological safety incidents.

[115] CONSUMERS' VS. PILOTS' PERCEPTIONS OF PUNITIVE CULTURE IN AVIATION

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(Education - Program / Process Review Proposal)

INTRODUCTION: The aviation industry takes a different approach to safety compared to many other industries. For example, when things go wrong in the medical industry, hospitals and providers tend to "circle the wagons" for fear of lawsuits and other punitive damages. The aviation industry, on the other hand, actively seeks voluntary safety reporting. The premise here is that participants (pilots, flight crew, or other members of the organization) should feel comfortable submitting voluntary safety reports in cases of accidents, incidents or the presence of other safety hazards. This safety culture is not present in all countries, however. Some countries already inflict punitive measures on persons who have been deemed responsible for these events, including prison terms in some cases. Over the past decade, we have seen a rise in calls by the American public for criminalization of those who might be perceived as being responsible for accidents, particularly for ones that result in loss of life. This trend is a growing concern for those of us in the safety profession, as we believe that the short-term demand for punishment will become a significant deterrent to the long-term safety goals of the aviation industry. When flight crew fear criminal prosecution or career-ending punitive damages, they will be far less likely to provide voluntary reports or cooperate with investigations aimed at finding the root cause of accidents with the goal of preventing future accidents.

METHODS: The purpose of the current study was to experimentally examine perceptions of both aviation consumers and pilots in order to determine their level of agreement with the criminalization of pilots in a variety of specific cases that may or may not have resulted in loss of life.

RESULTS: Our results indicate that there are significant differences in attitudes toward criminalization, with consumers being much more likely to demand punitive measures compared to their pilot counterparts.

DISCUSSION: In all cases, pilots were generally opposed to criminalization regardless of blame, while consumers were supportive of criminalization when they felt that the pilot was in error. Neither group was supportive of criminalization when the accident was beyond the pilot's control.

Learning Objective

1. Understand the different perceptions toward punitive culture pilots and consumers.

TUESDAY, MAY 19, 2020

Tuesday, 05/19/2020

8:00 AM

Centennial Ballroom II/III/IV

7TH ANNUAL REINARTZ LECTURE

James C. McEachen, M.D., ME, M.P.H., and

Anthony P. Tvaryanas, M.D., Ph.D.

"The Flight Path Toward Precision-Based Aeromedical Decision Making"

Tuesday, 05/19/2020

10:30 AM

Centennial I

[S-26]: PANEL: FAA AEROMEDICAL RISK ASSESSMENT OF THE NEUROCOGNITIVE IMPLICATIONS OF HIV SEROPOSITIVITY – INTEGRATING CURRENT RESEARCH AND MEDICAL KNOWLEDGE

Endorsed by the American Society of Aerospace Medicine Specialists

Chair: James DeVoll

PANEL OVERVIEW: INTRODUCTION: The FAA has evaluated and certificated airmen who are seropositive for human immunodeficiency virus (HIV) for over 2 decades. HIV+ was previously considered debilitating and frequently evolving into acquired immune deficiency syndrome (AIDS) that was often fatal. Current antiretroviral therapies and other treatment has transformed HIV to a chronic, stable condition in many patients with few, if any, clinical symptoms and favorable long-term prognosis. The FAA's current protocol for evaluating HIV+ airmen focuses on evidence of viral suppression, adequate immune function, absence of any significant clinical manifestations of HIV/AIDS, and no evidence of neurocognitive deficiencies. As such, cognitive testing is central in evaluating HIV+ airmen for initial special issuance medical certification and recertification (annually for commercial pilots and air traffic controllers, and every 2 years for private pilots). In light of the overall clinical success in controlling HIV+, frequently the most critical question for aeromedical regulators is the rationale for neurocognitive testing and understanding how that testing informs aeromedical decision-making. **TOPIC:** The FAA's current evidence-based risk assessment (EBRA) approach focuses on finding a path to "Yes" by leveraging current medical literature, generally accepted clinical guidelines, and experts in a variety of medical disciplines. The purpose of this panel is to bring together expertise to review this topic. The first presentation will provide an overview of HIV infection with specific attention to neurologic issues, followed by presentations on the status and utility of neuroimaging and a review of aeromedically relevant medical literature. The last two presentations will focus on HIV+ neurocognitive testing results and the application of neurocognitive testing to aeromedical certification. **APPLICATION:** Because the safe performance of pilot duties so heavily depends on intact neurocognitive functioning, it is important to examine what we currently know about cognitive effects of HIV+ and how best to effectively evaluate and efficiently integrate neurocognitive testing into evidence-based risk assessment of HIV+ airmen.

[116] FAA HIV NEUROPSYCHOLOGICAL EVALUATION SPECIFICATIONS

Randy Georgemiller¹

¹FAA, Washington, DC, USA

(Education - Tutorial Proposal)

INTRODUCTION: This presentation will discuss FAA Neuropsychological Evaluation Specification updates for people living with HIV

(PLWH). **TOPIC:** Based on archival data gathered at the Civil Aviation Medical Institute, consultation with experts in the field, and an updated literature review, a revision to the original HIV Neuropsychological Specifications from 1997 was proposed impacting the frequency, timing, and content of aeromedical evaluations for HIV+ airmen applying for Special Issuance Medical Certification. **APPLICATION:** Given advances in medical treatment for PLWH such as the introduction of Combination anti-Retroviral Therapy, there is a need to update the specifications for neuropsychological evaluation with HIV+ airmen to both acknowledge the changing nature of what is now considered a chronic condition as well as mitigate the risk to aviation safety posed by changes in neurocognitive skills. **RESOURCES:** Heaton, R., et al. (2011). HIV-associated neurocognitive disorders before and during the era of combination antiretroviral therapy: Differences in rates, nature, and predictors. *J. Neurovirol.* 17:3-16 DOI 10.1007/s13365-010-0006-1. Sheppard, D., et al. (2015). Does older age confer an increased risk of incident neurocognitive disorders among persons living with HIV disease? *Clin Neuropsychol.* July; 29(5): 656-677. Tymchuk, S., et al. (2018). Associations between depressive symptomatology and neurocognitive impairment in HIV/AIDS. *The Canadian J of Psychiatry / La Revue Canadienne de Psychiatrie.* Vol 63 (5), 329-336.

Learning Objectives

1. Attendees will learn about the cognitive domains to be measured with standardized neuropsychological measures for PLWH.
2. Attendees will learn about proposed changes to the FAA HIV Neuropsychological Specifications as they relate to timing, frequency, and content of the examinations.
3. Attendees will learn about the use of internal archival data gathering in the decision making process for updating specifications for neuropsychological specifications.

[117] EXAMINING IMPACT OF EXISTING POLICY AND ALTERNATIVES

Thomas Chidester¹

¹FAA, Oklahoma City, OK, USA

(Education - Tutorial Proposal)

In 2016, airmen and Aviation Medical Examiners (AMEs) expressed concern that annual screening of HIV+ airmen for neurocognitive deficit might be unwarranted. Sacktor, et al. (2002) reported that HIV-associated Neurocognitive Deficit (HAND) frequency among HIV+ subjects averaging CD4 counts above 500 was less than 5% in a community sample. Skinner, et al (2009) found that cognitive impairment was rare among individuals without viral suppression failure. McArthur, et al (2010) concluded that cognitive screening should be applied to individuals with CD4 counts below 350. Crum-Cianflone, et al (2013) found among 200 HIV-infected patients with a median CD4 count of 546 and viral suppression achieved among 55%, a rate of impairment comparable to that among 50 controls. Pebody (2017) concluded: "Cognitive impairment caused by HIV is usually mild in people taking HIV treatment." In contrast, Eggers, et al (2017) cautioned that neurocognitive dysfunction caused by HIV increases over time with infection, and could be as frequent as 20 to 50% of cases. In response, Skaggs, et al (2018) assessed the impact of a possible policy change for screening neurocognitive deficit among HIV+ airmen. They evaluated the impact of an alternative that would waive annual screening for up to the five-year length of Special Issuance for airmen with CD4 counts and viral suppression conforming to Centers for Disease Control A-1 status. Analyses revealed that this alternative would have missed 4.5% of cases where A-1 status was accompanied by failed screening, but only 2 cases (1%) that would have changed the certification outcome. Rather than being reassuring, policy-alternative-unchanged cases instead highlighted where FAA had accepted neuropsychologist dismissal of screening without further testing. Additionally, like all analyses of certificated airmen, many dropped out of certification without explanation. This began a discussion within the Office of Aerospace Medicine to determine an optimal policy for screening HIV+ airmen. Subsequently, the neuropsychological community has become increasingly concerned with early compromise, compartmentalized viral evolution, and continuing viral and inflammatory activity within the central nervous system, even where viral suppression has been achieved. Our analyses can be interpreted as aligning with that caution.

Learning Objectives

1. The audience will learn about issues in certifying airmen infected with the Human Immunodeficiency Virus.
2. The audience will learn about processes of screening HIV+ airmen for neurocognitive deficit.

[118] Questioning the prevalence of HIV-associated neurocognitive disorders and causes of neuropsychological impairment in persons living with HIV:

Andrew Levine¹

¹University of California - Los Angeles, Los Angeles, CA, USA

(Education - Tutorial Proposal)

INTRODUCTION: HIV-associated neurocognitive disorders, or HAND, describe the spectrum of neuropsychological deficits presumed to be due to HIV infection. HAND has been reported to occur with an estimated prevalence of approximately 50%, with the vast majority of cases presenting with mild deficits that do not affect day-to-day functioning. However, these estimates were derived largely from studies that did not include HIV-uninfected controls, or in which control groups were not similar to the HIV+ groups. Recent findings from well-designed cohort studies and those applying improved statistical methods call into question whether or not HIV, in the current era of combination antiretroviral therapy, causes neuropsychological impairment. These findings are bolstered by the frontline (clinical) experience of the presenter. **TOPIC:** The assumption that HIV leads to neuropsychological impairment is scrutinized in this presentation. In particular, methodologies of studies that do and do not conclude a higher prevalence of neuropsychological impairment in HIV are compared. Results of recent analyses employing advanced statistical approaches that point to other causes of neuropsychological impairment in people living with HIV (PLWH) are discussed. Finally, an examination of the presenter's experiences of PLWH in clinical settings is discussed. **APPLICATION:** With a greater understanding of neuroHIV in the current era, FAA policy makers will be better informed when developing screening and monitoring protocols for PLWH.

Learning Objectives

1. The participant will gain a better understanding of HIV-associated neurocognitive disorder, including characteristics, prevalence, and course.
2. The participant will gain a better understanding of the co-morbid medical conditions that likely contribute to neuropsychological deficits in PLWH.
3. The participant will be better able to judge the importance of cognitive screening and monitoring pilots who are HIV+.

[119] NEUROIMAGING OF STRUCTURAL EFFECTS OF HIV SEROPOSITIVITY, AND THE RELATION TO TREATMENTS, COMORBIDITIES, AND PRE-/POST-INFECTION COGNITIVE STATUS

Erin O'Connor¹

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(Education - Program / Process Review Proposal)

INTRODUCTION: Prior to the introduction of effective HIV treatments, neuroimaging revealed extensive structural brain changes, including the characteristic appearances of opportunistic infections and HIV encephalitis and volumetric loss accompanying HIV encephalopathy. Mechanisms responsible for neurological impairment in treated HIV infection are debated and identification of patients at risk for progressive cognitive impairment remains a diagnostic dilemma. **TOPIC:** Evolving imaging methods allow more sensitive characterization of macroarchitectural, microstructural and physiological brain properties in the setting of treated chronic infection, but made difficult by associated measurement, design and analysis complexities. Numerous studies have focused on HIV associated effects on brain structure and function. While macroarchitectural brain MRI changes related to HIV infection in the ART era have grown smaller each year, HIV associated brain structural differences can still be detected in chronic, treated HIV infection, with voxel wise volumetric approaches, cortical surface shape analysis, and cortical thickness estimation approaches. Meta-analysis of

imaging studies has found lower gray matter volume (GMV), lower white matter volume (WMV) and higher cerebrospinal fluid volume (CSFV). **APPLICATION:** Studies have shown that serostatus effects in all tissue compartments have diminished with time. The source of these temporal trends is not certain, but may be related to changing clinical characteristics and suggests widespread use of ART may have diminished structural changes. Notably, many HIV neuroimaging studies have been confounded by multiple comorbidities associated with HIV infection, including substance use, hepatitis C co-infection, cardiovascular risk factors such as diabetes and hypertension, and heterogeneity in ART treatment. Also, premorbid cognitive abilities may interact with the effect of HIV infection. The Women's Interagency HIV Study reported that reading level, age, years of education, and race were more strongly associated with cognitive deficits than serostatus, challenging associations with HIV serostatus with changes in brain structure and function. We will discuss brain structure and function effects of the major HIV associated demographic characteristics and comorbidities in the context of different approaches taken to control or mitigate these confounds.

Learning Objectives

1. The audience will learn about the effects of HIV on structural brain changes detected by current neuroimaging techniques.
2. The audience will learn about the change in serostatus effects on brain structure over time, and the relation to anti-retroviral treatment.
3. The audience will learn about the HIV-associated demographics and comorbidities, and how they relate to treatments and risk mitigations.

[120] HIV INFECTION AND CNS IMPLICATIONS

Richard Roth¹

¹*Mercer University School of Medicine, Savannah, GA, USA*

(Education - Tutorial Proposal)

HIV infection has impacted individuals worldwide. The aviation population has not been immune to these effects. As HIV retroviral therapies have advanced the longevity of HIV patients has improved concordantly. Early in the HIV epidemic, clients died from opportunistic infections such as Pneumocystis, Toxoplasmosis and invasive Kaposi's sarcoma. In today's practice environment these infections are quite rare due to the advances of HIV highly active antiretroviral therapies. Unfortunately, data supports that as the survivorship of the HIV populations grows so does the central nervous system injurious effects of HIV inside the blood brain barrier which may act as a sanctuary for the virus avoiding the serum levels of HIV medications. With this said, although HIV clients have shown MRI and global cognition test scores independent of CD4 counts and ultrasensitive viral load detection that are worse than normative tests for cognition and executive functioning. In the assessment process of an airman pursuing medical certification this data supports that cognitive and potentially imaging modalities may be needed at more stringent intervals than prior parameters with special attention to the long-term survivors of HIV even with well controlled HIV viral loads and acceptable CD4 cellular quantification. HIV independent of cognitive impairment has been shown to have mental health impacts such as depression, anxiety and other mood disorders which directly impact the medical certification of aviators. The approach to the medical certification of HIV infected applicants warrants concern that solely relying on HIV virologic and cellular immunologic quantification in aviators taking well tolerated highly active combination antiretroviral interventions requires reassessment of both the frequency and the spectrum of the evaluation of long-term infected individuals.

RESOURCES: 1. Br. Med. Bull. 2018; 127:56-68. 2. Immune Defic. Syndr. 2016;73:374-383. 3. Lancet Infect. Dis. 2015;15:810-818.

Learning Objectives

1. Audience will learn about HIV CNS infection CNS implications of HIV Long term survivors require significant cognitive and imaging assessments.
2. The audience will learn about CNS implications of HIV.
3. The audience will have a better understanding of Neuroimaging and Cognitive evaluations of HIV impacts.

Tuesday, 05/19/2020

10:30 AM

Centennial II

[S-27]: PANEL: LESSONS LEARNED AND INNOVATIONS FOR ENHANCING HUMAN SYSTEMS INTEGRATION

Sponsored by Life Sciences and Biomedical Engineering Branch (LSBEB) of AsMA

Chair: Dwight Holland

Co-Chair: Carlos Salicrup

PANEL OVERVIEW: This education panel explores different approaches and lessons learned, or not learned (?) and innovative approaches for enhancing human performance through better Human Systems Integration (HSI) while exploring the earth, skies and space with an emphasis on newer technology opportunities in wearable computers, Augmented, Virtual Reality, and better HSI integration. We also look at new cutting edge technologies in the Life Sciences to examine how changes occur at metabolomic levels.

[121] AN EXAMINATION OF THE "SANS" PHENOMENON DUE TO EXTENDED STAYS IN MICROGRAVITY

Ari Shinjima¹

¹*Keio University, School of Medicine, Tokyo, Japan*

(Education - Program / Process Review Proposal)

INTRODUCTION: The term "Vision Impairment and Intracranial Pressure (VIIP)" was replaced by the term "Space Flight-Associated Neuro-ocular Syndrome (SANS)" in 2017. Because many of the ocular findings are difficult to attribute only to elevated intracranial pressure. Here we review the reasonable hypotheses of SANS as has been recently reported with the most recent thinking about this problem. Stable human visual attributes in multiple areas of functional performance are essential for safe and efficient spaceflight operations, whether in Earth orbit, the moon, or in Exploration class missions beyond. Furthermore, VR/AR systems, and most controls and displays are designed to be utilized by a normative human visual system.

DISCUSSION: SANS, characterized by increased Optic Nerve Sheath Diameter (ONSD), globe flattening and optic nerve tortuosity/kinking, has been detected in some astronauts. Our team created a model of the Optic Nerve Sheath (ONS) as a cylindrical tube, which enabled us to estimate cerebrospinal fluid (CSF) pressure from ONSD. We calculated CSF pressure for an inflight astronaut. However, the estimated CSF pressure was beyond the human standard value. This CSF pressure suggests a substantial deterioration of the elasticity of the ONS. Therefore, we hypothesized the origin of this deterioration. It is reported that narrowing of the central sulcus, upward shift of the brain, and narrowing of CSF spaces at the vertex occurred frequently in astronauts after long-duration flights. It is also reported that a sagittal MRI of an astronaut after a spaceflight shows an uplifting of the optic chiasm. We assumed that the optic nerve was pulled rearward according to the upward shift in the brain. This rearward shift of the optic nerve may result in an expansion and bending of the ONS, because the periosteum is connected to the dura of the ONS at the orbit. Thus, this rearward force on the optic nerve yields deformation of the eyeball, due to the force of the dura on it.

CONCLUSIONS: We devised an ONS model which enabled us to estimate CSF pressure from ONSD. The estimated CSF pressure suggests that the model is invalid for some astronauts because their ONS tissues may be changed by brain upward shift. If true, humans planning to stay in microgravity environment for long durations should have countermeasures for the upward shift of the brain and fluid shift, likely avoiding the issue of reduced visual performance by some in space.

Learning Objective

1. The audience will learn about the importance of countermeasures for the upward shift of the brain and fluid shift.

[122] HUMAN FACTORS SUBSYSTEM OF THE RxEVA HUMAN-CENTRIC MODEL FOR PRESCRIBING SURFACE EVA

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¹Embry-Riddle Aeronautical University, Daytona Beach, FL, USA

(Education - Program / Process Review Proposal)

BACKGROUND: The safety threshold of extravehicular activities (EVA) in terms of human performance limitations, is an unknown function of astronaut mental and physical workload, environmental parameters (terrain slope, gravity forces, duration, consumables), and EVA task intensity. A novel method of tactfully using metadata to maximize the potential of human capability on surface EVAs is necessary. Astronaut performance data for surface missions is limited to the Apollo program. Though they provide useful comparisons to begin characterizing baseline performance, advancements in technology and understanding of human performance capabilities require modern planning tools to refine data quantifying algorithms. RxEVA (Prescription EVA) seeks to fill that void as a conceptual human-centric model designed to receive physical and mental inputs to create recommendations for subsequent operations, which could mitigate potential injuries associated with exertion. **DESCRIPTION:** Currently, RxEVA development is focused on the human factors subsystem of the universal model, which include maximal oxygen intake (VO₂max), rest/sleep patterns, and perceived fatigue. These elements are crucial in identifying objective and subjective performance parameters to determine astronaut limitations and safety thresholds. Rest/sleep, fatigue and cognitive workload are all variables that can be quantified using validated, self-assessing tools that depend on astronaut reports of perceived individual alertness and performance readiness. This data can be collected from crew sleep logs or diaries and entries can be compared against robust scaling methods (Karolinska Sleepiness Scale (KSS), Samn-Perelli seven-point fatigue scale (SPS)) as well as psychomotor vigilance tests. Standardized surveys and protocols need to be developed to generalize post-EVA data collection, which will feed the biomathematical portion of the RxEVA model in order to predict peak-performance windows. **DISCUSSION:** At this point in time, the RxEVA Program is preparing human factors surveys that will help characterize astronaut fatigue and desired rest cycles for upcoming analogue missions. This data will be used to further refine the parameter fitting algorithm that the model will use to determine if an astronaut believes they are fit to continue with their duties. This information will also be beneficial as a usability study to determine if the biomedical monitoring equipment is comfortable and easy to use.

Learning Objective

1. The audience will learn about state-of-the-art data collection methods and human factors relevance to predicting human performance on EVA.

[123] EVALUATION OF AN AUGMENTED REALITY INTERFACE TO CONTROL TELEOPERATED SATELLITES

Andrew Liu¹, Jessica Todd¹, Leia Stirling²

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²University of Michigan, Ann Arbor, MI, USA

(Education - Program / Process Review Proposal)

INTRODUCTION: In future long-duration missions, free-flying teleoperated and autonomous satellites will replace astronaut extravehicular operations (EVA) for inspection or maintenance tasks. The satellite control interface will have to provide sufficient spatial and temporal awareness if astronaut operators are to safely complete their tasks. We present a pilot evaluation of an Augmented Reality (AR) interface for conducting an inspection of a spacecraft exterior and its impact on task performance and operator strategies. **METHODS:** Twelve subjects performed a simulated inspection task by flying a small satellite around the spacecraft exterior and identifying potential anomalies. They wore a Microsoft HoloLens and controlled their viewpoint and the satellite through a gesture-based interface. Four control modes were tested: (1) Manual control in a satellite-referenced frame, (2) manual control in a station-referenced frame, (3) waypoint navigation and (4) flexible mode control. Performance measures included percentage of station inspected, number of collisions, anomaly detection, and subjective workload. Interactions with the interface were recorded to characterize subject strategies. The experiment protocol was approved by MIT COUHES. **RESULTS:** Manual control in the global and local frames maximized the inspected area, but waypoint navigation resulted in fewer collisions. No

significant difference in accuracy of anomaly detection was found across the command modes. With free choice of command mode, subjects generally preferred to remain in one of the manual control modes. Subjects reported that the global and local modes required less workload and were more usable than waypoint navigation. **DISCUSSION:** Although manual control modes were preferred, the higher risk of collisions could outweigh the benefits of improved coverage. Improving the usability of waypoint navigation is needed to realize the benefits of both control modes. Future studies should also compare task performance and usability against current interfaces (e.g., ISS Robotic Workstation).

Learning Objective

1. Understand the human interface issues of AR/VR displays to control robots.

[124] THE NASA TWINS STUDY: ELEVATION OF P-CRESOL AND CYP450 2E1 DURING SPACEFLIGHT, AND ITS IMPLICATIONS FOR DRUG METABOLISM AND ASTRONAUT PERFORMANCE

Michael A Schmidt¹, Cem Meydan², Caleb Schmidt³, Christopher Mason⁴

¹Sovaris Aerospace, Advanced Pattern Analysis & Countermeasures Group, Boulder, CO, USA; ²Weill Cornell Medicine, New York, NY, USA;

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⁴Weill Cornell Medicine, New York, NY, USA

(Education - Program / Process Review Proposal)

INTRODUCTION: *p*-Cresol is a metabolite that is produced when gut bacteria act upon dietary tryptophan. *p*-cresol is absorbed into circulation and must be processed in the liver. Once in the liver, *p*-cresol requires sulfur groups for its metabolism and ultimate removal as a safe excretion product. Drugs, such as acetaminophen, also require sulfur groups for their metabolism. When *p*-cresol is produced by gut bacteria, it competes for the liver's sulfur pool that is needed to safely metabolize drugs, such as acetaminophen. This can lead to formation of drug intermediates (e.g. NAPQI) that produce hepatic damage and potential degradation in astronaut performance. CYP450 2E1 is the enzyme that governs the formation of NAPQI from acetaminophen. The present work explores the production of *p*-cresol and the expression of CYP450 2E1 genes (RNA) in spaceflight. Over a period of one year, two identical twins (one in space and one on earth as control) followed the same longitudinal protocol of multi-scale omics, clinical, and performance measures. Multi-scale omics measures included genome, epigenome, transcriptome, metabolome, and microbiome. The targeted *p*-cresol glucuronide and *p*-cresol sulfate features were extracted from the high dimensional metabolome data, during pre-flight, in-flight, and post-flight periods. RNA data for CYP450 2E1 were also extracted. **RESULTS:** A significant elevation in *p*-cresol glucuronide and *p*-cresol sulfate was observed in space. *p*-cresol glucuronide and *p*-cresol sulfate returned to baseline levels, upon return to Earth. In addition, a two-fold elevation in gene expression of CYP450 2E1 was observed in space in relation to the ground control. **DISCUSSION:** This appears to be the first evidence that *p*-cresol sulfate and *p*-cresol glucuronide are elevated during spaceflight and return to baseline upon return to Earth. This suggests changes in the gut metagenome involving species, such as clostridia. Second, CYP450 2E1 is the cytochrome responsible for metabolizing about 15% of acetaminophen, which results in the formation of the toxic intermediate NAPQI. Normally, a rich sulfur pool protects the against NAPQI via conjugation with glutathione (GSH) and safe excretion of the NAPQI-GSH conjugate. The increase in *p*-cresol and the upregulation of CYP450 2E1 in space may pose a previously unidentified risk to the ingestion of specific drugs that impact astronaut safety and performance, which warrants further investigation.

Learning Objectives

1. To understand the role of gut bacteria in the production of para-cresol.
2. To understand the role of para-cresol and sulfur compounds in drug metabolism.
3. To understand the role of CYP450 2E1 in drug metabolism.

[125] INNOVATIVE IN-MISSION APPLICATIONS FOR WEARABLE, INGESTIBLE, AND IMPLANTABLE TECHNOLOGIES

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¹University of California, San Francisco / TRISH, San Francisco, CA, USA;

³Human Systems Integration Associates, Roanoke, VA, USA

(Education - Program / Process Review Proposal)

BACKGROUND: The landscape of modern Aerospace Medicine and Human Systems Integration (HSI) has shifted in recent years due to the progressive digitization of healthcare. While the field of Aerospace Medicine has benefited considerably by these advanced capabilities, by refining the role of wearable technology, virtual and augmented reality (VR/AR) in the inflight setting, we can further optimize crew HSI, performance, and safety. **OVERVIEW:** Nearly every physiologic system in the body is impacted by the aerospace environment; many of these effects have terrestrial parallels that are most apparent in austere, resource-limited settings. Through judicious use of innovative wearable and VR/AR technologies, we can enhance our preventive capabilities and identify opportunities to intervene before conditions advance. **DISCUSSION:** The human body is a rich, yet untapped fount of biometric, biomechanical, and physiologic data; early detection of deleterious trends is especially useful in remote, austere terrestrial analogs, such as Antarctica, the deep ocean, and some low- and middle-income countries. Strategic use of innovative, miniaturized devices allow for collection, synthesis, and application of information to facilitate precision medicine in the aerospace environment. Aviation Environment: Pilots, particularly those flying high-performance jets, encounter unique conditions that challenge the human body, to include high G-loading, altered ambient levels of O₂ and CO₂, muscular and cognitive strain resulting in fatigue, and other factors. Feedback from AR displays and wearable devices can improve awareness of performance parameters in this setting and permit early detection of problems before they are amplified through continued stress. In time critical situations, latency is a key concern. Spaceflight Environment: The unique challenges of spaceflight can be targeted with wearable, ingestible, and implantable sensors, permitting a shift from reaction to prevention and early intervention. In particular, critical trends in sleep, fatigue, hydration, nutrition, and cognitive performance can be targeted for personalized interventions. VR/AR can be used for refresher training, recreation, and simulations. **SUMMARY:** The health technology arena has seen an explosion in availability of wearable, implantable, and ingestible devices in recent years. Strategic longitudinal monitoring permits prevention and early treatment through personalized interventions.

Learning Objectives

1. Understand the trends in data-based healthcare processes over the last two decades.
2. Understand the ways in which health data may be collected in order to permit personalized medical interventions.
3. Recognize the critical areas within Aerospace Medicine that wearable technologies can target.

Tuesday, 05/19/2020**10:30 AM****Centennial III****[S-28]: SLIDE: PHYSIOLOGY FOR SPACEFLIGHT****Chair: John Charles****Co-Chair: Ksenia Masterova****[126] SYSTEMATIC REVIEW INVESTIGATING EFFECTS OF PHYSICAL EXERCISE ON RESPONSES TO RADIATION WITH IMPLICATIONS FOR DEEP SPACEFLIGHT AND TERRESTRIAL MEDICINE**Anna Fogtman¹, Tobias Weber¹, David Kim²¹European Space Agency (ESA), Cologne, Germany; ²University of British Columbia, Nanaimo, British Columbia, Canada*(Original Research)*

INTRODUCTION: With future spaceflight missions planned outside of low earth orbit beyond the protection from the Earth's atmosphere and electromagnetic shielding, we need to better understand the biological effects of radiation in the space environment and how to protect astronauts from it. It has been hypothesized and shown experimentally in limited studies that physical exercise may be a protective factor against the harmful effects of radiation. This systematic review synthesizes current literature on the protective effects of physical exercise during exposure to radiation to help inform operational experts in planning future deep space exploration

missions and to explore its medical applications here on earth. **METHODS:** A systematic review following the Cochrane guidelines was carried out which yielded 2798 search hits from 6 electronic databases. Search criteria was for human and animal studies looking at exercise as an intervention with radiation exposure across all groups. Of the 2798 publications, 22 studies were included in the final data extraction and analysis. Outcomes assessed were categorized into 5 groups: clinical, functional, DNA damage/oxidative stress, neurogenesis, and cellular function. Hedges effect size values were calculated and bias corrected for each outcome then visualized using effect size plots. **RESULTS:** Of the final 22 included studies, 9 were human and the remaining 13 were experimental animal studies. Exercise decreased radiation-induced DNA Damage, oxidative stress, and inflammation in all studies and increased antioxidant activity. Further, there was a clear beneficial effect of exercise when exposed to radiation in clinical, cellular, and functional outcomes when effect sizes were plotted and visualized. **DISCUSSION:** This is the first study of its kind to investigate a protective mechanism of physical exercise against radiation effects in a systematic review. Although the studies analyzed in this review had a high degree of heterogeneity in the study design, population, and outcomes analyzed, most showed a beneficial outcome of exercise with respect to radiation protection. As further research is directed in this field, it will help us better plan and design a robust approach for radiation protection in future deep space flight mission capabilities and potentially improve terrestrial clinical radiotherapy outcomes.

Learning Objectives

1. Participants will understand the possible beneficial effects of exercise and its mechanisms with respect to radiation protection in planning deep spaceflight operations.
2. Participants will learn about a current review of literature in a systematic review about radioprotection with regards to exercise.

[127] 4-ACETYLANTROQUINONOL B INHIBITS OSTEOCLASTOGENESIS OF MACROPHAGES THROUGH SUPPRESSION OF NFATC1 AND C-FOS IN A SIMULATED MICROGRAVITY MODELChia-Hsin Wu¹, Shih Yu Lee¹, I-Chuan Yen¹¹National Defense Medical Center, Taipei, Taiwan*(Original Research)*

INTRODUCTION: Astronauts suffered from 1-2% bone loss per month during space mission. Targeting osteoclast differentiation has been regarded as a promising strategy for anti-osteoporosis under microgravity (μ Xg) conditions. Alendronate, a common osteoporosis drug, is a positive control in the study. 4-acetylanthroquinol B (4-AAQB), an ubiquinone from *Antrodia cinnamomea*, has showed the anti-inflammatory and anti-hepatoma activities. However, the effect of 4-AAQB on μ Xg-induced osteoclastogenesis remains unclear. **AIMS:** To explore the mechanistic insight of 4-AAQB on osteoclast formation under μ Xg conditions. **METHODS:** The monocyte/macrophage-like cell line RAW264.7 cells were exposed to simulated μ Xg (rotary cell culture system, NASA) or vehicle for 24h and then treated with 4-AAQB, alendronate, or vehicle and the receptor activator of nuclear factor kappa-B ligand (RANKL). Osteoclastogenesis, bone resorption, and the differentiation related signaling pathways were analyzed by tartrate-resistant acid phosphatase (TRAP) staining, fluorescent staining, cathepsin K assays, bone resorption assays, and western blotting assays. **RESULTS:** We found that 4-AAQB significantly inhibited μ Xg-induced osteoclasts formation based on the results of TRAP and the F-actin ring staining. Consistently, cathepsin K levels and bone resorption area were decreased by 4-AAQB. In addition, the critical regulators of osteoclast differentiation including nuclear factor of activated T-cells cytoplasmic 1 (NFATc1), c-Fos, and dendritic cell-specific transmembrane protein (DC-STAMP) were decreased. Meanwhile, osteoclast apoptosis were observed. **DISCUSSION:** We found that 4-AAQB exerts a greater effect than alendronate does under in μ Xg conditions. Our findings suggest 4-AAQB might be a potential intervention for disuse osteoporosis.

Learning Objectives

1. To investigate the effects and the regulatory mechanisms of 4-acetylanthroquinol B on osteoclast cells under microgravity conditions.
2. To understand the difference between normal gravity and microgravity effects on osteoclast formation.

[128] ASSESSMENT OF PHYSIOLOGICAL RESPONSE TO REPEATED EXPOSURES OF -Gz TO +Gz ACCELERATIONS IN TRAINING AND SUBORBITAL SPACEFLIGHT

Ann Tsung¹, Tarah Castleberry², James Vanderploeg³, Lin-Na Chou¹

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(Original Research)

INTRODUCTION: Commercial suborbital spaceflight profiles will expose pilots to sustained +Gx (some in combination with +Gz) during the launch phase of flight as well as a period of microgravity followed by high +Gz acceleration during re-entry portion of the flight. Pilots must maintain the ability to actively pilot the spacecraft throughout flight. To train for suborbital spaceflight, pilots undergo centrifuge-simulated suborbital flights along with regular aerobatic flights with profiles including transitions from -Gz to high +Gz acceleration. Previous studies with U.S. Navy Blue Angels indicate that training can improve tolerance to push-pull profiles, with less heart rate variability and bradycardia with -Gz flight. This study compares heart rate responses in experienced pilots and inexperienced non-pilots during the acceleration environment of aerobatic flights, centrifuge training, and two suborbital spaceflights. **METHODS:** HR and triaxial accelerometry were measured in 5 experienced pilots and 2 non-pilots by a Zephyr Bioharness device during repeated aerobatic flight profiles (4 pilots), one-time aerobatic flights (2 non-pilots), centrifuge simulated suborbital spaceflight profiles (4 pilots), and two suborbital spaceflights (4 pilots). Each pilot served as his own control for heart rate response and variability between training and suborbital flights. Non-pilot responses were aggregated and compared to those of the pilots to evaluate training effect. **RESULTS:** Using -Gz phase of aerobatic flights as a reference, spaceflight had larger HR decrease during microgravity exposure and a higher minimum HR than those under aerobatic flight. During +Gz or space flight re-entry, the centrifuge had larger HR increase than those under spaceflight and aerobatic. Both centrifuge and spaceflight had higher maximum HRs compared to aerobatic flights. There were no differences in time to initiation of HR response when pilots experienced $Gz < 0.5$ or $Gz > 0.5$. There were no differences in all measured variables between non-pilots and pilots. **DISCUSSION:** Aerobatic training resulted in attenuated heart rate decreases in trained pilots during -Gz exposures and increased heart rate response to +Gz transitions after -Gz exposures. Limited data from this study show steady decline in heart rate throughout the microgravity period of suborbital spaceflight but adequate response with return of +Gz during reentry for trained pilots and absence of push-pull phenomenon.

Learning Objectives

1. To compare and understand the heart rate responses of pilots during aerobatic flights, centrifuge, and space flight.
2. To understand if the push-pull phenomenon affects space flight pilots.

[129] A STUDY ON THE EFFECT OF SURYANAMASKAR ON ORTHOSTATIC TOLERANCE AND NEUROVESTIBULAR FUNCTIONING UPON EXPOSURE TO SIMULATED MICROGRAVITY CONDITION

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¹Institute of Aerospace Medicine, Bengaluru, Karnataka, India

(Original Research)

INTRODUCTION: Yoga has been widely accepted as a practice to modulate human physiology in varied professions. One of the fields of modern medicine where there is an adaptive physiological response is in the microgravity environment of space. Two important changes due to space adaptation are orthostatic intolerance and neurovestibular desynchronization. The study aimed to find out whether effective practice of *Suryanamaskar* was able to allay the cardiovascular and neurovestibular deconditioning that take place upon exposure to microgravity. **METHODS:** Ten age-matched, healthy participants voluntarily took part in the study. Ethical clearance and informed consent were obtained. After initial baseline reading of their responses to Head-up tilt and a disorientation run on Barany's chair mode to calculate the Coriolis Time Interval, the responses were re-evaluated after exposure to 4 hours of microgravity by Head-down tilt, before and after practice of *Suryanamaskar* for 21 days. The findings were then compared using repeated measures ANOVA and paired t-tests. **RESULTS:** Mean age of the participants was 34.2 ± 3.9 years. The findings

suggested that there were significant reductions in heart rate (-5.8 beats/min), systolic blood pressure (-3.1 mm Hg), mean arterial pressure (-2.8 mm Hg) and increase in pulse pressure (+2.1 mm Hg) after yogic intervention on exposure to microgravity. The comparisons of diastolic blood pressure, Coriolis time interval and motion sickness rating scale evaluation pre and post *Suryanamaskar* practice did not yield statistically significant results.

DISCUSSION: Yoga is an easy, economic, less space occupying, and effective way to mitigate the cardiovascular changes that take place in space and the outcome of this study gravitates its usefulness. However, repeated trials, both on ground and during short duration space missions, are necessary to validate the outcome and implement use of *Suryanamaskar*, both pre-flight and in-flight, as a countermeasure to microgravity induced physiological deconditioning.

Learning Objectives

1. The study is concentrated on looking for ways to improve human efficiency and to detect whether short term effects by practicing yoga has beneficial outcome on astronauts' physiological conditioning. It will provide an idea of effectiveness of practice of *Suryanamaskar* to allay the deconditioning induced by microgravity.
2. The audience will be able to learn about a technique which can be an easy alternative / adjunct to numerous bulky and heavy equipment necessary to be carried on board for astronaut's protection against the discussed physiological compromise.

[130] CHANGES IN PERFORMANCE AND BIO-MATHEMATICAL MODEL PERFORMANCE PREDICTIONS DURING 45 DAYS OF SLEEP RESTRICTION IN A SPACEFLIGHT ANALOG

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¹NASA Ames Research Center, Moffett Field, CA, USA; ²San Jose State University Research Foundation, Moffett Field, CA, USA

(Original Research)

INTRODUCTION: Lunar crews are likely to be comprised of small groups of individuals living in confined spaces for more than a month at a time, and mission support personnel may not be consistently available to assist crewmembers. Prior spaceflight missions have established that crewmembers achieve less than the recommended number of hours of sleep per night on Earth; however, it is unclear whether short sleep in space among highly motivated individuals relates to performance changes. Furthermore, it is unclear whether bio-mathematical models that are used to design work schedules on Earth can accurately predict performance in isolated and confined operational environments. **METHODS:** We studied crewmembers over 45 days during a simulated space mission that included five hours of sleep opportunity during the week and eight hours of sleep on weekends to characterize changes in performance on the psychomotor vigilance task (PVT) and subjective fatigue ratings. We further evaluated how well bio-mathematical models designed to predict performance changes due to sleep loss compared to objective measures of performance. **RESULTS:** We studied 20 individuals during five missions and found that objective performance, but not subjective fatigue declined from the beginning to the end of the mission. We found that bio-mathematical models were able to predict average changes across the mission but were less sensitive at predicting average performance changes throughout the day. **DISCUSSION:** Our findings suggest that sleep should be prioritized in lunar crews to minimize the potential for performance errors. Bio-mathematical models may be useful tools for crews to schedule their sleep and activities during lunar missions.

Learning Objective

1. The participant will understand the capabilities and limitations of using bio-mathematical models to predict human performance changes in the spaceflight environment.

[131] THE PERFORMANCE OF CARDIOPULMONARY RESUSCITATION IN HYPOGRAVITY SIMULATION: DO GENDER DIFFERENCES AND CPR EXPERIENCE INFLUENCE OUTCOMES?

Sindujen Sriharan¹, Gemma Kay¹, Yu Chan Lee², Ross Pollock¹, Thais Russomano¹

¹King's College, London, London, United Kingdom; ²King's College, London, Singapore, Singapore

(Original Research)

INTRODUCTION: Limited research exists into extra-terrestrial CPR despite the drive for interplanetary travel. There is also a clear lack of knowledge on the influence of gender on extra-terrestrial CPR. This study investigates whether the terrestrial CPR method can provide quality external chest compressions (ECCs) in line with the 2015 UK resuscitation guidelines in simulated hypogravities. It also explored whether gender and CPR experience influence CPR quality in these environments. **METHODS:** 21 participants performed continuous ECCs for 5 minutes in the simulated hypogravities of Mars (0.38Gz) and the Moon (0.16Gz) with Earth's gravity (1Gz) as the control. Participants were unloaded using a body suspension device (BSD). ECC depth and rate were measured. Heart rate (HR), ventilation (VE), VO₂ and Borg scores were also measured. One and two-ANOVAs was used to assessed statistical significance. The study was done in accordance with the Declaration of Helsinki. **RESULTS:** ECC depth was significantly lower in 0.38Gz (42.9±9mm, p<0.001) and 0.16Gz (40.8±9mm, p<0.001) compared to 1Gz (51.2±9.2mm). ECC depth significantly decreased by minute 5 in 0.38Gz and by minute 2 in 0.16Gz. ECC rate was adequate in all gravity conditions. There were significant increases in HR, VE and VO₂ when comparing CPR minute 1 and 5. There were no significant differences in ECC depth and rate when comparing gender or CPR experience. Simulated weight was shown to be a predictor of ECC depth (r²=0.2, p<0.001). **DISCUSSION:** The terrestrial method of CPR does not provide adequate ECC depth in keeping with 2015 guidelines due to reduced effective body weight, however, ECC rate remains consistently satisfactory. Prolonged ECCs cause a decline in ECC depth in simulated hypogravities due to fatigue and thus regular changing of rescuers is warranted. In addition, gender and prior CPR training were not found to be associated with improved ECC outcomes and this gives confidence that males and females can work safely as a team when performing CPR in hypogravity. Given the findings, space-specific guidelines with increases in ECC rates should be considered and future studies should investigate the use of mechanical CPR devices in extra-terrestrial environments.

Learning Objectives

1. The audience will learn about the use and efficacy of the terrestrial method of CPR in simulated hypogravity environments.
2. The audience will learn about the influential factors to providing quality CPR in simulated hypogravity environments.

Tuesday, 05/19/2020**10:30 AM****Centennial IV****[S-29]: PANEL: NAVY RAM GRAND ROUNDS****Chair: Nathan Almond****Co-Chair: Kimberly Everett**

PANEL OVERVIEW: This panel is aerospace medicine resident grand rounds to include case reports by the residents.

[132] MILITARY FIXED-WING NAVIGATOR WITH GALACTOSE-ALPHA-1,3-GALACTOSE NON-MAMMALIAN MEAT TICK RELATED ALLERGY (ALPHA-GAL)

Karl Kingry¹, De Cecchis Daniel¹¹NAMI, Pensacola, FL, USA*(Education - Case Study: Clinical / Human Performance)*

INTRODUCTION: This is a case report describing a military fixed-wing navigator with galactose-alpha-1,3-galactose non-mammalian meat tick related allergy (alpha-gal). **BACKGROUND:** The true prevalence of this syndrome is unknown but it is estimated to be as high as 10% in the U.S.¹ In areas with a high prevalence of ticks associated with this syndrome, idiopathic anaphylaxis should raise clinical suspicion of this syndrome. As this condition is now recognized in the Americas, Asia, Europe, and Australia, this syndrome is of rising public health concern. **CASE PRESENTATION:** The subject is a 32 year-old USMC navigator with over 1,600 total flying hours who first presented in anaphylactic shock of unknown etiology in the squadron

hangar. The patient was immediately transferred to off base emergency services via personal vehicle with the flight surgeon in attendance. In route decompensation required self-administration of epinephrine resulting in immediate reduction in respiratory compromise. On next day follow-up, the aviator immediately underwent a downing physical. The patient was referred to Naval Medical Center Portsmouth on temporary duty for an allergy workup. With astute clinical suspicion, the allergist uncovered an important environmental exposure leading to the diagnosis of alpha-gal delayed onset anaphylaxis. **DISCUSSION:** The most significant operational concern associated with this allergy is going undiagnosed resulting in an in-flight anaphylactic episode which could easily result in a mishap. For reference, the median time from the onset of symptoms to diagnosis in the U.S. in 2017 was 7.1 years.¹ Desensitization can occur in these at risk individuals which was once not though possible. Personal protective equipment and insect sprays will drastically reduce recurrence in previously sensitized individuals. After an extensive aeromedical evaluation process, the navigator was recommended for a waiver for all duties involving flight. **RESOURCE:** 1. Jackson, W.L. "Mammalian meat allergy following a tick bite: a case report." *Oxford Medical Case Reports*. Feb 21, 2018 (2): omx098. doi: 10.1093/omcr/omx098. Approved for public release; distribution is unlimited. The views expressed herein are those of the authors and do not necessarily reflect the official position of the Department of Defense or its components.

Learning Objectives

1. The participant will be able to correlate the history and physical surrounding a patient with delayed anaphylaxis with a possible diagnosis of alpha gal.
2. The participant will be able to provide preventive measure counseling to a patient with possible alpha gal to reduce the risk of future anaphylactic episodes.

[133] A HETEROGENEOUS, ILL-DEFINED WHITE MATTER FRONTAL LOBE LESION THAT PRESENTED AS NAUSEA AND VOMITING IN A STUDENT PILOT: A CASE REPORT

Sadie Henry¹¹USN NAMI, Pensacola, FL, USA*(Education - Case Study: Clinical / Human Performance)*

INTRODUCTION: This case report describes a student pilot with a chief complaint of nausea and vomiting, a common condition in student aviators that ended up being a brain tumor. **BACKGROUND:** Nausea is a common complaint in student aviators but it is important to keep a wider differential if that nausea and vomiting does not improve with standard interventions. **CASE PRESENTATION:** The subject pilot was a 24-yr old Saudi Arabian student pilot. He originally presented to the flight surgeon with several week history of nausea and vomiting. The spells of nausea are discrete that last for a few minutes followed by occasional vomiting, then resolve spontaneously approximately twice a day. He was worked up by GI and eventually got a MRI of his brain. The MRI demonstrated heterogeneous non-enhancing lesion involving the left posterior frontal lobe. He was sent to the neurology clinic for further evaluation and management. He has no seizure history. No myoclonus. No past trauma or CNS infections. He denied vision disturbance, no focal weakness, numbness, or tingling. He denies headache, lightheadedness, or dizziness. No reports of fever, chills, night sweats, or unexplained weight loss. He did endorse weight loss due to nausea and vomiting and general lack of appetite. His past medical and surgical history was unremarkable. No significant family history. He is single without children. No tobacco or alcohol use. He had a completely normal physical exam including a complete neuro-exam. His labs were fairly unremarkable as well including normal: serum magnesium, lipase, Hemoglobin A1c, Corticotropin, cortisol, parathyroid, and comprehensive metabolic panel with normal kidney and liver function. Urine drug screen was normal. His Free T4 was elevated at 1.24 and his Thyroid stimulating hormone (TSH) was elevated at 5.4. Vitamin D levels were extremely low at 11.7. He was referred to a NeuroSurgeon for care. He was grounded by the flight surgeon and directed to seek care by his Embassy in Texas. **DISCUSSION:** This case highlights the potential complex pathology hidden among seemingly benign and commonplace symptoms. It is important to keep a wide differential when what seems common does not resolve with standard practice.

Learning Objectives

1. The participant will be able to correlate the history and physical surrounding a patient with wide differential diagnosis.
2. The participant will be able to be familiar with a work up of unresolved case of nausea and vomiting.

[134] IDIOPATHIC ACUTE EOSINOPHILIC PNEUMONIA IN A NAVY PILOT

Ryan Baxter¹, Sean O'Mara²

¹NAMI, Pensacola, USA; ²NAMI, Pensacola, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This is a case report describing a fixed-wing Navy Pilot presenting with Idiopathic Acute Eosinophilic Pneumonia (AEP). **BACKGROUND:** AEP is characterized by a healthy individual experiencing acute illness of less than four weeks manifested by nonproductive cough, dyspnea, and fever. Numerous drug and toxin interactions, neoplasms, and organism infections must be excluded as well. Hypoxemic respiratory insufficiency is often identified at presentation and may become life-threatening. **CASE PRESENTATION:** A healthy 33 year old male pilot presented with 10 days of flu like symptoms. The patient was treated for CAP however he followed up in 6 days with worsening shortness of breath and admitted and after improvement discharged on day 3 with oral Levaquin. Four days later his dyspnea and cough returned and he was admitted to the ICU. Failing mechanical ventilation, he was transferred for ECMO and presumptive AEP diagnosed. After starting high dose steroids, clinical improvement was dramatic. The patient was discharged on hospital day 13 on a steroid taper. All follow-up tests returned to normal reference ranges. The patient has had no relapses and a waiver to return to flying was granted. **DISCUSSION:** AEP is a rare condition, but typically in seen in previously healthy individuals aged 20-40, with males affected twice as frequently as women. 63% of patients require mechanical ventilation. Given the severity and the fact that the condition is seen in a population and demographic common in Naval aviation, eosinophilic pneumonia is an important condition to keep on your differential. Patients that use tobacco products, inhaled chemical exposure, or take certain medications are at higher risk for developing eosinophilic pneumonia. Recognizing and diagnosing the condition early can greatly improve the outcome. Approved for public release; distribution is unlimited. The views expressed herein are those of the authors and do not necessarily reflect the official position of the Department of Defense or its components.

Learning Objective

1. The participant will be able to identify the history/physical and basic lab/imaging markers that would warrant inclusion of Idiopathic Acute Eosinophilic Pneumonia in the physician's differential.

[135] RAM INTERESTING CASES PANEL - FLICKER VERTIGO

Daniel Liddell¹, Daniel Monlux¹

¹Naval Aerospace Medicine Institute, Pensacola, FL, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This is a case report describing a 24-year-old Marine Corps Helicopter Crew Chief with reported transient episodes of symptoms consistent with flicker vertigo. **BACKGROUND:** Flicker Vertigo or Flicker-Induced Vertigo is a largely unstudied condition with a limited volume of dedicated literature. Because of this, the underlying pathophysiologic process, risk factors, effective means of diagnosis, and any potential means of treatment or prevention are of limited understanding. Furthermore, the implications for continued flight service by the effected individual is not explicitly addressed, presenting an admittedly rare but noteworthy challenge. **CASE PRESENTATION:** The subject is a 24-year-old Marine Corps Helicopter Crew Chief with approximately 1,200 total flying hours with reported transient episodes of altered mental status associated with uncontrolled diffuse muscular rigidity and loss of vision. Symptoms had reportedly occurred on approximately 5 separate dates over the preceding year, each time being provoked in an identical scenario – during initial turn-up sequence, standing in position beneath the spinning rotor arc of a CH53E at the approximate 2 o'clock position off the aircraft nose, Sun high in the sky, upon staring at a blank section of grey aircraft fuselage

just aft of the right crew door he would begin to experience a flickering of light as sunlight passed through the spinning rotors and reflected off the aircraft. He experienced an initial period of progressive vision loss, followed by diffuse generalized muscular rigidity and uncontrolled neck extension. He denied falling or losing control of posture and noted that upon complete vision loss all symptoms would spontaneously and instantaneously resolve. **DISCUSSION:** The primary concern regarding spatial disorientation of any kind in the context of aviation is the inability to correctly interpret aircraft position, attitude, and airspeed. Add the component of transient loss of muscular function/control as exemplified in this case, and the possible ramifications in flight are significant and potentially tragic. Due to its clinical rarity – be that due to underreporting, underdiagnosing, or unawareness, this condition may be misdiagnosed or missed entirely. Knowledge of this condition and its presentation may afford accuracy of future diagnosis and further inquiry regarding implications for flight.

Learning Objectives

1. The participant will gain a better understanding of potential history and presentation of symptoms of flicker vertigo.
2. The participant will be able to develop a differential diagnosis for flicker vertigo and correlate the impact on safety of flight.

[136] NAVY FIGHTER PILOT RETURNED TO DUTY WITH RESIDUAL ANTERIOR MEDIASTINAL MASS: A CASE REPORT

Jami Buckley¹

¹NAMI, Pensacola, FL, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This case report details a fighter pilot returned to flight status with a residual anterior mediastinal mass after lymphoma treatment. **BACKGROUND:** Increasing numbers of aviators are being returned to flight status after cancer diagnoses. Many authorities require that the members be completely asymptomatic without a significant risk of recurrence or complication. Lymphomas are associated with residual masses which can be difficult to characterize. Risk mitigation is paramount. **CASE PRESENTATION:** A 30 year old male presented with shortness of breath and chest pain with exercise. On imaging he was found to have a 6cm anterior mediastinal mass (AMM). A biopsy returned as diffuse large B-cell lymphoma (DLBCL). Final staging placed him at IIax, bulky disease with an International Prognostic Index of low risk. Treatment was with dose-adjusted etoposide, prednisone, vincristine, cyclophosphamide, doxorubicin, and rituximab (DA-EPOCH-R). After six cycles he met criteria for clinical remission. However, his AMM—though much smaller—was still present. Due to his initial presentation of exercise intolerance, concerns remained over risks of the patient returning to tactical flight. Pulmonology deemed he had normal pulmonary function tests. Cardiology completed an echocardiogram, stress test, and Holter monitor—all normal. The aviator was sent to repeat centrifuge testing to increase confidence that the residual AMM would not compromise G-tolerance or cause arrhythmias. He completed a profile up to 7.5 Gs without any abnormalities in his electrocardiogram and no episodes of light loss in his vision. The patient was granted a waiver to return to fighter aviation with appropriate oncological follow up required. He has been flying the full spectrum of missions without any symptoms for the past several months. **DISCUSSION:** This case illustrates risk mitigation with many unknowns. Currently there are no other known cases of pilots flying high-G aircraft with residual AMMs. Masses within this area are of concern because of the risks of cardiopulmonary compromise due to mass effect or potential arrhythmias in the case of tumor cardiac infiltration. In a dynamic flight environment, a decrease in G-tolerance and increased risks of hypoxia and arrhythmia are not of trivial concern. However, with tools such as centrifuge training and cardiopulmonary testing, a reasonable amount of confidence can be ascertained prior to returning an aviator to flight status.

Learning Objectives

1. The audience will learn about physiological concerns of anterior mediastinal masses in a high-G flight environment.
2. The audience will understand one method of testing that can be done to evaluate cardiovascular concerns for pilots.

[137] TOXOPLASMA CHORIORETINITIS IN A NAVAL AVIATORJeremy McCullough¹¹Naval Aerospace Medical Institute, Pensacola, FL, USA*(Education - Case Study: Clinical / Human Performance)*

INTRODUCTION: The scope of this case is to discuss the aeromedical implications of toxoplasma chorioretinitis. **BACKGROUND:** Toxoplasma gondii, an intracellular protozoan parasite, has three major genotypes that vary in virulence and geographical distribution. In the USA, the prevalence of T.gondii seropositive individuals is approximately 11%. Of these individuals, only 2% will develop chorioretinitis. T.gondii infection is the most common cause of chorioretinitis in the U.S. The main presenting symptoms for toxoplasma chorioretinitis are visual acuity loss and floaters. If the infection involves the macula, visual acuity will be severely impacted. If the infection does not involve the macula, floaters are a more common presentation. Examination of the eye during an acute infection will demonstrate extensive iritis and vitritis. The presence of flat whitish retinal lesions should help guide the diagnosis of chorioretinitis. These whitish retinal lesions frequently leave retinal scars that may be seen on routine examinations after the infection has resolved. Most cases of toxoplasma chorioretinitis will resolve spontaneously in four to eight weeks. **CASE PRESENTATION:** This is a 27 y.o. male helicopter crew chief that initially presented to primary care for evaluation of migraine headaches. His work up included an eye exam by an optometrist where a large retinal scar was identified in his left eye. The patient denied any history of floaters or changes in visual acuity. The patient was subsequently referred to a retinal specialist who documented the left eye had "good foveal light reflex with a large chorioretinal scar along the superotemporal arcade, no vitreous cell, and flat periphery flat 360." Based on the location and appearance of the chorioretinal scar the retina specialist deemed it likely secondary to "toxoplasmosis with corresponding non-central visual field defect with good UCVA." It was recommended for the patient to have an annual eye examination and to use a home amsler grid. **DISCUSSION:** The disposition of naval aviators with a history of toxoplasma chorioretinitis is dependent on the extent of any visual field loss or impact to visual acuity. Waivers are considered on a case by case basis. This patient has excellent visual acuity with a left visual field defect resulting from the retinal scar. However, his final disposition is complicated by a diagnosis of migraine with aura.

Learning Objective

1. The scope of this case is to discuss the aeromedical implications of toxoplasma chorioretinitis.

Tuesday, 05/19/2020**10:30 AM****Regency 6**

[S-30]: PANEL: PRE-CLINICAL RESEARCH & EFFECTS OF HYPOBARIA DURING AEROMEDICAL EVACUATION

Chair: Anke Scultetus**Co-Chair: Catriona Miller**

PANEL OVERVIEW: During recent conflicts, aeromedical evacuation (AE) has been demonstrated to be an effective way to rapidly evacuate patients to the continental U.S. (CONUS). While there appears to be minimal to no mortality during an AE, there is a dearth of knowledge on the possible adverse effects associated with hypobaria, hypo- or hyperoxia and vibration during extended transport. Clinical providers along the continuum of care over the past 19 years have reported neurological degradation in wounded warriors with TBI and unexplained physiological complications concerning for the potential adverse effects of CCATT and aeromedical evacuation. Data related to these observations will be presented. During the panel we will also provide an update on the most recent findings on the effects of the stressors of flight in various laboratories, across multiple pre-clinical injury models in different species, and correlate them with clinical observations made by active duty combat surgeons throughout the continuum of care. Exposure to hypobaria following traumatic brain injury (TBI) and hemorrhagic shock increased organ damage and mortality. Moreover, hypobaria adversely affected

behavior and increased neuroinflammation in ferret polytrauma models. In a swine model of TBI with multiple flights, physiological instabilities were observed in the hypobaria animal group compared to normobaric control animals several hours into the flight, and there was a significant increase in white blood cells several days after the second flight. In a rat model of blast TBI with hypobaria and vibration we discovered that vibration reduced organ damage and modulated the inflammatory response. Overall, these clinical observations and basic science results could provide a possible explanation for unexplained clinical degradations upon arrival at CONUS hospitals or military treatment facilities, and upon further investigation could provide a platform for revisions of current clinical practice guidelines. Note: We are submitting 6 abstracts for 10 min presentations each to allow for ample discussion time.

[S-30-A] CLINICAL OBSERVATIONS AFTER CCATT TRANSPORTDebra Malone¹, Jennifer Gurney²¹WRNMMC/USUHS/NMRC, Bethesda, MD, USA; ²ISR, San Antonio, TX*(Education - Program / Process Review Proposal)*

BACKGROUND: During recent conflicts, aeromedical evacuation (AE) including Critical Care Air Transport Team (CCATT) transport has been demonstrated to be an effective way to rapidly evacuate patients to the continental United States (CONUS). While there is evidence for minimal mortality associated with AE, there is concern for considerable morbidity amongst clinicians who have cared for these patients over the continuum of care. **OVERVIEW:** Clinicians stationed at LRMC and in CONUS who have cared for wounded warriors during the continuum of en route care were surveyed as related to the comparison between patient physical exam just prior to and just after AE. The JTS DOD Trauma Registry (DODTR) data as related to physical exam (e.g., GCS) prior to and immediately after CCATT were examined in relation to key injury diagnoses. JTS Case studies were reviewed. **DISCUSSION:** Clinicians surveyed reported perceptions of discrepancies in physical exam findings pre and post AE with CCATT. This was most often noted to be declines in GCS for patients with TBI. Major wounds (e.g., traumatic amputations) were often noted to be infected/necrotic after AE compared to before AE. JTS Case Studies occasionally demonstrated support for complications after CCATT. DODTR data was incomplete as related to pre- and post- AE exam findings. Critical patient diagnoses were not always documented in the DODTR. **CONCLUSIONS:** Clinicians surveyed verbalized perceptions of declines in physical exam after CCATT for wounded warriors. This is consistent with recently published data suggesting that worst outcome, including increased mortality is associated with expedited CCATT transport. DODTR data is incomplete regarding this investigation. Future studies will include in-depth patient chart reviews so as to complete patient records related to CCATT transport so that a more in-depth evaluation of potential complications can be performed.

Learning Objectives

1. The learner will be able to list 3 diagnoses potentially linked to CCATT transport.
2. The learner will describe clinical concerns with transport at altitude.
3. The learner will be able to list 3 mitigating factors for potential complications associated with CCATT transfer.

[138] EFFECTS OF AIR-EVACUATION-RELEVANT HYPOBARIA ON FERRETS FOLLOWING POLYTRAUMAGary Fiskum¹, Juliana Medina¹, Julie Proctor¹, Su Xu¹, Rao Gullapalli¹, Molly Goodfellow¹, Parisa Rangghran¹, Catriona Miller¹¹University of Maryland School of Medicine, Baltimore, MD, USA*(Original Research)*

INTRODUCTION: Rats exposed to aeromedical evacuation (AE) relevant hypobaria within seven days after traumatic brain injury (TBI) alone or in combination with hemorrhagic shock (HS) exhibit greater neurologic injury and mortality than those maintained under normobaria. The applicability of these results to humans may be limited, however, by differences in brain neuroanatomy. Like humans, ferrets have a gyrencephalic brain. We therefore developed a ferret polytrauma (PT) model consisting of controlled cortical impact (CCI) followed immediately

with mild HS. The objective was to determine if the deleterious effects of AE-relevant hypobaria observed in rats after TBI are also observed in a distinctly different species with a gyrencephalic brain. **METHODS:** The ferret PT model was very similar to our rat PT model. Anesthetized adult male ferrets were subjected to CCI and HS by withdrawing blood to maintain MAP 35-45 mm Hg for 30 minutes. Resuscitation with Hextend was followed one hr later by blood re-infusion. At 24 hr, ferrets were placed in a "flight" chamber for 6 hr and exposed to normobaria or to hypobaria (=8000 ft) under normoxic conditions (21-28% O₂). MRI and MRS measurements were performed prior to injury and 2 days later. Behavioral tests included a novel object location test for evaluation of spatial memory. Brains were perfusion-fixed on day 7, immunostained for IBA-1 (microglia) and used for quantification of cortical lesion volume and activated microglia in the penumbra. **RESULTS:** In contrast to our rat PT model that results in 30-60% mortality, no ferret deaths occurred. Ferrets exposed to hypobaria after PT performed worse on the novel object location test compared to those maintained under normobaria. The lesion volume, expressed as a percent of total cortical volume, was similar to that of rats, whereas microglial activation was more extensive. MRS results obtained at 48 hr indicate significant reduction in cortical levels of creatine, N-acetyl aspartate, GABA and glutamate after polytrauma. **CONCLUSIONS:** To our knowledge this is the first ferret polytrauma model combining CCI plus hemorrhagic shock. Despite neuropathology that was comparable to that of rats, there was no ferret mortality. Preliminary results indicate that exposure to hypobaria adversely affects behavior and may increase neuroinflammation. Acknowledgments: Supported by US Air Force FA8650-15-2-6D21.

Learning Objectives

1. The participant will learn about animal polytrauma models indicating that exposure to aeromedical evacuation-relevant hypobaria following trauma can worsen outcomes, including mortality, behavior, neuroinflammation, neurochemical alterations, cerebral blood flow and multi-organ dysfunction.
2. The participant will learn about responses of different species to aeromedical evacuation-relevant hypobaria following polytrauma. Specifically, the participant will understand the differences between the gyrencephalic brain present in humans, ferrets, and swine and the lissencephalic brain present in rodents.

[139] AEROMEDICAL EVACUATION RELEVANT HYPOBARIA-INDUCED OXIDATIVE STRESS IN RATS WITH MILD TRAUMATIC BRAIN INJURY FACILITATES HOMOCYSTEINE TRANSULFURATION

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(Original Research)

BACKGROUND AND OBJECTIVE: Hyperhomocysteinemia (hhcy) is a stress biomarker with neurotoxic properties. Hhcy results from the accumulation of the non-proteinogenic amino-acid homocysteine and was reported in people who stayed at high altitude starting at 7500 ft. Similarly, injured service members are often aeromedically evacuated at high altitude (8000 ft) for advanced medical care. Herein, we examined the effects of aeromedical relevant hypobaria (HB) on hcy metabolism and related oxidative stress markers. **METHODS:** Adult Sprague Dawley rats were subjected to mild traumatic brain injury (mTBI) by Controlled Cortical Impact (CCI) method or sham surgery. The next day, they were exposed to experimental-HB at 8000-ft and 28% oxygen or normobaria (NB) as control for 6h. Thereafter, rats (n = 8/group), were tested for anxiety-like behavior and for working memory performance. Other rats (6/group) received intraperitoneal injections of 2-dihydroethidium (6mg/kg), to track ROS formation during HB exposure. Plasma and brain tissues were collected for histological and biochemical analyses. Statistical analysis was performed by one-way ANOVA with Tukey-Kramer post-test analysis. **RESULTS:** Plasma hcy levels were very low to undetectable in HB-rats 2-hours post-exposure. This was associated with significant increase in malondialdehyde levels compared to NB-CCI and sham rats (p < 0.01). In addition, brain sections of these HB-CCI rats showed greater number of HDE incorporated cells compared to HB-sham and NB-CCI rats (p < 0.05). Increased oxidative stress markers resulted in 2.5-fold increase in oxidized glutathione (p < 0.05) and gene expression analysis demonstrated was

driven by the upregulation of glutathione metabolizing genes glutathione synthase and glutathione peroxidase. Lesion volume measurements found relative increase in the HB-CCI rats 24-hours post-exposure. This was significantly resolved in both HB and NB CCI rats at day-30 post-exposure (p < 0.01). Behavioral assessments showed that HB exposure worsened anxiety like behavior in CCI rats (p < 0.05). **CONCLUSIONS:** HB exposure facilitated hcy trans-sulfuration resulting in increased glutathione oxidation in response to HB-induced oxidative stress. Aggravated injury lesion by HB resolved 30-days post-injury, suggesting stress-induced increased glutathione metabolism as a compensatory neuroprotective mechanism to mitigate the effects of HB exposure on mTBI neuropathology.

Learning Objective

1. To learn about ongoing research in the field of aeromedical medicine and stay current on the impact of aeromedical evacuation simulated experiments on different pathological conditions.

[140] ADDING VIBRATION TO HYPOBARIA IN A RAT BLAST MODEL REDUCES TISSUE DAMAGE AND MODULATES THE INFLAMMATORY RESPONSE COMPARED TO HYPOBARIA ONLY

Yaron Dayani¹, Ye Chen¹, Joshua Stierwalt², Jordan Hubbell¹, Françoise Arnaud¹, Michelle Jefferson³, David Burch⁴, Carl Goforth¹, Debra Malone², Anke Scultetus¹

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(Original Research)

INTRODUCTION: Aeromedical evacuation (AE) is a rapid and effective way to evacuate patients to higher levels of care. However, little is known about the effects of AE and its associated potential stressors such as hypobaria and vibration on patients with blast and other injuries. In the current study, we investigated the effects of hypobaria and vibration on histopathology and inflammatory response in rats exposed to blast overpressure (BOP) as a model of polytrauma injury. **METHODS:** Anesthetized male Sprague Dawley rats were exposed to BOP of 110kPa. After 48hrs, animals underwent a 12-hour simulated AE flight in a hypobaric chamber with simulated cabin pressure equivalent to long-range fixed wing flights (8,000 ft. altitude; HYPO group) or at sea level (NORMO group), with, or without simulation of constant vibration (mimicking the vibration in a C-130 during flight). Control animals underwent the same experiments but without injury (SHAM). 48 hours after flight, peripheral blood was sampled via cardiac puncture from the anesthetized animal for cytokine analysis. Animals were then euthanized, perfused, and organs were harvested for histopathologic analysis. **RESULTS:** Injured animals exposed to HYPO had more tissue damage in the intestine (p<0.001) and the brain (p<0.01) compared to NORMO. Overall tissue damage in HYPO animals that also underwent vibration was markedly reduced, and was statistically significant in lungs (p<0.01), heart (p<0.01) and intestine (p<0.001) compared to animals with hypobaria only. Similarly, animals exposed to hypobaria with vibration had a decrease in pro-inflammatory markers and increase in anti-inflammatory markers compared to hypobaria only. **DISCUSSION:** In this pre-clinical study of polytrauma injury, the reduction of histopathologic injury in animals exposed to hypobaria and vibration paired with the response of the immune system, suggests that vibration potentially attenuates injury severity via immune response modulation.

Learning Objective

1. The effect of vibration during aeromedical evacuation.

[141] INDUCTION OF ENDOTHELIAL BARRIER DYSFUNCTION BY SERUM FACTORS OF TRAUMATIC BRAIN INJURY IN RAT

Yunbo Ke¹, Julie Proctor¹, Juliana Medina¹, Catriona Miller², Junghyun Kim¹, Thomas Grissom¹, Anna Birukova¹, Gary Fiskum¹, Konstantin Birukov¹

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(Original Research)

INTRODUCTION: Acute respiratory distress syndrome (ARDS) can be induced by traumatic brain injury (TBI). Breach of lung endothelial cell (EC) barrier leading to pulmonary edema is a key feature of ARDS. Potential effects of hypobaria (HB) associated with air-evacuation of wounded personnel on severity of TBI-induced lung injury and breach of lung blood-gas barrier remain unknown. This study tested direct effects of serum factors from a rat model of experimental traumatic brain injury on permeability and inflammatory response by the lung EC. **OBJECTIVE:** To gain insight into mechanisms linking traumatic brain injury (TBI) and hypobaric exposure with development of ARDS. **METHODS:** The adult male rat polytrauma model consisted of controlled cortical impact (CCI)-induced TBI followed by 30 min of hemorrhage shock (HS) caused by blood withdrawal. The HS phase was followed by a 1-hr resuscitation phase and a 1-hr "hospital phase" when shed blood was reinfused. Then the animals were exposed to either HB or NB conditions. Serum samples were collected and tested in EC in vitro permeability assays. **RESULTS:** Treatment with serum from TBI exposed to both, HB and NB conditions, but not sham-operated animals, caused profound lung EC barrier dysfunction reflected by decrease in transendothelial electrical resistance (TER) and accumulation of fluorescently labeled FITC-avidin tracer under EC monolayers. In addition, HB significantly decreased survival rates compared to NB group. Further analysis indicated that thrombin was responsible for a transient early-phase barrier disruptive activity in TBI-serum, because both, thrombin inhibitor and thrombin receptor antagonist attenuated acute, but not late phase of EC permeability. In contrast, both the early and late-phase EC barrier disruptive effects were inhibited by preincubation of serum samples with heparin-sepharose and partially inhibited by sphingosine 1-phosphate receptor inhibitor AUY954. **CONCLUSION:** Serum from the TBI rats contain both early and late-phase barrier disruptive activities. Thrombin mediates the early phase barrier disruption by TBI sera. Studies are underway to identify late phase disruptive factors activated by hypobaric conditions and define severity of injury and associated levels of vascular barrier dysfunction.

Learning Objectives

1. Traumatic brain injury (TBI) may induce acute respiratory distress syndrome (ARDS) and the circulatory factors may be responsible for the development of the ARDS induced by TBI through interruption of normal endothelial barrier integrity.
2. Thrombin, a coagulant is one of the circulatory factors responsible for TBI induced endothelial barrier dysfunction. However, there are more important factors contributing to endothelial barrier dysfunction remain unknown.
3. TBI-induced endothelial barrier dysfunction can be partially reversed by an S1P receptor agonist AUY954.

Tuesday, 05/19/2020**10:30 AM****Regency 8****[S-31]: SLIDE: PERCEPTION IS EVERYTHING****Chair: Deborah White****Co-Chair: Michael Gallagher****[142] RESPIRATORY SYMPTOMS IN RAAF AIR COMBAT GROUP AIRCREW: VARIATION IN SYMPTOMOLOGY BETWEEN DIFFERENT HIGH-PERFORMANCE AIRCRAFT.****Adrian Smith¹**¹RAAF Institute of Aviation Medicine, Adelaide, Australia*(Original Research)*

INTRODUCTION: RAAF operates four high-performance platforms with different breathing systems. Physiological episodes have been reported by F/A-18F and EA-18G aircrew, but infrequently by F/A-18A and BAE Hawk aircrew, attributed to differences in the breathing systems. This study explored the pattern of respiratory symptoms on the different platforms. **METHODOLOGY:** IAM adapted the USAF Respiratory Symptoms Questionnaire looking at coughing, shortness of breath, and

difficulty breathing during and after flight. The anonymous voluntary survey approved by Joint Health Command Low-Risk Ethics Panel was distributed to all Air Combat Group aircrew. **RESULTS:** Responses were received from 132 of 212 eligible aircrew (62%), with balanced representation of all platforms, and good representation from pilots and non-pilot-aircrew. There were no significant meaningful differences in height or weight (t-test, $p < 0.05$), total flying hours (1650-1850 hrs) (t-test, $p > 0.05$), or hours on type (660-900 hrs) (t-test, $p < 0.05$) between the different platforms. Notwithstanding the overall similarity in the sub-groups, 46% of F/A-18F and 60% of EA-18G aircrew reported troublesome coughing during or after flight compared to 12% of F/A-18A and 8% of BAE Hawk aircrew; 37% of F/A-18F and 30% of EA-18G aircrew reported shortness of breath during or after flight, compared to 6% of F/A-18A and 3% of BAE Hawk aircrew; 37% of F/A-18F and 30% of EA-18G aircrew reported difficulty breathing during or after flight, compared to 4% of F/A-18A and 0% of BAE Hawk aircrew. These apparent differences were highly statistically significant (chi square, $p < 0.001$). A significant majority of F/A-18F and EA-18G aircrew (60-90%) reported their respiratory symptoms to be worse than they had experienced on other platforms they had flown previously. **CONCLUSION:** These data demonstrate presentation of respiratory symptoms in a pattern that is consistent with differences in breathing systems design. Importantly, the population studied represents a single-service environment with few differences in reporting bias or safety culture. These results underscore the importance of understanding breathing system design when evaluating respiratory symptoms arising during physiological episodes, and the importance of a MIL-STD-3050-compliant breathing system to mitigate respiratory symptoms during or after flight.

Learning Objectives

1. The audience will understand the importance of oxygen system design as a contributing factor to respiratory symptoms in flight.
2. The audience will appreciate the importance of characterizing symptomatology as a key to understanding the nature of PEs.

[143] CEREBRAL AND PHYSIOLOGICAL RESPONSES TO SUBMAXIMAL EXERCISE IN PILOT TRAINEES IN VARIOUS NORMOBARIC/HYPOBARIC AND NORMOXIC/HYPOXIC CONDITIONS**Mathias R Aebi¹, Nicolas Bourdillon², Grégoire P Millet¹, Denis Bron²**¹Aeromedical Center - Swiss Air Force, Dübendorf, Switzerland;²University of Lausanne, Lausanne, Switzerland*(Original Research)*

INTRODUCTION: In hypoxic environment, cerebral blood flow regulation is vital to maintain adequate oxygen supply to the brain. The present study aimed to evaluate change in cerebral blood flow velocity (MCAv) and its influence on cerebral oxygen delivery (cDO_2) at rest vs. moderate-intensity exercise, in acute normobaric vs. hypobaric normoxic/hypoxic conditions. **METHODS:** Eighteen healthy pilot trainees (26 ± 3 years old, 177 ± 10 cm, and 70 ± 11 kg) performed a 6-min moderate-intensity exercise (1 W/kg, at 80 rpm) on a cycle ergometer (eBike II basic, GE medical systems, Germany) in four randomized conditions (normobaric normoxia, NN; hypobaric hypoxia, HH and normobaric hypoxia, NH at 5000m; and hypobaric normoxia, HN). Inspired oxygen pressure (P_{O_2}) was matched between normoxic (NN vs. HN, 141.2 ± 0.8 vs. 141.5 ± 1.5 mm Hg) and hypoxic (NH vs. HH, 75.7 ± 0.4 vs. 74.3 ± 1.0 mm Hg). Pulse oxygen saturation (SpO_2), heart rate (HR) and MCAv (transcranial Doppler, ST3, Spencer Technology, Seattle, WA) were measured at rest and during exercise as well as rating of perceived exertion (RPE). Repeated measures ANOVAs were performed to assess statistical significance. **RESULTS:** At rest, MCAv was higher in HH (48 ± 7 cm/s) than in NN (43 ± 6 cm/s, $p = 0.022$) and HN (42 ± 5 cm/s, $p = 0.003$). HR was higher and SpO_2 lower in NH and HH than in HN and NN (i.e., hypoxic effect, $p < 0.001$). During exercise, MCAv was higher in HH (57 ± 6 cm/s, $p = 0.01$) than in NN and HN (49 ± 6 and 48 ± 6 cm/s, respectively). Moreover, HH induced greater HR (131 ± 17 bpm, $p = 0.002$) and lower SpO_2 (69.2 ± 5.7 %, $p < 0.001$) than NH (119 ± 15 bpm and 81.4 ± 4.8 %). RPE was higher ($p < 0.001$) in NH (11.3 ± 2.2) and HH (11.8 ± 2.3) compared to NN (8.1 ± 1.3) and HN (9.1 ± 1.3). There was no significant difference in cDO_2 between conditions either at rest or during exercise. No significant difference was reported between NN and HN. **DISCUSSION:** Hypoxemia in NH and HH induced an increase in MCAv to

maintain cDO_2 (Brugniaux *et al.*, 2007). The present results (i.e., lower SpO_2 and greater HR) confirm the more severe condition in HH than in NH (DiPasquale *et al.*, 2015; Savourey *et al.*, 2003). However, the effect of hypobaria seems negligible in normoxic conditions since there was no difference in MCAv, HR and SpO_2 between NN and HN. These findings are of clinical importance for pilots training in flight simulator (i.e. NH) to prepare for flights hypoxic events at real altitude in HH.

Learning Objective

1. The participant will be able to identify some differences in cerebral and physiological responses in young pilot trainees exposed to normobaric and hypobaric hypoxia during submaximal exercise.

[144] MRI/DTI vs. NEUROCOGNITIVE RESULTS IN U2 COHORT: EFFECTS OF AGE, NDCS, & EXPOSURE HOURS

John Sladky¹, Paul Sherman¹, Bianca Cerqueira², Holly Chappapas²

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(Original Research)

INTRODUCTION: Repeated human exposure to extreme hypobaria is associated with increased white matter hyperintensities (WMH) in humans on MRI with decline of axonal integrity as measured by fractional anisotropy (FA) in U-2 pilots, and changes in neurocognitive function compared to Air Force pilots flying other platforms. This analysis assessed whether age, flight hours and/or prior history of neurological decompression sickness (NDCS) had an effect on FA values or neurocognitive performance in U-2 pilots.

METHODS: MRI and neurocognitive data obtained from 103 U-2 pilots prior to the implementation of the CARE program were analyzed. FA values within multiple white matter tracts were obtained from diffusion tensor imaging (n=103). Neurocognitive data was obtained through MAB-II (Multi-dimensional Aptitude Battery) evaluation (n=102) and MicroCog evaluation (n=101). Generalized linear model was utilized to investigate independent effects of age, exposure hours, and prior history of NDCS on either FA, MAB-II or MicroCog metrics. **RESULTS:** Results demonstrate that age was a significant factor for FA values with higher ages correlating with lower FA values for white matter average, corpus callosum body, corona radiata, and thalamic radiation tracts. Exposure hour duration had no effect on FA values and prior history of NDCS was only significant for reduced value in the Internal Capsule. Exposure hour duration correlated directly with improved scores in both picture completion and object assembly testing on MAB-II, and increased reasoning scores on MicroCog. Age had no effect on MAB-II scores but demonstrated increased scores in both attention and decreased scores in spatial processing on MicroCog. History of NDCS revealed reduced MAB-II values in performance (PIQ) and full-scaled intelligence quotient scores (FSIQ), similarities, picture arrangement and object assembly which assess visual spatial abilities. History of NDCS had no impact on MicroCog testing. **DISCUSSION:** In this subgroup analysis of U-2 pilots, increased age was the primary determining factor in reduced FA values, both global and of specific tracts while longer exposure hour duration was shown to be predictive of higher scores in certain cognitive domains of both MAB-II and MicroCog. Pilots with prior NDCS demonstrated reduced overall IQ performance and visual spatial skills on MAB-II but no significant changes on MicroCog.

Learning Objective

1. Understand the impact that age, prior history of NDCS and flight exposure hours has on white matter integrity and neurocognitive testing.

[145] OCCURRENCE OF HEART ARRHYTHMIAS DURING MILD NORMOBARIC HYPOXIA INDUCTION AND LABORATORY TASK/FLIGHT SIMULATION PERFORMANCE

Chad Stephens¹, Juan Beltran², Kellie Kennedy¹, Nicholas Napoli²

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(Original Research)

INTRODUCTION: Aviator medical certification involves assessment of medical standards by an Aviation Medical Examiner (AME). To qualify for a first-class medical certificate, cardiovascular health of a pilot is assessed via electrocardiogram (ECG) allowing the AME to detect

abnormalities/pathology (e.g., heart arrhythmias). Certification standards are in place to ensure aviators are medically fit for duty and serve as a risk mitigation in the event of adverse conditions (e.g., hypoxia due to aircraft cabin decompression). The occurrence of physiological events (PEs), of which hypoxia is one potential contributing factor, in U.S. military aviators underscores the need for medical certification. Understanding effects of workload inducing tasks during physiological stressors on cardiac function informs aviator medical assessment. **METHODS:** Professional pilots served as test subjects (n=57) in a study involving simulated altitudes of sea level (21.0% O₂) and 15,000 feet (11.2% O₂) induced by an Environics, Inc. ROBD. Each subject experienced non-hypoxic and hypoxic exposures while performing three tasks (computerized neuropsychology tests-CFT/CS, computerized multi-tasking battery-MATB, and fixed-based flight simulation-SIM) each 10-minutes in duration. Physiological data (ECG, PPG, and SPO₂) were recorded and temporally synchronized to permit data analysis. The ECG and PPG signals were visually inspected to identify PVCs in accordance with identification methods accepted in the medical research literature to obtain PVC counts. **RESULTS:** Odds ratios were calculated to examine the association between stimulus task and the occurrence of PVCs during hypoxia induction. The odds of PVCs during SIM was estimated to be 6.81 times the odds of PVCs during CFT/CS. The odds of PVCs during SIM was estimated to be 3.18 times the odds of PVCs during MATB. The odds of PVCs during MATB was estimated to be 2.42 times the odds of PVCs during CFT/CS. The 95% CIs are between 0.98 and 22.22, 0.83 and 12.16, and 0.46 and 12.79 respectively. **DISCUSSION:** The occurrence of PVCs during hypoxia induction had a stronger association with the SIM task than with the MATB or CFT/CS. The results indicate that workload induced by stimulus tasks influences the occurrence of PVCs. Considerations for the compounding effects of workload and physiological stressors underscores the necessity of screening for abnormalities/pathology during aviator medical certification as a mitigation against PEs.

Learning Objective

1. The audience will learn about how mild hypoxia exposure can impact operator performance.

[146] APPLYING ADRAC TO GENERAL AVIATION FLIGHT-PLANS >18,000 FEET: UNCOVERING AN UNDERAPPRECIATED RISK OF DECOMPRESSION SICKNESS IN GENERAL AVIATION?

Michael F Harrison¹, M Hassan Murad¹, Gary N Toups¹

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(Original Research)

INTRODUCTION: Decompression sickness (DCS) can occur during flight to altitudes >18,000ft (FL180) in unpressurized aircraft. This has been studied in military and NASA personnel but not in the general aviation (GA) population. Recently, aircraft models capable of flying >FL180 have become very popular and one of these models represents the highest volume GA sold annually for the last 5 years. The risk of DCS in the GA population and the public health impacts of this risk remain unknown. **METHODS:** Data from a one-year period in a commercial flight tracking database was analyzed to identify flight plans flown at >FL180 in unpressurized, piston aircraft in the USA. Data included in the analysis included aircraft model, registration N-number, origin and destination airports, date, peak altitude, and time at FL180 and peak altitude. All N-numbers were cross-referenced through the FAA database to confirm the aircraft was an unpressurized piston model. DCS risk was calculated using the USA Air Force (USAF)'s Altitude Decompression Sickness Risk Assessment Computer (ADRAC). Registration N-numbers were cross referenced in the databases of the FAA and NTSB to identify any incidents or accidents that might be attributable to impairment due to DCS. **RESULTS:** 1699 flights in 22 different aircraft models occurred during the data collection period. The average DCS risk was calculated to be $1.9 \pm 4.2\%$ annually and each aircraft performed an average of 2.8 ± 4.8 flights >FL180. No safety events were identified for any of the aircraft in the dataset during the study period. The airport associated with the greatest proportion of flights >FL180 was Duluth MN (13%), also the site of manufacture for the most popular model of GA aircraft capable of flying >FL180. **DISCUSSION:** An underappreciated risk of DCS incidence in the GA community is present. The present study likely underestimates the magnitude of this population health risk and incidence for a variety of reasons. Further study into this topic is warranted.

Learning Objectives

1. The audience will learn about an underappreciated risk to aviators and passengers in general aviation.
2. The AMEs and other healthcare providers in the audience will learn about DCS, a diagnosis to add to their differential in general aviation pilots flying specific aircraft.
3. The audience will learn about the public health impact of DCS in GA and potential future approaches to mitigate the risk.

[147] CONTINGENCY OXYGEN FLOW RATE FOR SAFE RETURN FROM ANTARCTICA IN THE EVENT OF DEPRESSURIZATIONAmy Kreykes¹, Robert Sanders², Johnny Conkin³, David Alexander⁴¹University of Texas Medical Branch, Galveston, TX, USA; ²Neutral Buoyancy Laboratory, NASA – Johnson Space Center and UTMB, Houston, TX, USA; ³KBR, Houston, TX, USA; ⁴NASA, Houston, TX, USA

(Original Research)

INTRODUCTION: The National Aeronautics and Space Administration (NASA) uses a Gulfstream V (GV) aircraft for science flights over Antarctica from Hobart, Tasmania, Australia. At its furthest point, the aircraft is seven hours from Hobart, flying at an altitude of 25,000ft to conserve fuel. There is enough oxygen to return to Hobart for three crewmembers, but not enough for the four scientists in the cabin. The purpose of this study was to model the risk of decompression sickness (DCS) and to determine an adequate oxygen flow rate for the scientists in the cabin to prevent hypoxia. **METHODS:** A hypobaric chamber at the Neutral Buoyancy Laboratory at NASA was used for this study. Two middle-aged male subjects volunteered. A 15-minute chamber run was conducted at 25,000ft with data measurements including: oxygen saturation using pulse-oximetry, respiratory rate, and observations of functionality of the non-rebreather reservoir. The chamber was taken to 25,000ft and subjects donned non-rebreather oxygen masks, breathing 100% oxygen at a rate of 6L/min. At six, 12, and 14 minutes the flow rates were changed to 4L/min, 2L/min, and 4L/min, respectively. At 15 minutes, the test was terminated, and the chamber returned to sea level. Mathematical modeling using ADRAC and the Tissue Bubble Dynamics Model was used to model the risk of DCS at 25,000ft for 6+ hours. **RESULTS:** Subjects maintained oxygen saturations of 96% or greater and respiratory rates of 12-16. The reservoir of the non-rebreather mask exhibited best performance at an oxygen flow rate of 6L/min. At a flow rate of 4L/min one of the subjects felt self-limited palpitations. Otherwise, the subjects felt well throughout the study. Mathematical modeling indicates there may be up to a 39% risk of DCS during the return flight to Hobart. **DISCUSSION:** In a worst-case emergency depressurization of the GV aircraft over Antarctica with a seven-hour return flight to Hobart, hypoxia could be prevented in the cabin for scientists at an altitude of 25,000ft using non-rebreather masks and 100% oxygen at a flow rate of 6L/min. However, the risk of DCS is up to 39% on this return-flight. Prompt evaluation in Hobart is recommended.

Learning Objective

1. Understand the risk of hypoxia and DCS in the event of depressurization over Antarctica during return flight to Hobart.

Tuesday, 05/19/2020

10:30 AM

Regency 5

[S-32]: PANEL: AVIATION DENTISTRY. DIGITAL ADVANCES & COMMON RELATED ISSUES

Chair: Jose Luis Mompell

PANEL OVERVIEW: INTRODUCTION: According to IATA, in 2017 the estimated number of commercial flights is 36.8 million, not including private, business and military aviation. More than 100,000 flights a day. According to World Health Organization (WHO) 23% of the population received dental treatment in the last 12 months. Many of those patients flew within the following 48h. These both facts together, make Aerospace dentistry a very important medical science to be taken into account. Dentistry as a medical related science, has evolve a lot in the past decades, and aviation related dentistry is no an exception. Some of the most up to the minute topics will be covered in this panel **TOPIC:** Aviation dentistry.

APPLICATIONS: Digital era has arrived to this field, and many changes have happened. The so call digital changes can be applied to aviation dentistry in terms of improving diagnosis, reducing treatment times and doing a more predictable and less invasive dentistry. Presentations about different approaches related to implant dentistry will be showed. they will show how digitalization may play a crucial role in aviation dentistry. Although digitalization is here to stay we can't forget that the most common issues in commercial and military aviation related to aerospace dentistry is barodontalgia and barotrauma, an up to date will be presented in terms of diagnosing and treatment plan. This panel will also present an "interactive" presentation. It will show daily situations at a Flight surgeon/ AME office related to dental care. Would you let this patient flight?

[148] WOULD YOU LET THIS PATIENT FLIGHT?Jose Luis Mompell¹, Juan Lara Chao¹, Daniel Robles², Ramon Dominguez- Mompell³, Rafael Gomez de Diego¹¹University Rey Juan Carlos, Madrid, Spain; ²Univesidad Europea de Valladolid, Valladolid, Spain; ³UCLA, Madrid, Spain;

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: Many patients/aircrew members/military personal may consult to an AME/Flight Surgeon about, present, past or future dental treatments. Dentistry is not normally studied at medical schools leading to a lack of knowledge on how to face certain very common situations in people's daily life. **BACKGROUND:** This presentation will try to provide some kind of guideline of how to act when a patient comes to consultation asking about some of the most common dental treatments performed or to be performed in relation with their future flying plans. **CASE PRESENTATIONS & DISCUSSION:** Cleaning and polishing, Implant treatment, filling, root canal treatment and extractions will be evaluated from a flight surgeon point of view and how this medical acts may affect or not the capability of flying, as a passenger or as a crew member.

Learning Objectives

1. Understand how Aviation dentistry may play a crucial role in aerospace medicine.
2. Learn how to face some of the most dental related situations that may come to an AME/Flight surgeon office.

[149] DIGITAL GUIDE SURGERY IN IMPLANT DENTISTRY: HOW DO OUR TREATMENTS REALLY IMPROVE?Daniel Robles¹, Jose Luis Mompell², Juan Lara²¹Miguel de Cervantes University (UEMC), Valladolid, Spain; ²University Rey Juan Carlos, Madrid, Spain

(Education - Case Study: Clinical / Human Performance)

Currently, digital dentistry and the tools we have made it possible for us to improve our treatments in many ways: precision, accuracy, shorter times, postoperative periods with lower morbidity, aesthetic advantages ... In oral surgery and more concretely, in implant dentistry, the use of surgical guides for Implant placement is something that is not new, given that the first guides appeared more than 15 years ago, with more problems than benefits, but with the technological advances we have: how do our surgeries really improve? Is it really a safe and accurate procedure? Do they really offer benefits for our patients? How are they designed and how are these current designs? The main objective of this communication is to try to answer these questions.

Learning Objectives

1. Learn how the surgical guides can improve the surgical treatments in terms of precision and accuracy, morbidity and time of healings.
2. Learn how the surgical guides must be designed.
3. Learn how is the procedure, from design to performance of a guided surgery.

[150] PREVENTION AND CONTROL OF SURFACE POLLUTION DURING USE OF DENTAL SPRAY. CONSIDERATIONS IN MICROGRAVITY CONDITIONSVÍCTOR L LORO BOADA¹, María Laura Giovanonni¹, Vicente Lozano de Luaces¹¹Universitat de Barcelona, Barcelona, Spain

(Education - Tutorial Proposal)

INTRODUCTION: The use of spray is necessary for the cooling of dental tools and machinery in the practice of dentistry. These aerosols when expelled from the oral cavity can cause environmental and surface contamination around the initial focus. This situation can be aggravated by achieving higher levels of dispersion in microgravity conditions.

TOPIC: The study of the dispersion and levels of pollution produced by the dental spray in controlled environments and the creation and study of containment methods. **APPLICATION:** In future long stays or space trips, the crew must be trained and must be able to treat dental pathologies, using the usual machinery modified for microgravity conditions, without the risk of creating secondary problems in the crew or the ship. It is therefore necessary that we study and give solution to the dispersion of aerosols and their involvement in cross contamination in enclosed spaces.

Learning Objectives

1. The audience will learn about the importance of dispersion of dental aerosols in enclosed spaces.
2. The audience will learn about the dispersion control systems of dental sprays outside the oral cavity.
3. The participant can understand the need to control and avoid contamination of surfaces around the focus of dental spray dispersion.

[151] THE IMPORTANCE OF PERIODONTAL DISEASE IN MICROGRAVITY

Maria Laura Giovannoni¹, Victor Lloro¹, Vicente Lozano de Luaces¹, Eduardo Chimenos Küstner¹

¹University of Barcelona, Barcelona, Spain

(Education - Tutorial Proposal)

INTRODUCTION: Microgravity is one of the various conditions that affect the oral and systemic health status during space missions. Periodontal disease is a chronic inflammatory disease of periodontium and its advanced form is characterized by periodontal ligament loss and destruction of surrounding alveolar bone. The periodontal disease is one of the most common oral condition of human population. Several risk factors such as smoking, poor oral hygiene, diabetes, medication, age, hereditary, and stress are related to periodontal diseases. The study of the conjunction of the human genome with that of the resident microbiota (microbiome) is strong. Perturbations of the oral microbiome through lifestyles can have detrimental consequences for the general and oral health. In dysbiosis, the equilibrium of the oral ecosystem is disrupted, allowing disease promoting bacteria to manifest and cause conditions such as gingivitis and periodontitis. Promoting a balanced microbiome is therefore important to effectively maintain or restore oral health.

TOPIC: The periodontal pathology treatment, and prevention.

APPLICATION: Periodontal pathology treatment, there are a number of pathologies in long period space missions that must be treated. It will be necessary to adopt specific preventive measures.

Learning Objectives

1. Learn to the importance of periodontal disease in long period space missions.
2. Analyze different aspects may include individual assessment of the microbiome.
3. Assess the different aspects that influence the periodontal disease and that may aggravate in long period space missions.

[152] DENTAL TRAUMA. GUIDELINES FOR AIRCREW MEMBERS/MILITARY STAFF

Juan Lara Chao¹, Jose Luis Dominguez Mompell¹, Soumaya Berrazzouk², Daniel Robles³

¹Univ. Rey Juan Carlos, Madrid, Spain; ²Univ. Complutense, Madrid, Spain; ³Univ. Europea Valladolid, Valladolid, Spain

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: Dental traumatism is one of the most common situations at a dental office. Would and aircrew/military member know how to act in case of dental traumatism? **BACKGROUND:** Guidelines of how to act depending the severity and dental structures affected will be analyzed. **CASE PRESENTATION & DISCUSSION:** Several different situations involving dental traumatism will be discussed. From a simple

concussion, to an enamel fracture (Small fracture) To a complete dental avulsion will be considered. Emergency treatment on the field, and future considerations will be discussed from an aircrew acting point of view.

Learning Objective

1. The participants will learn a guideline about how to face an emergency treatment concerning dental trauma.

Tuesday, 05/19/2020

2:00 PM

Centennial I**[S-33]: PANEL: RESIDENT RESEARCH AND QI/PI PRESENTATIONS**

Chair: Edgar Rodriguez

Co-Chair: David Miller

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

[153] ANALYSIS OF 40,595 USAF AEROMEDICAL WAIVERS ACROSS MAJCOMS FROM 2014-2019

Andrew Long¹, Joseph Wagner¹

¹US Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Original Research)

INTRODUCTION: USA Air Force (USAF) aviators and special operators with disqualifying medical conditions may require waivers to perform required duties. Such waivers are submitted in the Aeromedical Information Management Waiver Tracking System (AIMWTS) for disposition. The purpose of this study is to describe the general diagnostic distribution of AIMWTS waivers across individual USAF Major Commands (MAJCOMs) compared to the USAF as a whole, hereafter referred to as Big Blue. **METHODS:** There were 40,595 Big Blue waivers analyzed from Sep 2014 to Aug 2019. Each member's waiver data was de-identified and assigned a randomly generated unique identifier. Multiple diagnoses listed in a single waiver were treated as separate waivers. Multiple waivers submitted for the same individual were treated as separate waivers. Waivers were then grouped by ICD-10 chapter diagnostic categories and MAJCOM data was compared to Big Blue data. **RESULTS:** Of the 40,595 Big Blue waivers, 35,523 (87.5%) were dispositioned as medically qualified and 5,072 (12.5%) were disqualified. The leading ICD-10 chapter diagnostic categories included diseases of the eye (10,005, 24.6%), diseases of the nervous system (7,306, 18.0%), and diseases of the musculoskeletal system (3,549, 8.7%) mental and behavioral disorders (3,347, 8.2%) followed by other chapter categories. In addition, multiple analyses comparing Big Blue results to MAJCOM-specific data were performed. **DISCUSSION:** Although study limitations may impact results, there are apparent differences in the types of waivers coming from different MAJCOMs. Further research is needed to investigate the reasons for these differences.

Learning Objectives

1. Understand the approval rate of USAF aeromedical waivers.
2. Describe the general diagnostic distribution of aeromedical waivers across the USAF as a whole.
3. Describe differences in diagnostic distribution of aeromedical waivers in individual MAJCOMs.

[154] A COST-EFFECTIVENESS ANALYSIS FOR RETURNING MILITARY PILOTS WITH VENOUS THROMBOEMBOLIC DISEASE TO AVIATION DUTIES

Kevin Alford¹

¹US Air Force, Wright-Patterson, OH, USA

(Original Research)

INTRODUCTION: To compare the impact on total active years of flying and costs of three distinct aeromedical waiver strategies for single seat high-performance pilots after completing treatment for a first venous thromboembolic (VTE) event using a computer-based simulation and decision analysis. **METHODS:** We developed a decision analytic tool to compare three waiver strategies over a time horizon of ten years using VTE recurrence rate estimates and aviation mishap costs found in the medical literature and government publications. The strategies were: granting a waiver to all pilots after treatment for a first VTE; delaying disposition for one year after VTE treatment (temporary disqualification); and permanent disqualification of pilots after a first VTE. The study was conducted from the perspective of the USAF. Future flying years and costs were discounted at a rate of 3%. **RESULTS:** Total years of active flying and costs were lowest for the temporary-disqualification strategy (7.57 years and \$2.71 million). The grant-waiver strategy resulted in the most active years of flying at the second highest costs (8.57 years and \$2.75 million). The permanent-disqualification strategy was dominated by the grant-waiver strategy as it resulted in fewer years of flying at higher costs (7.78 years and \$11.1 million). The incremental cost effectiveness ratio for the grant waiver strategy compared to the temporary disqualification strategy was \$34,100 per active flying year. However, the grant-waiver strategy resulted in an increase in the risk of fatal mishap after return to flight from a first VTE. Results of the analysis were sensitive to the overall risk of recurrence and the impact of active flying duties on recurrence risk. **DISCUSSION:** An aeromedical strategy of granting waivers to all single seat, high-performance pilots who have been treated for a first VTE results in an increase in active flying years with a low increase in cost compared to other strategies but may increase the risk of fatal mishaps.

Learning Objective

1. Identify the role of decision analysis modeling in determining the costs and benefits of differing waiver strategies.

[155] ASSOCIATIONS BETWEEN FLYING WAIVERS AND AVIATION MISHAPS

Mitchell Radigan¹

¹US School of Aerospace Medicine, Wright Patterson Air Force Base, OH, USA

(Original Research)

BACKGROUND: The Flight Surgeons' application of medical standards are a primary prevention for aviation mishaps. USA Air Force (USAF) aviator candidates are measured against medical standards prior to and throughout training and operations to mitigate medical conditions leading to an aviation mishap. **PURPOSE:** This study looked for associations between medical waivers on initial pilot exam and the prevalence of medical conditions in fatal mishaps among single pilot aircraft accidents in the USAF from 2013-2018. **METHODS:** The USAF Safety Center maintains safety investigation data for all USAF aviation mishaps. Unique mishap events resulting in pilot fatality were extracted from this database for aviation mishaps in the USAF occurring between 2013 and 2018. Records were included if the safety investigation indicated a Human Factors Code (HFAC) of Physical and Mental States, or Acts, that was found to be causal or contributory to the mishap. Cases were excluded if there was an additional pilot on the same flight. **RESULTS:** Fourteen safety records met inclusion criteria. Three records did not have corresponding initial flight waiver information and were excluded from analysis. Eight of the analyzed records (8/11, 73%) required a medical waiver on initial examination. The number of waivers granted by body system were as follows: Neurological (2), Ocular (5), Cardiac (1), Pulmonary (1), Gastrointestinal (1), and Integumentary (2). Five physiologic HFACs were identified: Spatial Disorientation (6), Loss of Consciousness (2), Substance Effects (alcohol, supplements, medications, drugs) (1), Hypoxia/ Hyperventilation (1), and Body Size/Movement Limitations (1). **DISCUSSION:** Analysis shows those involved in a fatal mishap are more likely to have had an initial flight waiver. However, the analysis was too narrowly focused to identify any significant associations between initial flight waivers and fatal mishap events, and likely only represents correlation. The HFACs not specifically determined to be medically related, such as pilot error, may represent subtle degradations in cognitive performance that may be related to a medical condition.

However, more robust accident information would be required to draw any specific conclusions. A repeat analysis of a broader classification of mishap is recommended for evidence to support decisions related to pilot selection and risk stratification.

Learning Objective

1. The audience will learn what is and isn't known about the relationship between USAF flying waivers and aviation mishaps.

[156] THE RELATIONSHIP OF PERFLUOROALKYL AND POLYFLUOROALKYL SUBSTANCES AND CANCER RISK: 2011 – 2016 NHANES DATA

Michael "Cobra" Crowder¹

¹USAF Resident in Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Original Research)

INTRODUCTION: Perfluoroalkyl substances (PFASs) are persistent synthetic compounds that are nearly ubiquitous environmental contaminants and have associated health risks. Occupational exposure introduces another tier of risk. Aviation firefighters have been exposed to PFAS compounds for years in the form of Aqueous Fire Fighting Foams (AFFFs). The purpose of this study was to determine a baseline risk of four common detectable PFASs and cancer risk in the USA. **METHODS:** Data from 4497 participants from the 2011 – 2016 National Health and Nutrition Examination Survey (NHANES) were analyzed including population descriptive examination, unadjusted, univariate, and multivariate logistic regression in order to determine an independent association between serum PFASs levels (low, medium, and high) and gender specific risk of cancer controlling for age, ethnicity, income, and gender. PFASs included in the study were perfluorooctanoic acid (PFOA), perfluorooctyl sulfonate (PFOS), perfluoro hexane sulfonate (PFHxS), and perfluoro nonanoic acid (PFNA). Specific cancer types were also analyzed using unadjusted and multivariate logistic regression including breast cancer and prostate cancer. **RESULTS:** Unadjusted odds ratios for males were significant for males in the high exposure category for PFOS. Females were significant for medium and high exposure categories for PFOA, PFOS, and PFHxS. Unadjusted odds ratio for high exposure to PFOS and medium and high exposure to PFHxS were significant for breast cancer. Unadjusted odds ratios for high exposure to PFOS and PFHxS were significant for prostate cancer. After controlling for cofounders, serum tertiles for PFASs levels were not significantly associated with cancer. **DISCUSSION:** In U.S. adult serum tertiles for PFASs levels were not significantly associated with cancer. Although the study did utilize an extended dataset over multiple survey cycles, it would likely benefit from a larger number of participants to better understand the unadjusted significant relationships seen in this study. This would not only allow likely demonstration of a significant modeled relationship between PFAS and cancer, it would also accommodate numbers large enough to look at the other specific cancers previously demonstrating a relationship with PFAS levels. In addition, model results could possibly be used occupationally for monitoring of aviation firefighters.

Learning Objective

1. Understanding the current extent of PFAS contamination, occupational exposures, and cancer risk.

Tuesday, 05/19/2020

2:00 PM

Centennial II

[S-34]: SLIDE: WELL BEING

Chair: Christopher Flynn

[157] PROMOTING COGNITIVE HEALTH FOR PILOTS USING VIRTUAL REALITY: COLLABORATION BETWEEN RESEARCHERS, PILOT REPRESENTATIVES, AND CIVIL AVIATION MEDICINE

Kathleen Van Benthem¹, Chris Herdman¹, Heather Langille², Bernard Gervais³

¹Carleton University, Ottawa, Ontario, Canada; ²Transport Canada, Ottawa, Ontario, Canada; ³Canadian Owners and Pilots Association, Ottawa, Ontario, Canada

(Original Research)

INTRODUCTION: The world's aging population along with the current global pilot shortage, has resulted in the current commercial and general aviation pilots being the oldest cohort of pilots in aviation history. The civil aviation medicine community has accepted standards and protocols for assessing the medical fitness of pilots across the lifespan, but there is a lack of ecologically valid assessment and remediation tools for pilot cognitive health. Accident analysis and flight simulation research highlight cognitive function as the most significant factor associated with accidents and critical incidents during flight.

METHOD: In consultation with stakeholders from civil aviation medicine and general aviation pilot representatives, a cognitive engineering research team developed a prototype virtual reality (VR) cognitive screening and intervention tool for general aviation pilots – "CANFLY". General acceptance of the VR tool from the aviation community was assessed via a national online survey. User experience was tested via a laboratory-based flight simulation experiment using the CANFLY (N=47).

RESULTS: We report on the user experience of licensed pilots regarding this VR tool. We also present the findings of an online survey geared towards gauging acceptance of a VR tool for cognitive health screening in general aviation by pilots and the aviation medicine community.

Preliminary survey results show support from a range of stakeholders for the VR platform as a method for cognitive health screening and intervention. User experience reports from pilots who flew the CANFLY strongly support its relevance and suitability within the pilot population.

DISCUSSION: Implications of a VR cognitive health screening tool for pilots are presented from the stance of research, pilot, and medical community stakeholders.

Learning Objectives

1. The participant will learn about the purpose and utility of a prototype cognitive health screening tool for pilots, including user experience from a laboratory-based experiment.
2. The participant will learn about the acceptance of virtual reality for pilot cognitive screening, including its benefits and challenges.

[158] SMARTPHONES AS A MENTAL HEALTH SCREENING TOOL: WHAT'S IMPORTANT FOR AEROSPACE MEDICINE?

Diederik De Rooy¹, Laura Müller²

¹Leiden University Medical Center / Transparent Mental Healthcare, Leiden, Netherlands; ²Leiden University Medical Center, Leiden, Netherlands

(Education - Program / Process Review Proposal)

BACKGROUND: Mental disorders of civilian and military pilots may cause a substantial threat to aviation safety. There is increasing evidence that smartphone data may be used to detect mental disorders. Theoretically, smartphone data may help to predict or screen for mental disorders in pilots. **OVERVIEW:** Smartphone and wearable data may be used to collect information on physiological and behavioral functions. Social media content and internet search entries may be analyzed to predict behavioral problems. This may be used in clinical practice for predicting and monitoring the onset and course of mental disorders(1,2). However, there is a risk that commercial parties will develop unreliable tools that are being used without proper testing. At this moment, there is not yet regulation on the application of data from smartphone use in daily clinical practice, or to prevent that data are used by commercial parties for non-clinical purposes. **DISCUSSION:** Likely, in a few years it will be possible to detect mental disorders by smartphone data. It might seem attractive to ask pilots to share their smartphone data in order to detect mental disorders early. Still, important practical and ethical barriers exist. There is the chance of false positive results. Also, it is questionable whether people will be able to make a free consent if their employer or aeromedical examiner asks them to share smartphone data. Sharing these data has a massive impact on someone's privacy. It is debatable whether this huge infringement of the privacy of so many, is justified. Given the speed of technological advances, the aeromedical community should consider developing technical and ethical guidelines together with other stakeholders, such as pilots and their unions. **RESOURCES:** (1) Insel, T. Digital Phenotyping, Technology for a New Science of Behavior. JAMA 2017; 318, 1215-1216. (2) Martinez-Martin N, Insel TR, Dagum P, Greely H, Cho MK. Data mining for health: staking out the ethical territory of digital phenotyping. NPJ Digit Med 2018;1. pii: 68.

Learning Objectives

1. The participant will learn that in a few years' time, data obtained from smartphone and wearable use may be applied to screen for mental disorders in aerospace medicine, but this comes with several practical and ethical challenges.
2. The participant will be challenged to think about the need of establishing technical and ethical guidelines to deal with the developments in using smartphone and wearable data for diagnosing mental disorders.

[159] ALPA PEER EMPOWERMENT

Ellen Brinks¹

¹Air Line Pilots Association, Int'l, McLean, VA, USA

(Education - Program / Process Review Proposal)

ALPA-International (ALPA-I) is the world's largest airline pilot union, representing more than 63,000 pilots at 35 airlines in the U.S. and Canada. ALPA-I has led the industry in promoting and protecting pilot health by providing aeromedical services to its members since 1969 and has thereafter added additional programs including alcohol/substance abuse, professional standards, and critical incident response. This presentation will focus on and describe the development of its newest program, Pilot Peer Support (PPS), which is designed to help pilots cope with stress. A U.S. government/industry aviation rulemaking committee recommended in 2015 that airlines establish pilot assistance programs to help crewmembers disclose emotional distress concerns and obtain support as needed. The PPS program was developed with the assistance of numerous emotional health professionals and other experts, and was peer reviewed to ensure that the guidance given to pilot peers is current and sound. The training of pilot peers focuses on four major concepts: assessing the caller's needs and safety, listening non-judgmentally, providing hope and encouragement, and accessing appropriate resources for further assistance. PPS became available in late 2018 to all ALPA-I members 24 hours per day via a hotline that is staffed by trained pilot peers. The presentation will describe the PPS program and how it was developed, and will help any organization which is desirous of learning how to protect their employees from the effects of stress, whether originating from work or their personal lives.

Learning Objective

1. Participants will learn how the world's largest airline pilot union proactively protects each facet of its members' physical and emotional wellbeing. ALPA's Pilot Assistance group has industry-leading pilot health programs. This presentation will focus on its newest program, pilot peer support, which is designed to help pilots cope with stress.

[160] AN APPRAISAL OF HAPPINESS IN CIVIL AIRCREW

Divya Narayanappa¹, Sowgandhi Chathurvedulu¹, N K Tripathy¹, Anupam Agarwal¹

¹Institute of Aerospace Medicine, Benagaluru, India

(Original Research)

INTRODUCTION: Commercial aviation is a unique occupation where the professional responsibility to ensure the safety of the aircraft and its occupants lie with the pilot. Psychological fitness plays a crucial role in helping the crew adapt to the occupational demands. In the recent past, mental health awareness amongst civil aviators and aviation industry has been on the rise. In this context, happiness as a fundamental emotion is characterized as a lasting state with presence of positive emotions, absence of negative emotions and life satisfaction. Based on this, the main goal of this paper is to conduct a survey concerning the happiness index of civil aircrew. The findings of this paper may be useful to aircrew, aviation medical examiner, and the airline for taking cognizance of the psychological practice. **METHODS:** A widely used scale for assessment of happiness called Oxford Happiness Questionnaire (OHQ), was administered on both male and female civil aircrew (n=100) reporting at the Institute of Aerospace Medicine. OHQ is a 29 item self-reported questionnaire. Internal consistency was calculated using Cronbach's alpha which was found to be 0.97 on the current sample. Personal factors as age, rank was also investigated. **CONCLUSION:** A mean score of 4.87 was obtained in OHQ

which indicated that the civil aircrew perceived themselves to be happy. Age, Rank and gender wise analyses was also carried out. This study reported the happiness index of Indian civil aircrew and recommended that it is important for the concerned agencies to take cognizance of happiness which is a predilection to psychological well-being and ensure flight safety.

Learning Objective

1. The audience will learn about the utilization of positive psychology in enhancing flight safety.

[161] DEVELOPMENT OF HAZARDOUS ATTITUDE INVENTORY FOR FIGHTER AVIATORS IN INDIA (HAIFAI): AN AWARENESS TOOL

Anupam Agarwal¹, Sowgandhi Chaturvedula¹

¹Institute of Aerospace Medicine, Indian Air Force, Bangalore, India

(Original Research)

INTRODUCTION: There has been a growing interest in the hazardous attitudes of aviators vis a vis flight safety. The pilot's attitude(s) in the face of a hazard forms the core of Aeronautical Decision Making (ADM). Literature regarding hazardous attitudes in military aviation is scant in India. The present study deliberates on the development of a self-reporting inventory to profile military pilots on each of the five hazardous attitudes. **METHOD:** Extensive job analysis was carried out by Subject Matter Experts and few real-life aviation accidents and incidents were identified which were believed to occur due to decision and judgment errors. These accidents were further iterated by expert fighter pilots and 10 accidents were retained for the inventory. For each of these 10 situations, stems corresponding to the five hazardous attitudes were developed. A paired comparison method of rating each situation was considered and military pilots (n=189) had to rank all five stems in order of preference resulting in ipsative data. Reliability analyses was performed on each of the hazardous subscale. As a result of rank ordering, the resulting score on each individual subscale was relative to the score on every other subscale. Subsequently, the total score for each participant was obtained by summing the scores on each individual attitude subscale, which added up to the same value of 150. The Hazardous Attitude Inventory for Fighter Aviators in India (HAIFAI) was aimed at making the aviator aware of the 'dominant' hazardous attitude present in him/her, as well as the attitude that he/she scored the least on, relative to his score on the remaining attitude subscales. **FINDINGS AND DISCUSSION:** The hazardous attitude scales reported excellent to poor internal consistency. The sample was found to be dominant on Invulnerability and impulsivity. The sample reported low resignation and anti-authority attitudes. An important finding of the study is the realisation that it is not the reduction of a hazardous attitude that contributes to safe military flying but to have the right amount of these attitudes. The tool has significant pedagogic value to provide insight to the aviators on hazardous attitudes and efficient flying. **CONCLUSION:** The study brings out that the identification of hazardous attitudes is important and HAIFAI serves as an effective tool to provide insight to the aviators regarding their hazardous attitudes.

Learning Objectives

1. The audience will be able to recognize the importance of identifying Hazardous Attitudes in aircrew and their impact on Aeronautical Decision Making and flight safety while being culture sensitive.
2. The audience will be able to measure hazardous attitudes with the help of Hazardous Attitude Inventory developed for fighter aircrew of Indian Air Force.
3. The audience will be able to specify Attitude Management training programs and recommend judgment training programs based on the aviators' dominant hazardous attitudes.

[162] PILOT WORKLOAD IS ASSOCIATED WITH LONG DUTY DAYS AND MULTIPLE FLIGHT LEGS

Lucia Arsintescu¹, Kenji H Kato², Erin E Flynn-Evans³

¹San Jose State University Research Foundation, San Jose, CA, USA;

²ASRS Research and Technology Solutions, Mountain View, CA, USA;

³NASA Ames Research Center, Mountain View, CA, USA

(Original Research)

BACKGROUND: Pilot workload is a real concern throughout aviation, especially in short-haul operations due to short flights and multiple flight legs. Our goal was to examine the workload experienced by pilots during normal operations in a short-haul airline. **METHODS:** Thirty pilots flew a roster consisting of a cycle of five days of mid-day start time duty hours with many flight legs (baseline block) followed by four days off, five early start time duty hours followed by three days off, five mid-day time starts with many legs followed by three days off and then five early start time followed by one day off. The pilots provided evaluations of workload by scoring the six subscales of NASA-TLX (i.e., Mental Demand, Performance, Physical Demand, Effort, Temporal Demand, and Frustration) on their duty days during each flight and once during rest days. The analyses included the raw TLX scores for each demand, the mean raw TLX, and the overall weighted TLX mean for duty days and rest days. **RESULTS:** We found that mental demand was significantly lower for each duty schedule and rest relative to baseline (early start 1st block p = 0.016, late duty p = 0.017, early start 2nd block p < 0.001, rest p < 0.001). Temporal demand was significantly lower than baseline on early duty 1st block (p = 0.02), early start 2nd block (p < 0.001), and rest (p < 0.001). Effort was significantly lower than baseline only during early start 1st block (p = 0.014) and early start 2nd block (p < 0.001). Frustration was significantly lower during early start 2nd block relative to baseline (p = 0.039). Physical demand and performance were higher relative to baseline during rest days (p < 0.001). Mean raw TLX showed significantly lower workload for early start 1st block (p = 0.011) and early start 2nd block (p < 0.001). The overall weighted TLX showed significantly lower workload for early start 1st block (p = 0.004), early start 2nd block (p < 0.001) and rest (p < 0.001). **DISCUSSION:** We found that pilots experienced higher workload on longer duty days with multiple flight legs. Pilots experienced lower mental demand, temporal demand, and effort on short duty days even though when their duty started earlier in the day. During days off pilots experienced higher physical demand and higher performance.

Learning Objective

1. The audience will learn about workload experienced by pilots during normal operations in a short-haul airline.

Tuesday, 05/19/2020

2:00 PM

Centennial III

[S-35]: PANEL: OPERATIONAL CONSIDERATIONS FOR DEATH IN SPACE - PART 1

Chair: Philip Stepaniak

Co-Chair: Robert Patlach

PANEL OVERVIEW: BACKGROUND: As human spaceflight increases in frequency and duration the risk of a death in space increases as well. This is the first of two panels discussing operational considerations of a death in space. **OVERVIEW:** The tempo of flying in space is increasing, especially with the ongoing development of new, proposed NASA space programs working in participation with its international partners and commercial vendors involved in human space travel. Mishaps have occurred during launches and landings, while to date no catastrophic mishaps or deaths in space have occurred; nonetheless, the possibility certainly exists. The motion picture industry has somewhat trivialized this event on the big screen; conversely, in reality there are many challenges, impacts, and workarounds should a death occur. The goal of this panel, as well as Part 2, is to highlight and outline the multiple, operational considerations in responding to a death in space. **DISCUSSION:** This panel will discuss the background, historical aspects, and potential mortality risks while on-orbit; containment of human remains; expected on-orbit human decomposition rates; pathological consideration, forensic sampling rationale, and determination of cause of death.

[163] OPERATIONAL CONSIDERATIONS FOR DEATH IN SPACE: HARDWARE CONSIDERATIONS FOR PREPARATION, STOWAGE, AND POTENTIAL RETURN OF REMAINS

Travis Houser¹, Natacha Chough², Philip Stepaniak³, Kathleen McMonigal³, Kjell Lindgren³, Michael Barratt³, Joan Bytheway⁴, Edward Mazuchowski⁵, Steven Uhl⁶, Robert Patlach⁶, Michael Misiora⁶
¹KBR, Houston, TX, USA; ²University of Texas Medical Branch, Galveston, TX, USA; ³NASA, Houston, TX, USA; ⁴Sam Houston State University, Huntsville, TX, USA; ⁵USAF, San Antonio, TX, USA; ⁶KBR, Houston, TX, USA

(Education - Program / Process Review Proposal)

BACKGROUND: An in-flight fatality would pose significant challenges with regard to preparation, storage, and final disposition of the decedent's remains. Ready access to refrigeration capability in the terrestrial model of remains handling has driven hardware down a path that is not entirely suitable for use in the space flight environment. The products of human decomposition are well documented in forensic literature, and pose no significant physical health risk to the surviving crew. Odoriferous compounds do pose some level of psychological health risk however, and likewise there is an unquantified risk to the hardware of the space vehicle. The inability to inhibit or arrest the decomposition process via refrigeration while onboard any current or planned future vehicle requires us to assume the stance of complete containment of the remains. **OVERVIEW:** The current Human Remains Containment Unit (HRCU) is nearing the end of its service life, and is no longer commercially available. A replacement HRCU was found from a manufacturer that primarily serves the defense market with body bags designed to facilitate the transportation and disposition of chemically or biologically contaminated remains. The proposed new HRCU utilizes a NASA designed zipper and modified 3M filter canisters to ensure full containment of chemical or biological contaminants while still allowing for pressure equalization across the bag barrier. **DISCUSSION:** The spaceflight environment presents a number of inherent challenges to stowage and disposition of human remains. Commercial off the Shelf solutions are, reasonably, designed for terrestrial use. Any potential HRCU will, necessarily, require some level of modification in order to meet the challenges presented by spaceflight. This presentation addresses the specific challenges and workarounds involved with the stowage and final disposition of crewmember remains. All decisions were made in the context of current vehicular constraints while simultaneously considering potential constraints imposed by future vehicles.

Learning Objective

1. The audience will become familiar with the hardware limitations and challenges associated with handling and stowage of the remains of deceased crewmembers in the event of a space flight fatality.

[164] OPERATIONAL CONSIDERATIONS FOR DEATH IN SPACE: HISTORICAL BACKGROUND, ASPECTS, AND RISKS OF SPACEFLIGHT

Natacha Chough¹, Philip Stepaniak², Kathleen McMonigal², Michael Barratt², Kjell Lindgren², Edward Mazuchowski³, Ann Tsung¹, Travis Houser⁴, Steven Uhl⁴, Robert Patlach⁴, Michael Misiora⁵
¹University of Texas Medical Branch, Galveston, TX, USA;
²NASA, Houston, TX, USA; ³Joint Base, San Antonio, TX, USA;
⁴KBR, Houston, TX, USA; ⁵SGT, Houston, TX, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Human spaceflight presents a challenging and unique environment that comes with inherent risks, some of which can be fatal. Resources for handling in-flight fatalities are limited, leading to reduced capabilities for proper post-mortem forensics and respectful disposal of human remains. The following review of relevant human spaceflight contingency plans, spaceflight close calls, and challenges of working in microgravity serves to highlight both improvements needed to historic in-flight loss-of-crew contingency procedures, and the operational challenges of working in this remote clinical setting in preparation for exploration class missions. **OVERVIEW:** Previous US

human spaceflight contingency plans, in-flight close calls, and medical challenges of working in microgravity will be discussed. A review of internal NASA documentation for Apollo and Skylab Medical Operations Projects was conducted. Search terms included "fatal," "death," "contingency," "procedure," and "loss of crew." Additionally, the ISS Health Maintenance System team was surveyed to solicit the most prominent physical and environmental challenges encountered during medical operations of the Space Shuttle and ISS Programs, in order to highlight existing gaps to address when planning future missions. **DISCUSSION:** The risks of human spaceflight underscore the potential for fatal events in an austere environment, which in turn present a unique set of challenges for health care providers and their surrogates working with limited resources when addressing the in-flight death of a crewmember. The evidence presented demonstrates the scope of considerations required, while simultaneously identifying continued operational gaps and updates to medical forensic needs for future spaceflight expeditions. These recommendations may also have cross-applicability for certain military and international environments.

Learning Objectives

1. The audience will become familiar with historic risks of human spaceflight.
2. The audience will become familiar with challenges of performing medical procedures in microgravity.
3. The audience will become familiar with current procedures in place for death on-orbit.

[165] OPERATIONAL CONSIDERATIONS FOR DEATH IN SPACE: HUMAN DECOMPOSITION

Joan Bytheway¹, Philip Stepaniak², Kjell Lindgren², Kathleen McMonigal², Edward Mazuchowski³, Ann Tsung², Travis Houser², Steven Uhl², Rachel Richardson², Lorraine Benavides Gibson², Michael Misiora²
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(Education - Program / Process Review Proposal)

BACKGROUND: The human decomposition process is composed of four phases: Fresh, Early, Advanced, and Skeletonization. The process is complex and transitional with internal and external factors affecting the timing of each of the four phases. The Applied Anatomical Research Center (AARC), at Sam Houston State University, Huntsville, Texas is a forensic science human decomposition and trauma laboratory, one of six in the USA. AARC opened in March 2009 and decomposition of the human body has been studied over the last decade. Globally, previous decomposition and trauma research focused on human analogs, which are metabolically, physiologically, and physically different. With the increasing need to estimate the human postmortem interval with more accuracy, the use of human cadavers for research has increased exponentially. Cadavers used in human decomposition studies at AARC are placed in a wide range of temperatures, humidity levels, seasons and locations. In all human decomposition studies, the physical descriptors associated with the three specific regions of the body are observed on a daily basis (i.e. head & neck, abdomen, and limbs) and correlated with accumulated degree-days and normal day count. This presentation will describe the human decomposition process and discuss what the postmortem interval of a deceased individual would be in a specific space environment.

OVERVIEW: The design of the study simulated a death event that could occur in space. Human cadavers were used to 1) analyze the timing of the decomposition process in parameters specific to the International Space Station (ISS) environment and 2) to test medical and forensic protocols that would be used to obtain pertinent information relevant to the death and subsequently return the deceased to earth. The results of the study will be presented, showing the timing of each decomposition phase under similar temperature and humidity values of the space station.

DISCUSSION: Understanding the timing of the human decomposition process provides the information ISS program managers need to determine when and how the body should be handled for transport.

Learning Objective

1. The audience will learn about the specific phases of decomposition and what was discovered in the environment created to simulate space.

[166] OPERATIONAL CONSIDERATIONS FOR DEATH IN SPACE: FORENSIC PATHOLOGY INVESTIGATIONSEdward Mazuchowski¹, Philip Stepaniak², Robert Patlach²¹Defense Health Agency, Joint Trauma System/Armed Forces Medical Examiner System, JBSA Fort Sam Houston, TX, USA;²NASA-JSC, Houston, TX, USA*(Education - Program / Process Review Proposal)*

BACKGROUND: When a death is sudden, unexpected, and/or violent, a forensic pathology investigation is conducted. Space presents a challenging environment for the completion of this investigation. This presentation will discuss how the standard forensic pathology protocol must be modified in order to conduct an accurate, timely, and thorough investigation in space. **OVERVIEW:** Forensic pathology investigations were conducted on the individuals that died during previous spaceflight mishaps. These investigations followed standard forensic pathology protocols that are used during aviation mishaps. Forensic pathologists were able to examine the individual's remains soon after death and determine the cause of death in each instance. The cause of death is the injury or disease that creates a physiologic derangement that leads to death. In previous mishaps, the cause of death was an injury. In current and future spaceflight operations, an individual may die from an injury or a disease. Additionally, the forensic pathologist will most likely not be able to examine the remains soon after death, if it at all. Thus, procedures for documentation of the remains and collection of samples in the weightless space environment have been developed. **DISCUSSION:** Comprehensive forensic pathology investigations are necessary to determine the cause of death and to provide information to prevent future fatalities. Spaceflight operations leadership and flight surgeons must be familiar with the unique procedures necessary to conduct a forensic pathology investigation in the space environment.

Learning Objective

1. The audience will become familiar with the procedures necessary to complete a comprehensive forensic pathology investigation for a death on-orbit.

Tuesday, 05/19/2020**2:00 PM****Centennial IV****[S-36]: SLIDE: AIRCREW SLEEP AND FATIGUE****Chair: Tom Nesthus****Co-Chair: David Schroeder****[167] AIRCREW SLEEP SCHEDULES: A COMPARISON OF ACTUAL AND PRESCRIPTIVE SCHEDULES***Endorsed by the Aerospace Human Factors Association*Megan Morris¹, Bella Veksler², Alex Gaines³, Michael Krusmark⁴, Helen Jantscher⁵, Glenn Gunzelmann¹¹Air Force Research Laboratory, Wright-Patterson AFB, OH, USA;²TIER1 Performance Solutions at the Air Force Research Laboratory, Wright-Patterson AFB, OH, USA; ³Air Force Institute of Technology, Wright-Patterson AFB, OH, USA; ⁴L3Harris at the Air Force Research Laboratory, Wright-Patterson AFB, OH, USA; ⁵Air Force Joint Test Program Office, Nellis AFB, NV, USA*(Original Research)*

INTRODUCTION: Fatigue is an important risk in the aviation community that can be very costly in terms of resources and human life. Several organizations implement fatigue risk management programs to mitigate fatigue. Air Mobility Command's Aviation Operational Risk Management (AvORM) program provides fatigue predictions in the form of mission effectiveness (ME) graphs which exhibit predicted performance effectiveness levels and prescriptive sleep schedules based on mission information. Mission planners commonly use the graph to schedule missions and aircrew can use the graph as a fatigue mitigation tool. In the current study, we compare aircrew's actual sleep during missions to prescriptive sleep schedules outlined in the ME graphs.

METHODS: Forty-four Airmen ($M_{age} = 28.23$; $SD_{age} = 4.23$; $Proportion_{male} = 77.27\%$) from the C-17 community at Travis AFB participated in the Air Force Research Laboratory Institutional Review Board approved study, generating 25 instances of corresponding useable actigraph data and available ME graphs for schedule comparison (80 flights total). Aircrew wore actigraph watches to measure sleep during missions and prescriptive sleep schedules were collected from AvORM. Actual and prescriptive sleep was compared in terms of differences in calculated performance effectiveness values per minute across mission flights based on the Sleep, Activity, Fatigue, and Task Effectiveness (SAFTE) model. **RESULTS:** Prescriptive schedules generally overestimated sleep during missions, such that, on average, 75.15% of performance effectiveness values during flight were lower than predicted. The average difference of these values was 6.76%, which can cause transitions to effectiveness ranges that require fatigue mitigation efforts. Additionally, longer missions tended to result in increasingly disparate estimates of effectiveness as the mission progressed. **DISCUSSION:** The current study suggests that actual aircrew sleep often does not align with prescriptive sleep schedules during missions, resulting in actual effectiveness estimates that are generally lower than predicted estimates based on prescriptive sleep schedules in AvORM. This may discourage aircrew from using the ME graph as a fatigue mitigation tool. Additionally, given that mission planners use these predictions when planning missions, ME graphs in AvORM may underestimate risks to safety and performance, impacting the success of missions and the overall health of aircrew.

Learning Objective

1. Understand issues associated with assumptions of prescriptive sleep scheduling to maintain acceptable levels of fatigue during missions.

[168] DIFFERENCES IN FATIGUE AND PERFORMANCE MEASURES AMONG AIRLINE PILOTS DURING EARLY STARTS AND LATE FINISHES*Endorsed by the Aerospace Human Factors Association*Erin Flynn-Evans¹, Lucia Arsintescu², Kevin Gregory¹,Cassie Hilditch², Sean Pradhan²¹NASA Ames Research Center, Moffett Field, CA, USA; ²San Jose State University Foundation, Moffett Field, CA, USA*(Original Research)*

INTRODUCTION: Pilots are limited in the number of hours they can work based on duty start time and flight duration. Current regulations in the USA and Europe allow for a longer duty day when work start occurs in the morning, while the duty day is restricted when work start occurs later in the day. However, early starts often require pilots to report for work during the window of circadian low, which has the potential to impair performance relative to later starts. Few studies have examined objective measures of performance by time of day. We hypothesized that performance on the psychomotor vigilance task (PVT) would be impaired according to both work start time and time awake during short-haul aviation operations. **METHODS:** Short-haul airline pilots completed sleep diaries over 34 days of data collection. They completed a five-minute version of the PVT and the Samn-Perelli fatigue rating scale upon waking, pre-flight, at the top of descent during each flight, post-flight, and before bed for all duty days. Data were stratified by duty start time, with early starts defined as 05:00-06:59, mid-morning starts as 07:00-10:59, afternoon starts as 13:00-16:59, and evening starts as 17:00-20:59. The PVT was inverse transformed (1/reaction time; response speed). Data were analyzed using linear mixed-effects models (R Studio Version 1.1.419). All *p*-values were Bonferroni corrected. **RESULTS:** One hundred pilots completed the study. Pilots reported significantly higher fatigue on the Samn-Perelli at duty end when their flight duty period (FDP) started in the afternoon ($n = 356$ FDPs) and evening ($n = 60$ FDPs) compared to early- ($n = 423$ FDPs) and mid-morning ($n = 135$ FDPs; both $p < 0.01$). Pilots' subjective fatigue scores were also significantly higher for FDPs that began in the early morning as opposed to the mid-morning ($p < 0.05$). Subjective fatigue was also significantly impacted by both prior sleep period time and time awake at duty start, whereby increased time awake and sleep periods were associated with higher reported fatigue. The results were identical for objective fatigue, as measured by PVT response speed. **DISCUSSION:** Both early starts and late finishes are associated

with reduced performance relative to mid-morning starts. These findings suggest that it may not be appropriate to allow longer duty length for early starts due to the influence of the circadian rhythm on alertness during the window of circadian low.

Learning Objective

1. The participant will be able to understand how time awake and circadian factors influence operational performance.

[169] MEASUREMENT OF FATIGUE AND PERFORMANCE OF OPERATIONAL RISK MATRIX IN IDENTIFYING FATIGUE – EX GREEN FLAG WEST 19-5

Ian Mollan¹, Emma Smith²

¹Royal Air Force, Carterton, United Kingdom; ²RAF Centre of Aviation Medicine, Henlow, United Kingdom

(Original Research)

INTRODUCTION: Previously, an objective fatigue measurement in RAF Typhoon pilots on Ex GREEN FLAG 17-04 indicated that fatigue management was sub-optimal in around 1 in 7 sorties. A more precise measurement by actigraphy was therefore undertaken with the primary aim to determine the level of aircrew fatigue on FLAG Exercises.

METHODS: All aircrew on Ex GREEN FLAG 19-5 were offered entry to the study; 17 out of 18 participated for the entire 3-week period. Daily sleep diaries and actigraphy were analyzed using the FAST model to generate an effectiveness score. A secondary objective was to assess the performance of the Operational Risk Matrix (ORM) in identification of fatigue pre-flight. Individual pilots completed an ORM before each sortie, the responses were compared against effectiveness using ANOVA. The null hypothesis was that there was no difference in the measured mean effectiveness between ORM question responses. **RESULTS:** Participation was extremely high, with 17 out of 18 pilots taking part for the entire 3-week Exercise. A total of 140 flying tasks, comprising: 96 simulated weapons release, 28 live weapons release and 18 familiarization sorties were examined. Mean effectiveness at ORM completion was 83.9 ± 15.8 ; effectiveness was normally distributed. Only 5 sorties were undertaken with effectiveness less than 70. There was no difference in measured effectiveness for number of consecutive previous duties ($p=0.91$), reported sleep quality ($p=0.57$), reported time to adjust to current time zone ($p=0.54$) or anticipated duty length ($p=0.15$). There were significant differences in measured effectiveness for duty start time ($p<0.001$), number of prior consecutive night duties ($p<0.001$), sleep immediately prior to flight ($p<0.001$), hours of rest since previous duty ($p=0.001$), sleep in the previous 3 days ($p=0.001$) and number of reported wakeful hours at the end of duty ($p=0.01$). **DISCUSSION:** Measured effectiveness was improved compared to the previous Ex. Measurement precision, pharmacological fatigue countermeasure trials and the ability to issue medications were factors likely contributing to the improvement in fatigue; detaching a flight doctor should be undertaken for all future Exercises. The ORM can be useful to identify fatigue pre-flight; further work should be undertaken to refine question sets. Whilst question sets may generate discussion for flight authorizers, future work should try to develop a scientifically valid scoring system.

Learning Objectives

1. Operational Risk Matrices can be useful in identifying fatigue pre-flight.
2. Aviation Medicine doctors' participation in flying exercises help to reduce measurable fatigue.

[170] CONTROLLED REST: INVESTIGATING THE USE OF AN IN-FLIGHT SLEEPINESS COUNTERMEASURE

Endorsed by the Aerospace Human Factors Association

Cassie Hilditch¹, Lucia Arsintescu¹, Kevin Gregory², Erin Flynn-Evans²

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(Original Research)

INTRODUCTION: Sleepiness is commonly reported amongst commercial airline pilots and is recognized as a safety risk due to its impact on performance. Controlled Rest (CR) refers to a short, voluntary nap opportunity taken by pilots on the flight deck as a countermeasure

to unanticipated sleepiness in flight. This study explores the profile of CR use in a long-haul commercial airline. **METHODS:** Forty-four pilots filled in an application-based sleep/work diary and wore actiwatchers for approximately 2 weeks. Complete data sets from 239 flights including sleep diaries, actigraphy, and schedules were merged and analyzed. Sleep diary entries were used to set CR intervals in the actigraphy software, which was then used to predict sleep within these intervals. All time-stamps of sleep periods and flight schedules were adjusted for home-base time of the pilots. Pearson correlations were used to assess the influence of pilot demographics on CR use. A mixed-effects logistic regression was used to analyze the impact of schedule factors on CR. **RESULTS:** Pilots reported taking CR on 46% ($n=110$) of observed flights. Average CR attempt duration was 43.1 ± 11.0 minutes. Eighty-percent ($n=106/133$) of all CR attempts were estimated by actigraphy to have successfully achieved sleep with an average sleep duration during successful rest periods of 31.7 ± 12.2 minutes. Captains reported taking CR on 38% of flights ($n=39/102$), compared to First Officers reporting 52% ($n=71/137$) of flights with CR ($p=0.131$). Age, experience, BMI, and sleep need were not associated with the percentage of flights with CR (all $p>0.244$). The following schedule factors were associated with a higher frequency of CR: night (55%, $n=76$) vs. day flights (34%, $n=34$); <10 h (63%, $n=80$) vs. >10 h duration flights (27%, $n=30$); return (60%, $n=71$) vs. outbound flights (33%, $n=39$); and 2-pilot (69%, $n=83$) vs. >2 -pilot flights (23%, $n=27$) (all $p\leq 0.001$). There was a trend for more CR on eastbound flights, but this was not significant (eastbound: 51%, $n=57$; westbound: 40%, $n=44$; $p=0.059$). Of note, 22% ($n=26$) of augmented flights (>2 -pilots) contained both CR and Bunk Rest (in a designated rest facility). **DISCUSSION:** Data from this airline show that pilots commonly use CR to mitigate sleepiness in-flight, especially on flights <10 h duration and during home-base night flights. Future studies are required to determine the generalizability of these results to other airlines.

Learning Objective

1. The audience will learn about the prevalence and distribution of Controlled Rest as a countermeasure to sleepiness in a long-haul commercial aviation operation.

[171] SNOOZE OR YOU WILL LOSE: FATIGUE AND SLEEP EFFECTS ON PERFORMANCE IN MILITARY AVIATION TRAINING

Joanna Nelms¹

¹USAF, San Antonio, TX, USA

(Original Research)

INTRODUCTION: Pilot Training Next (PTN) is tasked to discover and develop a more effective learning methodology as it applies within the context of pilot training. As part of this effort, PTN is researching the physiological, psychosocial, and cognitive aspects of pilot training to incorporate into a more effective pilot training learning experience for the student pilot. Fatigue has long been associated with decrement in performance, but often the only data we can collect on operator sleep is subjective reported from individuals. Given the innovative and operationally experimental environment of PTN, we wanted to execute an operational test of objective, sensor-assisted sleep monitoring and reporting as a part of a holistic human performance optimization program. The intent for use of all data collected was predominantly for exploratory reasons as to the best of the author's knowledge, objective sleep monitoring has never been observed in military aviation training. **METHODS:** Sleep performance was tracked for the 26 PTN version 2 students using both the Fatigue Science Readiband and the Fitbit Charge 3 for the duration of their pilot training (January to August 2019). Wear of these devices was considered a part of training program, all of which was voluntary and considered a part of the operational training environment of PTN. Average sleep effectiveness, quantity, quality, number of awakenings per hour, as well as sleep onset and wake time were all tracked by the Readiband with the Charge 3 providing secondary supportive data for the quantity of time. **RESULTS:** The results were muddled by compliance and technological issues; however we saw positive correlation between higher sleep metrics and higher performance in the training course as measured by aircraft track. Additional operational anecdotal evidence of using real-time objective fatigue management in regards to daily operational decisions was also observed and valued by the organization command. **DISCUSSION:** The HPO integration efforts at PTN will directly influence management of human resources in aviation training pipelines

of military and civilian organizations. This may be especially true for objective fatigue monitoring and education initiated at the start of the aviation training and operational pathway. More research is needed to establish the causality and better strategies for adherence to sleep monitoring in the future and is a continued goal of the PTN construct.

Learning Objective

1. The audience will learn about a method of operational sleep and fatigue monitoring strategies in the military aviation training environment.

[172] COMPARISON OF PHYSIOLOGICAL AND COGNITIVE PERFORMANCE IN HIGH PERFORMANCE PILOTS DURING DAY AND NIGHT FLYING: A PILOT STUDY

Elizabeth Combs¹, Jennifer Heissel², Nita Shattuck², Anna Dahlman², Lyn Whiteaker²

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(Original Research)

BACKGROUND: Pilots routinely transition to night flying to maintain night currency and proficiency. The physiological toll as a result of this transition is not understood. This research investigated the changes in physiological markers of stress and cognitive performance as high-performance pilots transitioned short-term to night-flying weeks using salivary cortisol, wrist activity monitors, the National Aeronautics and Space Administration-Task Load Index (NASA-TLX), and a go/no-go (GNG) developed by Naval Medical Research Unit at Dayton. **METHODS:** Seventeen fully qualified high-performance pilots took part in a two-week data collection using salivary swabs, wrist worn activity monitors, the NASA-TLX, and a GNG test. **RESULTS:** No differences were found in GNG reaction time or accuracy, NASA-TLX scores, or sleep quantity as participant's transition to night-flying weeks. Cortisol levels were significantly higher than civilian levels in all experimental conditions and control days. Unique participant cortisol curves were fitted and we found higher-than-predicted participant cortisol levels post-flight in the day-flying condition and lower-than-predicted participant levels post-flight in the night-flying condition. Two negative relationships; aircraft hours by magnitude of cortisol change (pre- to post-flight) in the day-flying condition and age by Perceived Stress Survey scores suggested stress adaptation in the pilot community. **DISCUSSION:** We hypothesized that the night-flying environment would be more stressful, but our results disputed this claim. Our results suggest day-flying elicits more of a stress response; however, a larger sample size is required to verify results.

Learning Objective

1. The audience will learn about salivary collection measures and the limitations that occurred within a field environment.

Tuesday, 05/19/2020

2:00 PM

Regency 6

[S-37]: PANEL: PRACTICAL AEROMEDICAL EVACUATION: WHAT WE KNOW, WHAT WE DON'T KNOW, AND WHAT TO DO ABOUT IT

Chair: Jeffrey Kinard

PANEL OVERVIEW: Combatant commanders rely on the Joint Trauma System (JTS) to care for those wounded in battle. Aeromedical patient movement using fixed wing and rotary assets is a key component of the JTS. Aeromedical clinicians and their support teams must train and organize to ensure optimal patient care and outcomes for their patients as they transit the Joint Trauma System. Much of our success over the past several decades has come from highly visible transportation of complex polytrauma patients using critical care assets. However, until recently, less institutional focus has been given on moving the vast majority of patients, those with less severe acute injuries such as those injuries caused by blast injuries and other lower acuity traumas, with their resultant traumatic brain injuries (TBI) and acute lung injuries (ALI). These large numbers of patients applied across the spectrum of injuries, will drive a host of clinical and operational decisions made by junior medical officers at the point of movement decision. Collectively, these decisions

have significant policy and political implications far distant from the actual execution of the patient movement decision. This panel, focused to support the needs of those junior clinical and support practitioners of patient movement, will provide current practical knowledge to optimally care for these patients in the aeromedical evacuation environment. The session begins with some historical context on how we got here and where we may be heading. We will review basic physiology and updated science regarding these patients and the impact of stressors of flight including altitude. Special attention will be focused on TBI and ALI patients in the hypobaric flying environment. The panel will then provide high-yield clinical decision-making criteria to optimize care for patient movement. A senior Mobility Air Force line representative will discuss operational concerns relating to flying these patients. Finally we will conclude with the future of clinical care and aeromedical transport in anti-access/area denial (A2/AD) environments. Future wars will challenge foundational treatment paradigms and assumptions based on two decades of uncontested air superiority in the Middle East and Southwest Asia.

[173] PRESENTATION ONE: BACK TO THE FUTURE....REDUX

Paul Nelson¹

¹The Air University, Montgomery, AL, USA

(Education - Case Study: Clinical / Human Performance)

Our understanding of operational support continues to evolve as we refine our aeromedical support for the Joint Trauma System. As we work together across disciplines to create the JTS of the future, it is helpful to understand how we got here and where we are today. This presentation will review and analyze the current research and scholarly activity conducted by the Air University and partner organizations dealing with past 20 years of combat medical support. It will present a unified model of approaching movement of an individual patient while considering the implications to operational concerns to the line commander.

Learning Objectives

1. Understand the historical context of patient movement.
2. Understand our evolving understanding of patient movement and the role of evacuation by air.

[174] THE PHYSIOLOGY OF AEROMEDICAL EVACUATION

Alex Keller¹

¹The Air University, Montgomery, AL, USA

(Education - Case Study: Clinical / Human Performance)

Aerospace and operational medical clinicians base their movement prescriptions on the best available science. Foundationally, this means understanding normal physiology so we can understand how the body will react to the abnormal physiology of the stressors of flight. This presentation will provide some basic physiological overview, with special attention to emerging injury patterns, such as the effect of hypoxia, traumatic brain injury (TBI), and acute lung injury (ALI).

Learning Objectives

1. Understand the physiology of TBI and ALI.
2. Understand the stressors of flight can exacerbate certain medical conditions.

[175] SCIENTIFIC DEVELOPMENTS RELEVANT TO PATIENT MOVEMENT

Samuel Galvagno¹

¹Maryland Critical Care Network, Baltimore, MD, USA

(Education - Case Study: Clinical / Human Performance)

Scientific developments over the past decade significantly impact patient movement in the Joint Trauma System. The epidemiology of injuries from recent conflicts indicates a high proportion of patients with traumatic brain injury and acute lung injury. Preclinical studies have demonstrated exacerbation of neuronal following exposure to hypobaric histopathological changes that lead to axonal damage and impaired motor function. Hypobaric may also have an adverse effect on the respiratory system, aggravating lung injury. These findings have raised concerns about the timing of aeromedical evacuation (AE) for patients with traumatic brain injury and acute lung injury. A discussion of these updated scientific findings holds potential for further optimization of

patient care both at the individual and population levels. The limitations of preclinical studies will be discussed, highlighting practical aspects and the challenges of bringing the results of bench work to the bedside.

Learning Objectives

1. List key findings from recent preclinical (animal) blast injury/traumatic brain injury studies.
2. Analyze future avenues for translational research and the implications for aeromedical evacuation.

[176] PRACTICAL AEROMEDICAL PRESCRIPTIONS

Samuel Galvagno¹, Alex Keller²

¹Maryland Critical Care Network, Baltimore, MD, USA; ²Air War College, Montgomery, AL, USA

(Education - Case Study: Clinical / Human Performance)

Chances are for junior aeromedical clinicians, that a set of best practices exist for their patients, especially those with recent TBI. Appropriate Aeromedical prescriptions are key to providing en-route care during Aeromedical movement. Prevention of hypoxia and hypotension can be the two most important and treatable conditions in the acute moderate to severe TBI patients. Additionally, commonly implemented, and sometimes overlooked, measures like hearing protection and cognitive rest are simple and implementable solutions that can be implemented earlier in the CASF or holding area pre-transport for mild TBI. Understanding the patient requirements and capabilities of the crew complement allow the FS to make appropriate aeromedical prescriptions for best possible outcomes. While "no one gets better at altitude" we owe it to our warriors to provide the best aerospace medicine prescriptions we can based on their condition and current medical knowledge.

Learning Objectives

1. Appreciate how scientific updates translate into useable aeromedical prescriptions.
2. Participants should be able to identify four basic and vital aeromedical prescriptions for patients with mild-moderate TBI.

[177] AN OPERATOR'S PERSPECTIVE ON AEROMEDICAL EVACUATION AND THE IMPACT ON THE PERFORMANCE OF THE MOBILITY AIRLIFTER

Theresa Weems¹

¹Air War College, Montgomery, AL, USA

(Education - Case Study: Clinical / Human Performance)

Support for fixed wing aeromedical evacuation is one of four USA Mobility Air Force's core competencies. Mobility airlifters are proud to support this critical mission, and appreciate the dedicated professionalism from members of the aeromedical community as they advocate for their patients. As we have effectively transitioned away from airframes dedicated solely to aeromedical evacuation, we have had tremendous advances in our ability to get the right lift capability to the right patient or group of patients at the right time. At the same time, this means that every mobility airlifter may be called to support an aeromedical evacuation request, usually with medical crews with which they have little interaction with. This reinforces the needs for mutual understanding between the front end and back end crews. This presentation will review common aeromedical requests for operational support that come from the aeromedical evacuation policy as currently practiced. It will explain the tradeoffs in terms of impact on individual airframes and missions, including variables such as costs and fuel consumption, but also discuss the implications on enterprise level concerns. Finally, it will discuss limitations in our current mobility fleet and options that could be explored to expand capacity as a combat enabler.

Learning Objectives

1. Help facilitate discussion between line and medical operators.
2. Understand the implications of aeromedical evacuation prescriptions and policy on the Mobility Air Force mission.

[178] WARGAMING CONTINGENCY CARE IN NEAR-PEER CONFLICTS: A2/AD AND CBRNE

Jeffrey Kinard¹

¹The Air University, Montgomery, AL, USA

(Education - Case Study: Clinical / Human Performance)

Uncontested U.S. air superiority over the last two decades of conflict in the Middle East and Southwest Asia provide combatant commanders a sense of complacency regarding medical care and aeromedical evacuation of military forces. Reports of around-the-world flights for a single casualty feed this perception. Future conflicts are likely defined by anti-access/area denial (A2/AD) technologies, and a potential introduction of chemical, biological, radiologic, nuclear and explosive (CBRN) weapons, producing casualties at orders of magnitude greater than current low-intensity fighting. This is the fifth year of partnership between Air University (AU) and the Air Force Surgeon General assessing the Air Force Medical Service's (AFMS) role in providing combat medical support for near peer conflicts. Via a unique wargaming research model, a team of AU students and faculty gathered subject matter experts from across the Air Force and Uniformed Services University to simulate this combat environment. Findings will require adjustments to AFMS training platforms and responsibilities to ensure operational success in future conflicts. These combat environments also generate tension with current standards of care and treatment paradigms as operational demands dictate maximal return to duty for mission essential personnel. Early successes with this wargame research model are to be expanded with later evolutions focusing on Joint medical operations in a similar combat environment.

Learning Objectives

1. Understand the variety of challenges in the A2/AD wartime environment and how they impact patient movement within the Joint Trauma System.
2. Appreciate areas in where current treatment paradigms need to be revisited based on future threats.

Tuesday, 05/19/2020

Regency 8

2:00 PM

[S-38]: PANEL: DEGRADED VISION IN THE AEROSPACE ENVIRONMENT

Chair: Micah Kinney

PANEL OVERVIEW: This panel presents new research on an assortment of degraded vision topics in various aerospace environments. Degraded vision can result from weather, night, hypoxia, or an ocular injury or disease. Understanding the operational impact that reduced vision has on the aviator leads to better training, mishap prevention, and improved vision standards. The first presentation in this panel comes from collaborative research between the Naval Medical Research Unit Dayton and the U.S. Army Aeromedical Research Laboratory. Researchers explored the relationship between spatial disorientation and mental workload. As pilots followed a lead aircraft into a cloud deck, all visual reference was removed and workloads were varied to better understand how spatial disorientation can be effected with increased mental tasking. Second, researchers from the Naval Medical Research Unit Dayton present data on a common nighttime visual illusion, the black hole (BH) approach. Findings from this human performance study suggest that incorrect True Aimpoint (TAP) selection, and the failure to recognize, leads to more BH errors. Next, with an increase in reported physiological episodes, a novel study from the Naval Medical Research Unit Dayton explored visual performance and photoreceptor physiology in a normobaric hypoxia environment using a more sensitive computerized cone contrast test. The fourth presentation will be on a collaborative data driven initiative between the Naval Medical Research Unit Dayton and the Naval Aerospace Medical Institute using operationally relevant human performance to help guide updates to U.S. Navy aviation vision standards and waiver policy. Finally, research performed at the Naval Medical Research Unit Dayton will be presented that explored how physical and visual stressors increase neck and back discomfort in a prolonged "helo hunch" posture. Audience members will get a variety topics related to degraded visual information and the impact that plays in the aerospace environment.

[179] REDUCED MONOCULAR VISION IN PILOT LANDING PERFORMANCEMicah Kinney¹, Michael Reddix¹, Dain Horning¹, Charles Powell², Matthew Rings³¹Naval Medical Research Unit Dayton, WPAFB, OH, USA; ²Henry F. Jackson Foundation for the Advancement of Military Medicine, WPAFB, OH, USA; ³Naval Aerospace Medical Institute, Pensacola, FL, USA

(Original Research)

INTRODUCTION: Vision standards have long been used in pilot selection and retention in both civilian and military aviation. Visual acuity for the U.S. Navy and Marine Corps remains one of the strictest of the services. In its 100+ year history, Naval Aviation has only granted one reduced monocular vision waiver. This study aimed to evaluate pilot performance with simulated reduced vision in one eye to establish operationally-based vision standards and data-driven waiver policy. **METHODS:** Thirty-two military pilots performed vision tasks under normal visual conditions and with reduced monocular vision using Bangerter foils over either the right or left eye of standard issue clear flight glasses. The experimental design was totally within subjects and participants were divided equally between dominant and non-dominant blurred vision with each task counterbalanced. Vision tasks were distant visual acuity, contrast acuity, stereopsis, and ocular dominance. Simulated approaches in the T-6A Texan II (Flite Advantage) were flown using a high fidelity cockpit with three 65" OLED 4K out-the-window displays. Measures of flight performance included root mean square error (RMSE) in altitude variance and glideslope deviation. **RESULTS:** Native binocular visual acuity averaged a Snellen equivalent of 20/14 (LogMAR -0.14, SD 0.05). Binocular vision utilizing a monocular Bangerter foil averaged a Snellen equivalent of 20/16 (LogMAR -0.10, SD 0.07). Foil reduced vision in either the dominant or non-dominant eye averaged a Snellen equivalent of 20/44 (LogMAR 0.34, SD 0.07). No significant interactions were found between dominant or non-dominant eye blur in RMSE altitude variance ($p = 0.1$) or glideslope deviation ($p = 0.27$). Overall, no significant difference was observed in performance between control and test conditions for RMSE altitude variance ($p = 0.58$) or glideslope deviation ($p = 0.47$). **DISCUSSION:** Mildly reduced monocular vision does not show a significant degradation in landing and binocular visual performance of experienced pilots. While visual acuity is an important measure of the visual system, learned skills such as flying may not be impacted significantly by a mild reduction in only one eye. Study results will be discussed from a vision standards standpoint and the importance of data-driven operationally relevant waiver policy.

Learning Objectives

1. Participants will better understand that vision standards are important in pilot selection and retention. Reductions in vision can occur during a pilot's career as a result of ocular injury or disease. Current U.S. Navy and Marine Corps vision standards do not allow for deviations from 20/20-0 in either eye.
2. The audience will learn how this study aimed to review current USN/USMC vision standards in the context of human performance following a simulated mild reduction in vision in one eye.

[180] EFFECTS OF VARIOUS TYPES OF COCKPIT WORKLOAD ON INCIDENCE OF SPATIAL DISORIENTATION IN SIMULATED FLIGHTHenry Williams¹, Dain Horning¹, Benton Lawson Lawson², Charles Powell¹, Frederick Patterson¹¹Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, USA; ²Naval Submarine Medical Research Laboratory, Groton, CT, USA

(Original Research)

INTRODUCTION: Spatial disorientation (SD) refers to a pilot's misperception of the attitude, position, or motion of his/her aircraft, with respect to the Earth, gravitational vertical, and/or other objects, including other aircraft. SD is one of the leading causes of fatal mishaps in military and civilian aviation. While several studies have examined the effects of SD on cognition or have linked increased cockpit workload to SD, few specifically and systematically compared how various types of workload interfere with maintenance of spatial orientation. **METHOD:** Twenty four pilots flew simulated flights, following a lead aircraft. Each flight started

above a cloud deck but then descended into the clouds where the lead aircraft eventually disappeared while in a turn. Participants were instructed to level their wings when the lead disappeared. Six flights were flown in each of four different workload conditions. The baseline condition presented no additional workload, while the other conditions added either a verbal working memory task, a spatial mental rotation task, or a spatial variable-following-distance task. Measures of SD included the number of control reversal errors (CREs) and percentage of time spent in unusual attitudes (UAs) while in the clouds. **RESULTS:** The verbal working memory task condition resulted in a statistically significant threefold increase in the number of CREs, while the mental rotation and variable-following-distance task conditions yielded significant increases in UAs. **DISCUSSION:** The elevated number of CREs in the working memory condition shows that cockpit workload need not be spatial in nature to interfere with maintenance of spatial orientation. However, the increase in UAs in the two spatial workload conditions provides evidence of competition for spatial resources. The results will be discussed from attentional resource and task interference perspectives, and the importance of using different SD measures will be emphasized.

Learning Objectives

1. The audience will learn that spatial disorientation is one of the leading causes of fatal mishaps in military and civilian aviation.
2. The audience will learn that secondary cockpit tasks and workload drivers need not be spatial in nature to increase the probability of spatial disorientation.
3. The audience will learn that when possible, it is usually advisable to employ more than one measure of spatial disorientation to detect a spatial disorientation event.

[181] APPROACH INITIATION AIMPOINT ERRORS AS A CAUSAL FACTOR OF BLACK HOLE ILLUSIONFrederick Patterson¹, Henry Williams¹, Richard Folga¹, Sarah Sherwood¹¹NAMRU-Dayton, Dayton, OH, USA

(Original Research)

INTRODUCTION: Pilot surveys and accident statistics document Black Hole Illusion (BHI) is a leading form of spatial disorientation that results in dangerously low approach paths during night landings. The existent literature supports the link between runway visual illusions and BHI, with particular emphasis on the role of unfamiliar visual angles of runway perimeter lights as a primary causal factor of BHI. However, these studies also suggest that BHI is unlikely to occur at distances greater than 4.5 nm, where the relatively small retinal image of the runway lights is presumed to be below the BHI visual threshold. Since mishap data documents BHI errors at runway distances greater than 4.5 nm, this research effort hypothesized BHI may also be caused by perceptual problems unrelated to visual angle variances of runway size or slope. **METHODS:** To investigate the possibility of BHI perceptual problems originating at distances greater than 4.5 nm, 26 pilot participants flew a series of simulated day and night landing approaches from a starting distance of 8.0 nm. **RESULTS:** In general, pilots flew significantly lower landing approaches during simulated nighttime conditions than daytime conditions. Of the 26 participants, 24 (92%) demonstrated BHI approach characteristics during simulated nighttime conditions. Results supported three sequential BHI error components that began 8 nm from the runway: (1) *BHI I*, excess push-over; (2) *BHI II*, improper True Aimpoint (TAP) selection; and (3) *BHI III*, failure to recognize incorrect TAP position. BHI I and BHI II errors were of short duration (4.5 and 9.0 sec., on average, respectively) and occurred within the first few seconds of approach initiation. In contrast, BHI III errors took place over a period of several minutes. **DISCUSSION:** BHI can be caused by incorrect TAP placement at distances where unfamiliar runway dimensions have little to no visual effect. Consequently, without proper instrumentation (ILS/PAPI lights), small errors in initial aim point placement are difficult to recognize during the first few minutes of visual night landing approaches and can result in BHI.

Learning Objectives

1. Understand that the Black Hole Illusion (BHI) is a leading form of spatial disorientation that results in hazardous low approach paths during night landings.
2. Understand the link between errors in runway aim point placement at up to 8 nm and the BHI.

[182] CONE CONTRAST THRESHOLDS: A MORE SENSITIVE MEASURE OF VISUAL DECLINE IN HYPOXIC CONDITIONS

Matt Funke¹, Micah Kinney¹, Dustin Huber², Vincent Billock¹, Michael Reddix¹

¹Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, USA; ²Naval Survival Training Institute, Navy Medicine Operational Training Center, NAS Patuxent River, MD, USA

(Original Research)

BACKGROUND: Of the physiological systems distressed by hypoxia, among the most demanding is the visual system, which requires a high level of oxygen due to the consumption requirements of those tissues involved. In the event of a failure in the equipment designed to maintain a physiological equilibrium in an aerospace platform, the pilot or aircrew within could be exposed to a hypoxic environment. As such, insufficient levels of breathable oxygen would result in numerous perceptual and cognitive impairments for those affected. Normal color vision is achieved by long- (L), medium- (M), and short- (S) wavelength sensitive cone photoreceptors. Traditional color vision tests (e.g. pseudoisochromatic plates) are not precise enough to measure individual differences in cone sensitivities, and as a result have not proven useful in hypoxia research. With the new Rabin Cone Contrast Test (CCT), a rapid, reliable, and sensitive test is now available to detect individual differences in color vision performance thresholds, and may be shown to be effective in this realm. **METHODS:** Participants performed the CCT under normal conditions to establish a performance baseline. The CCT consisted of a four-choice colored Landolt C only visible to L, M, or S cones in a decreasing staircase of cone contrasts to determine individual thresholds, which was able to be achieved in under three minutes. Using the Reduced Oxygen Breathing Environment, cone thresholds were measured during four sequential time periods while participants were exposed to a 9.7% oxygen concentration. Recovery from the low-oxygen exposure was also measured following the administration of 21% O₂ to participants. **RESULTS:** Findings indicated a relatively steady performance in participants' contrast thresholds in the L- and M-cone photoreceptors, but showed evidence of a rapid decline following a period of stability in the S-cone photoreceptors. Additionally, contrast thresholds for all stimulus types returned to baseline levels upon the administration of 21% O₂. **CONCLUSIONS:** In the presence of a hypoxic environment, as expected, short-wavelength cone photoreceptors were the first to be negatively affected. Given this finding, several approaches could be adopted to mitigate changes in S-cone sensitivity, such as making use of adaptive displays to accommodate the artificial deficiency in color vision created by hypoxia, or altering in-cockpit displays to incorporate elements of more easily seen color symbology.

Learning Objective

1. The audience will learn about the effects of hypoxia on cone contrast thresholds.

[183] AN EXPLORATORY STUDY ON THE INTERACTIONS BETWEEN PHYSICAL AND VISUAL STRESSORS, NECK PAIN, AND TASK PERFORMANCE DURING PROLONGED 'HELO-HUNCH' SEATING

Peter Le¹, Charles A. Weisenbach², Jacob Jadischke², Lanie Monforton³, Emily Mills⁴, Micah Kinney¹

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(Original Research)

INTRODUCTION: Neck pain (NP) has been associated with a substantial number of distracted/hurried flights. Given likely impacts to mission effectiveness and readiness, our study seeks to explore a potential progression from biomechanical changes to NP to performance decrements through the interaction of physical and cognitive factors. Visual display contrast has been associated with increased mental

loading and increased muscular tension in the neck. However, we do not know how visual stressors may influence biomechanical changes as an interaction with posture and physical loading from a helmet and the overall influence on task performance. The **objective** was to investigate these factors as a function of interactions between visual stressors and physical loading during prolonged seating in a 'helo-hunch' posture.

METHODS: 2x2x2 counterbalanced design; eight conditions total. Independent variables were helmet (H) (none (H0) vs. donned (H1)), posture (P) (symmetric (P0) vs. asymmetric (P1)), and visual stress (V) (low (V0) vs. high contrast (V1)). Each condition was tested for 30 minutes with rest between conditions. Measurements included kinematics and electromyography. Performance was evaluated through a Tumbling "E" task at two visual contrasts based on the assigned condition (V0, V1).

RESULTS: The interaction of P1xV1 resulted in 4° of increased head extension compared to P0xV0 (p = 0.0490), and V1 had more intermittent axial head rotations (p = 0.0319). V1 induced slower reaction times (p = 0.0144) and increased errors (p = 0.0362). The interaction of H1xP1 exhibited faster reaction times relative to H0xP0 (p = 0.0148). However, an increase in errors were seen for H1xP1, H1xP0, and H0xP1 compared to H0xP0 (p = 0.0395). Reports of subjective neck discomfort were also higher for H1xP1, H1xP0, and H0xP1 compared to H0xP0 (p=0.0298).

DISCUSSION: Visual stressors may influence posture and muscle activity when adapting to an environment. In conjunction with postural or physical discomfort, this may result in hurried responses and increased errors. These findings may support a need for further investigations on possible links between biomechanical loads, physical discomfort, and task performance, which may provide insight for near-term administrative controls (i.e., visual adjustments) and potentially guide downstream engineering controls (i.e., design or training/selection).

Learning Objectives

1. Understand that musculoskeletal loads endured in the occupational environment are multifactorial in nature and dependent on the interaction of multiple factors (physical, cognitive/psychosocial, and individual).
2. Discomfort and/or pain resulting from those loads may also have effects on task performance. Some of these factors may include areas outside of the common purview, such as physical loads (i.e., vibration, armor, head-supported mass).
3. The 'systems-perspective' may give us better insight on areas that we can control/adjust in the near-term and inform future areas of design, training (i.e., work-hardening), and/or personnel selection.

Tuesday, 05/19/2020

Regency 5

2:00 PM

[S-39]: PANEL: ADVANCES IN AEROSPACE MEDICINE IN IBEROAMERICA

Chair: Angela Gomez

Co-Chair: Lina Sanchez

PANEL OVERVIEW: In 2020, the panel sponsored by the Iberoamerican Association of Aerospace Medicine (IAAM) celebrates its 23rd year of sharing scientific advances in Iberoamerica. Conducted in the Spanish language, it will be chaired by the IAAM members, Dr. Angela Gomez-Reyes, of Colombia, and co-chaired by Dr. Lina Sanchez, of Colombia, the panel will commence with a clinical case about heart failure caused by cardiac hemochromatosis in a pilot student, conducted by Dr. Jean Carlos Duenes, of Venezuela. Next, Dr. Luis Merino, of Mexico, will talk about abnormalities of binocular vision in pilots in training as a risk to the safety of air operations. The panel will continue with a presentation by Dr. Rocio Garzon, of Colombia, spatial disorientation training at Colombian Air Force. Dr. Alexandra Mejia-Delgado, of Colombia, will then discuss circadian changes during acclimatization on the personnel involved in Antarctic mission and Dr. Diego Garcia, of Colombia, will complement the session talking about the first effort for achieving cultural and conceptual equivalence among different HFACS versions. As always, the panel offers an opportunity to learn from our colleagues and encourages an internationally united environment towards enhancing world aviation safety.

[184] HFACS FOR IBEROAMERICAN COUNTRIES: ACHIEVING EQUIVALENCE WITH THE ORIGINAL VERSION IN ENGLISH

Diego M Garcia¹, Johana Giraldo², Carlos Salicrup³

¹Embry Riddle Aeronautical University, Daytona Beach, FL, USA;

²UAEAC. Colombia Civil Aviation Authority, Bogota, Colombia;

³Iberoamerican Association of Aerospace Medicine, Mexico City, Mexico

(Education - Program / Process Review Proposal)

BACKGROUND: The Human Factors Analysis and Classification System (HFACS) framework and taxonomy is a widely accepted instrument for the analysis of the human role, preconditions, supervisory and organizational influences causing accidents and incidents. HFACS is extensively used in assessing mishaps in safety-critical industries, and have been proven to be comprehensive, reliable, and relatively easy to apply. Indeed, copious scientific evidence demonstrating HFACS suitability for safety assessment in complex systems makes it one of the most applied accident investigation tools worldwide, Iberoamerican countries included. Numerous military and civilian organizations in Spanish-speaking countries use HFACS versions loosely translated into Spanish, causing some elements of the taxonomy to be lost in translation or distorted from their original meaning. Previous research found that unstructured modification of the validated tool impacted its reliability greatly, encouraging a rigorous adaptation process for HFACS Spanish versions. **OVERVIEW:** Cross-cultural adaptation of analytic instruments requires a structured process to validate existing tools in other languages/cultural settings. A translation-retro translation approach was used to achieve a consensual Spanish version achieving conceptual equivalence with the original HFACS version in English. Using an online survey, native Spanish-speaking HFACS experts were asked to translate the main tiers, categories, and subcategories of the taxonomy into Spanish. A 3-step reassessment was used to solve discrepancies and to narrow down the final translated taxonomy to a general consensus among the panel of experts. Finally, the resulting Spanish version was translated back into English by native English-speaking experts, in order to evaluate conceptual equivalence between the resulted and the original version of HFACS. **DISCUSSION:** HFACS Spanish version will be presented as the initial step for cross-cultural adaptation of the taxonomy into the Spanish language. This Spanish version was built after a general consensus of HFACS experts and establishes the base for validating the instrument in different safety-critical operational settings in Spanish-speaking countries. Also, this constitutes the first effort for achieving cultural and conceptual equivalence among different HFACS versions, while maintaining its widely recognized attributes and advantages for accident investigation and safety management processes.

Learning Objective

1. Discuss the requirements for cross-cultural adaptation of the HFACS taxonomy into Spanish.

[185] HEART FAILURE CAUSED BY CARDIAC HEMOCHROMATOSIS IN A PILOT STUDENT

Jean Carlos Duenes R¹

¹Cardiocountry, BOGOTÁ, Colombia

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This case report describes a case of a pilot student who was studying to determine the presence of heart failure potentially caused by increase in iron deposits. **BACKGROUND:** Hemochromatosis is a recessive hereditary disorder that causes an increase of intestinal iron absorption. It is a disease characterized by an excessive iron deposit in a variety of tissues, including the heart. It occurs as a result of ferritin accumulation in the left ventricle bringing as consequences systolic dysfunction, heart rhythm disorders, clinical manifestations include atrials, ventricular tachycardia, atrioventricular block and symptoms of congestive heart failure, this last one is the first cause of death in these patients. Also, the diagnosis can be confirmed taking endomyocardial biopsy where iron deposit is seen in the sarcoplasm. **CASE PRESENTATION:** A 21-year-old male who was interested in obtaining an aeromedical certificate presented with risk factors for coronary heart disease, his symptoms were dyspnea,

paroxysmal nocturnal dyspnea, palpitations, generalized asthenia (weakness concomitant with erectile dysfunction) and a family history of sudden death. Results of the medical examination revealed the presence of apex beat displacement outside the fifth intercostal space with axillary midline hyperdynamic character. As a result of Holter monitoring, severe impairment of function was evident in the left ventricle, with ventricular tachycardia. After multiple other studies, the conclusion was reached that hemochromatosis was present. The student was treated with a cardio defibrillator, inhibitor angiotensin receptors, and beta-blocker therapy. **DISCUSSION:** Patients with dilated or restrictive cardiomyopathy must be examined for this condition. The patient, who was seeking to eventually obtain a commercial pilot's license was not granted a waiver due to the various aeromedical regulations associated with such privilege. Applicants would be considered not fit because of possible complications besides doing pulmonary edema, and sudden death there is also a high probability that paroxysms occur atrial fibrillation with the indication of anticoagulant therapy. **KEYWORDS:** Hemochromatosis, pilot, student, cardiomyopathy, aerospace medicine.

Learning Objective

1. To determine the presence of heart failure in a pilot student potentially caused by increase in iron deposits.

[186] SPATIAL DISORIENTATION TRAINING AT COLOMBIAN AIR FORCE

Rocío Garzón¹, Sonia Jaimes²

¹Colombian Air Force, Bogotá, Colombia; ²Colombian Air Force, Bogotá, Colombia

(Education - Program / Process Review Proposal)

BACKGROUND: Spatial disorientation (SD) continues to be one of the most important contributors to aircraft incidents and accidents in the world today. This phenomenon can be experienced by pilots whether they fly military or civil aircraft, regardless flight experience (represented by flight hours). During their career, pilots are exposed to presenting episodes of SD. For this reason, one of the main tasks to prevent the fatal consequences of SD is the education and training of aircrews. **REPORT:** The Colombian Air Force currently performs the SD training program supported by high-tech equipment, which integrates different axes movements, visual information on high definition, as well as the tasks to perform a normal flight mission. The aim of the training program is to show the manifestations of the physiological limitations of the human being. This training demonstrate the strategies to recognize, prevent, or overcome an SD episode. **DISCUSSION:** Colombian Air Force pilots must take this training every 4 years according to military regulations. The training consists of a theoretical session and a practical session of illusions. This training method was built after 6 months of work, including review of the SD literature and information provided by pilots most experienced in each type of aircraft (fixed and rotary wing) and operation. The first training is exactly the same for pilots of all type of aircraft; it includes the most frequent and most dangerous illusions. After this phase, the participants are trained on different illusions pertinent to the operations they perform. Under this training scheme, 329 students have been trained from April 2015 to September 2019. This training has been very well accepted by pilots. This training has allowed mixed groups of trainees with low and high experience. This approach has provided an opportunity for improved collaboration. Also enriched feedback to personnel with less expertise on regular flight missions.

Learning Objective

1. Presenting the Colombian Air Force flight physiological training program in SD. It was created with the purpose to supplement the formation of the aircrew, improving effectiveness and efficiency on aeronautical activity in different operational contexts. It can be used as a model for other physiological training programs.

[187] ABNORMALITIES OF BINOCULAR VISION IN PILOTS IN TRAINING AS A RISK TO THE SAFETY OF AIR OPERATIONS

Jose Merino¹

¹CEO Aeronautical Visual Therapy for Aviation Pilots Mexico, Mexico City, Mexico

(Original Research)

INTRODUCTION: There are different clinical situations that can prevent the development of a binocular vision, such as the different perception of the image in the retina of the right eye with respect to the left eye when the subject has a condition known as anisometropia. The aviator pilot is not exempt from presenting such anomalies and many students in training in different aviation schools may present such alterations which may put their air operations in risk, particularly in the approach and landing phases. **OBJECTIVE:** Once the cause of the anomaly in the binocular vision is determined, it is possible to establish an adequate treatment through oculomotor and perceptual exercises. This approach was assisted with flight simulation systems to correct in a program which can range from weeks to months depending on the visual problem to increase the safety of the student's air operation. **METHOD:** Twenty cases of aviation students were included in the study, who were rejected by aviation medicine services due to alterations in binocular vision with intermittent monocular suppressions and / or alternating at different distances and decompensated phorias triggered during exercises in a flight simulator. An ophthalmological medical examination was performed on each of the aviation students, which included refraction using dynamic retinoscopy and autorefractometry, visual capacity and a review of eye movements and accommodative flexibility. **RESULTS:** The average time from the diagnosis of the anomaly in binocular vision of the aviation student in our practice and its reincorporation to their flight activities was six months where eighteen of the 20 cases managed to obtain favorable results. **CONCLUSION:** The aeronautical visual therapy program has demonstrated excellent results that are completely measurable and reproducible, where all visual skills are developed in a favorable way supporting our work in brain neuroplasticity.

Learning Objective

1. The audience will learn about the importance of aeronautical therapy in increasing the safety of air operations in aviation students.

[188] CIRCADIAN CHANGES DURING ACCLIMATIZATION ON THE PERSONNEL INVOLVED IN ANTARCTIC MISSION

Alexandra Mejia-Delgado¹, Diana Pintor- Murcia¹

¹Colombian Air Force - Aerospace Medical Center, Bogota, Colombia

(Original Research)

INTRODUCTION: Circadian rhythms are delayed frequently and significantly during the lack of exposure to natural light in the Antarctic winter, as has been observed under certain conditions during the Antarctic summer. This internal desynchronization produces a sleep cycle during a suboptimal phase, which is reflected in late sleep time. The loss of regulation of the photoperiod, secondary to continuous illumination during the summer and constant darkness during the winter, has shown a disturbing effect on hormonal regulation, producing desynchronization and delayed melatonin phase, which is inhibited. **METHOD:** Pre mission and post mission Melatonin and Cortisol levels were measured in a group of researchers composed by 15 male and 01 female participating in the III Summer Antarctic Expedition (n= 16). Sleep Quality Index was analyzed also. **RESULTS:** After a chronic exposure (35 days) to Antarctic Summer, a decreased melatonin level was found in 51% of the researchers (p< 0.005) compared with pre exposition levels. Furthermore, 48% of the studied population reported poor sleep quality during the Antarctic mission. **DISCUSSION:** As has been repeatedly demonstrated, melatonin secretion is inhibited when exposed to constant daylight during Antarctic summer. Our findings on subjective sleep quality confirm previous reports, being that participants in Antarctica consistently complain about poor sleep quality. Timed light exposure as a function of endogenous phase, with or without carefully timed melatonin treatment, could be good prevention ways on this population.

Learning Objective

1. The participants will understand the body effects of hormonal changes and sleep disturbances during Antarctic missions.

Tuesday, 05/19/2020

Centennial I

4:00 PM

[S-40]: PANEL: UNUSUAL SITUATIONS IN CLINICAL AVIATION MEDICINE: HOW TO MANAGE?

Sponsored by Francophone Society of Aerospace Medicine

Chair: Olivier Manen

Co-Chair: Jonathan Monin

PANEL OVERVIEW: The role of the aeromedical expert (AME) is to assess the risk for a medical event in one individual to jeopardize the flight safety and also the evolution of the aircrew's career, based on a medical report including anamnesis, physical exam and all investigations required when necessary. The final decision shall respect national or international norms such as the EASA regulations which allow more or less flexibility, depending on the status of the aircrew. Usually, there is a discussion about aeronautical fitness in case of a precise diagnosis, leading to the study of scientific data for one particular disease including the natural history, the possible complications and the risk of the treatment. Consequently, the AME may be at ease to back up the decision and to explain when temporary or permanent unfitness. However, is the situation so simple in the real life, particularly regarding the daily practice in Aeromedical Centers? Indeed, sometimes the diagnosis is possible but not definite, or a clear diagnosis is not associated with any argument for an etiology. In other times, one pathology or syndrome is considered but is quite rare, and so the AME may neither have experience of it nor find a guide in the regulations like the EASA Acceptable Means of Compliance. There are also aircrews working in a very particular aviation specialty such as for civil fighter pilots flying with a Class 1 medical certificate only, and yet they are exposed to sustained +Gz accelerations. Pregnancy should also be considered as unusual situations in female aircrews if we refer to the low number of professional women who are able and decide every year to continue flying once they are aware of the diagnosis. Finally, the AME has to face, psychologically speaking, atypical applicants or confirmed pilots with some difficulties to manage despite the place of mental health in the European regulations. This panel will try to give key elements to the AME for the decision-making process in all these situations illustrated by different case reports.

[189] HOW TO COPE WITH A DIAGNOSTIC DOUBT IN AEROMEDICAL EXPERTISE?

Nicolas Huiban¹, Laetitia Corgie¹, François-Xavier Brocq¹, Jonathan Monin², Sebastien Bisconte², Dominique Luton³, Eric Perrier², Marc Monteil¹, Olivier Manen²

¹French Military Health Service, Toulon, France; ²French Military Health Service, Clamart, France; ³Public Hospitals of Paris, Paris, France

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: These case reports illustrate situations where the fitness decision issue is confronted with uncertain diagnoses. **BACKGROUND:** Decision making in aviation medicine is most often part of a well-established framework in which epidemiological data allow to assess the risk of in-flight incapacitation through possible sequelae, complications and the recurrence risk. When clinical profile is less obvious, the challenge of expertise takes on a new dimension. **CASES PRESENTATION:** We will first present some doubtful EEGs in selection for military applicants before describing three case reports illustrating various situations. A case of poorly systematized deficient symptoms with evocative white matter lesions findings in an airline pilot will lead to discuss a demyelinated disorder or an isolated radiological syndrome. Then, we will describe the occurrence of lipothymic discomfort at the exercise height in a flight test experimenter, leading to document a hypoglycemia as well as a coronary disease without argument for paroxysmal arrhythmia or ischemia. We will last present a transient confusional episode in a young student helicopter pilot where no obvious etiology will consider a not typical transient global amnesia.

DISCUSSION: Aviation medicine typically relies on making a double prognosis related to the in-flight medical incapacitation risk and the safety challenge. A fitness decision will therefore require a healthy status not modified by flight circumstances, allowing to perform all on-board duties without challenging mission safety. With no clear diagnosis after a medical event, this approach gives rise to new questions: Is it more appropriate to use the most frequent, the most probable or the most risky diagnostic hypothesis regarding aeronautical prognosis? Should doubt benefit fitness with regard to operational issues? Do flight duties then become the main determinant for decision? If so, could operational limitations be justified and which ones? Should the situations with uncertain diagnosis be considered equally for initial applicants and confirmed pilots? These questions thus define specific challenges in aviation medicine. In the end, a case-by-case approach will often take shape in the light of all these considerations and will highlight both the importance of the training and the interest of the practice of AME (which we would like to illustrate here).

Learning Objective

1. Be aware of the aeromedical decision-making issues in case of uncertain diagnosis.

[190] RARE DISEASES : HOW TO MANAGE THE AERONAUTICAL FITNESS?

Sebastien Bisconte¹, Marie Marechal¹, Gaetan Guiu¹, Jonathan Monin¹, Nicolas Huiban², Caroline Brescon¹, Jeran-Francois Oliviez¹, Anne-Pia Hornez¹, Eric Perrier¹, Olivier Manen¹

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

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This case report highlights the difficulties for the aeronautical expert to manage fitness to fly for a pilot who suffers from a rare genetic disease. **BACKGROUND:** Pseudoxanthoma elasticum (PXE) is a genetic metabolic disease with autosomal recessive inheritance caused by mutations in the ABCC6 gene. The clinical prevalence of PXE has been estimated from 1 per 100,000 to 1 per 25,000. In the clinical description of PXE, there are dermatological signs (yellow papules on the nape and sides of the neck and in flexural areas), ophthalmological signs (angioid streaks may trigger choroidal neovascularization and, ultimately, loss of central vision and blindness in late-stage disease) and cardiovascular lesions (peripheral artery disease, myocardial infarction, angina pectoris). There is no cure for PXE. **CASE PRESENTATION:** Routine screening during initial examination of a 19-yr-old helicopter pilot applicant revealed (an) angioid streaks and loose and wrinkled aspect of the skin. He was referred to a national eye hospital where the diagnosis of PXE was confirmed. A detailed analysis of this case report will be presented, including the medical and aeronautical management, the risk assessment of in-flight incapacitation and the potential consequences of the exposure to specific aeronautical constraints. **DISCUSSION:** The authors will try to extract general guidelines for the aeronautical fitness management in case of a rare disease.

Learning Objectives

1. The participant will learn about diagnosis of PXE and its clinical manifestations.
2. The participant will learn about rare disease management by an aeronautical expert.
3. The participant will learn about aeronautical considerations of rare disease.

[191] UNUSUAL DUTIES AND FITNESS ASSESSMENT: WHEN REGULATIONS ARE OF NO HELP

Jonathan Monin¹, Gaëtan Guiu¹, Nicolas Huiban², Anne-Pia Hornez¹, Jean-François Oliviez¹, Sébastien Bisconte¹, Eric Perrier¹, Olivier Manen¹

¹Military Aeromedical Center, Paris, France; ²Military Aeromedical Center, Toulon, France

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: The aeromedical assessment is generally based on the disease of the aircrew member. According to its severity, the risk of

worsening in relation to flights, and the risk of occurrence of inflight symptoms, the aeromedical expert can take a fit or unfit decision. But another criterion is very important to consider: the real duty of the crew. **BACKGROUND:** In this presentation, the authors will present some unusual duties which could be a problem for the aeromedical decision. Based on case reports of aircrews followed in our AEMC, we will first discuss the problem of the aerobatics fitness in civilian aviation, and then discuss some other unusual specialties. **CASES PRESENTATION AND DISCUSSION:** The European civilian regulations don't talk about aerobatics, which can be a problem for several professional pilots, but also for the private pilots who regularly practice aerobatics, sometimes as a competitive sport. We will first present a civilian professional pilot flying in Rafale as an instructor. The systematic EKG showed a 1st degree atrioventricular block, associated with supraventricular rhythm disturbances and a mild aortic valve disease. An evaluation including non invasive then invasive cardiological tests, but also human centrifuge and inflight test was performed to allow a return to fly. During the follow-up, the valve heart disease and the rhythm disturbances worsened, which jeopardized his fitness to fly. We will then discuss a civilian fast jet team pilot who regularly performed cardiological investigations for the follow-up of premature ventricular beats. Six years after the onset of this arrhythmia, a Holter monitoring showed a non sustained ventricular tachycardia which led to a diagnosis of arrhythmogenic right ventricular cardiomyopathy. Other unusual duties will be discussed like nurses working in hypobaric chambers who regularly suffer from decompression sickness whereas no regulation exists about their fitness, a flight engineer responsible for loading and unloading stuff on Beluga with hypertrophic cardiomyopathy and atrial fibrillation during the evolution, also the flight engineers and attendants in zero G flights who are asked to get a private pilot medical certificate to fly. **CONCLUSION:** This presentation shows that, when there is a lack in the official regulations when unusual but specific duties, the aeromedical decision must be taken according to science and a good knowledge of the aeronautical constraints.

Learning Objective

1. To understand how to take a fitness decision when the aircrew duty is not described in regulations.

[192] IMPLICATION OF PREGNANCY FOR PILOTS AND CABIN CREW FITNESS TO FLY

Dominique Luton¹, Olivier Manen², Catherine Cardines³, Pierre André Leduc⁴, Jean Francois Paris⁴, Vincent Feuillie⁴

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(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: Pregnancy is a non-pathological state which induce a particular vulnerability owing to profound physiological changes and specific jeopardizing conditions. The aeromedical expert will be confronted with standardized problems but also with unusual conditions necessitating sometimes multiple expertise. **BACKGROUND:** Medical issues in pregnancy implicates two beings: the mother and the fetus. For both the pilot and the cabin crew in flight duty is a physiological and potential emotional stress event that can interfere with the well being of the mother and the fetus. On the other hand some specific pregnancy risk can interfere suddenly and dramatically inducing a risk for the mother, the fetus and the flight security. The aim of the AME will have to deal with the wish of some pregnant staff to keep on flying with respect of the international rules and the ability to prevent at risk situation by either taking a decision of temporary grounding followed by a waiver or not. **CASES PRESENTATIONS:** One study and two type of cases will be presented. Our experience on a retrospective period of ten years will be presented giving the frequencies and the timing of flight for different crew categories mainly among our national airway company. The main items to be check listed before flight authorization will be discussed, and the main contra indication due to specific health condition or environmental factors and kind of flight will be reminded. Specific recurrent conditions such as management of early pregnancy or post miscarriage period will be displayed. Aftereffect of serious obstetrical conditions such as placenta accreta will also be shown with the aim to help the AME to determine the best timing for flight duty authorization.

Specific at risk infectious destination will also be discussed. **DISCUSSION:** The role of the AME for dealing with specific obstetrical condition need to have accurate knowledges and to have an available specialist network in order to take the best decision for the pregnant staff member but also for the flight security. As most of the obstetrical complications are difficult to anticipate one attitude could be to have a systematic grounding decision; but many staff individual wish to go on flying and therefore specific pragmatic rules have been established. One paradox is that early pregnancy which has a real risk of serious non predictable threatening complications is often not well considered in due time.

Learning Objectives

1. The audience will learn about the various pregnancy conditions which will indicate a decision of grounding or not.
2. The audience will be helped to manage a pragmatic decision for a pregnant cabin crew wishing to fly that will preserve her own safety and the flight safety.

[193] ATYPICAL MEDICO-PSYCHOLOGICAL PRESENTATIONS IN AVIATION MEDICINE

Olivier Manen¹, Jonathan Monin¹, Gaëtan Guiv¹, Nicolas Huiban², Jean-François Oliviez¹, Anne-Pia Hornez¹, Dominique Luton³, Sébastien Bisconte¹, Eric Perrier¹

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(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: Aeromedical experts are regularly confronted with initial applicants or confirmed pilots with a borderline psychological presentation, but such an expertise is usually difficult to manage from the beginning to the final decision. **BACKGROUND:** The Germanwings tragedy has highlighted the importance of mental health in pilots and has recently led to a renewal of the European regulations with a serious change in the psychiatric and psychological part of the Acceptable Means of Compliance for civil pilots. However, despite the practical impact of this official guide, there are situations where the AME may not be at ease. **CASES PRESENTATION:** Two categories of case reports will be presented: Firstly, there are applicants or pilots who have presented either a medical episode or a professional, personal or family event which clearly questions about the mental health, and yet the individual is not convinced about that, he may be opposed to a specific evaluation, and the trust relationship between him and the AME may turn into suspicion and conflict. Examples will be developed as this applicant coming with a strange tattoo, or these pilots who have stopped their activity in relation to a stress-related / aviation-related disorder or protective measures decided by the aviation authority. Secondly, during their career several aircrews ask for a definitive unfitness and yet there is theoretically not enough medical or psychological argument to conclude in this way, including after a specific assessment. This situation is typically related to fatigue and/or demotivation, also to working conditions presented as unfavourable to continue flying, and sometimes to a conflict with the employer who may be described as responsible for the medical condition of the aircrew ("aerotoxic syndrome"). **DISCUSSION:** The role of AME is crucial for the screening of atypical medico-psychological situations but also later after the knowledge of interesting findings. The accessibility to a psychiatrist or a clinical psychologist qualified in aviation medicine is not immediate. Consequently, AME are expected to determine particularly which individual shall require such an evaluation and shall continue flying while waiting for it. The decision is facilitated in the Aeromedical Centres by questioning about the feeling of the other members of the medical staff, a collegial thought if necessary, and a regular debriefing with colleagues about such cases to improve experience.

Learning Objectives

1. The audience will be aware of several various and difficult situations when the mental health is jeopardized in aircrews during the aeromedical expertise.
2. The audience will learn to determine which of the pilots with a mental health questioned shall require a specific psychological assessment and what immediate decision is the more appropriate.

Tuesday, 05/19/2020

Centennial II

4:00 PM

[S-41]: PANEL: AUTOMATION IN AEROSPACE AND HEALTHCARE: CHALLENGES AND OPPORTUNITIES

Chair: Brian Musselman

Co-Chair: Diego Garcia

PANEL OVERVIEW: Improving the capabilities of machines has increased productivity and safety, and enabled the development of complex systems. Despite these advances, human behaviors and cognitive limitations outputs are the main drivers for mishaps. Automation has become a successful countermeasure against human error in safety-critical operations; the automated human-machine interface poses challenges that can decrease overall safety. Unexpected failures that require a human to take control of a system, automation surprises, and the need to maintain vigilance for long periods of time are examples of how human performance can impact safety. Aviation and healthcare are two industries in which automated systems have become part of routine operations. Unmanned aerial vehicles are being developed for delivery, surveillance, and teamed operations with manned aircraft. Urban air mobility (UAM) vehicles that will transport people with little or no human control are being tested, and may be introduced to the commercial transportation system. Commercial aviation and space operations use highly automated systems that require a decreasing amount of human intervention. In fact, single pilot (and even pilotless) operations in commercial aviation are being proposed as safer and, of course, more profitable alternatives. Healthcare decision support systems and robotic surgery are becoming more prevalent. Aerospace and healthcare are two examples of industries in which the introduction of automation and other leading-edge technology has improved productivity while raising questions about safety. Human limitations and a loss of trust in technology are barriers to their implementation. This panel discusses barriers and opportunities for implementation of highly automated systems, and provides suggestions for research and education.

[194] QUALITATIVE ANALYSIS OF COMMERCIAL AVIATION COMMUNICATIONS BREAKDOWN AS A REQUIREMENTS INPUT TO SINGLE PILOT OPERATIONS

Brian Musselman¹

¹US Air Force, JB Charleston, SC, USA

(Education - Program / Process Review Proposal)

INTRODUCTION: Single pilot operations are an emerging development in commercial aviation. Effective communications are a challenge of single pilot operations. Understanding current communications challenges between aircrew and ground-based operators can inform requirements for single pilot operations development. The purpose of this study is to identify factors associated with poor human-machine interaction through qualitative analysis of Aviation Safety Reporting System (ASRS) reports submitted by personnel operating under Part 121. **METHODS:** The data for this research was obtained from the ASRS database. The search parameters included reports from January to December 2018 from Part 121 operations where human factors were the primary problem and communications breakdown was a reported human factor. Qualitative research was conducted using NVivo Plus version 12 for exploration, coding and analysis. **RESULTS:** More communication breakdowns were reported in descent, approach (initial and final), and cruise than other phases of flight. Majority of the communications breakdowns during descent and initial approach is with TRACON, during final approach is with tower, and during cruise is with center. There are potentially different factors contributing to communication breakdown with TRACON during descent than with other phases of flight. The coded occurrence of communication breakdown in February, September, and December is higher than other months. **DISCUSSION:** This quantitative study provides several remarkable results in the phase of flight and month of the year. Future research could involve targeted audits for increased granularity as to the types of communication

breakdown during descent, approach (initial and final), and cruise, and factors contributing to the month.

Learning Objectives

1. The audience will learn about cause of communication breakdowns between pilots and ground-based controllers.
2. The audience will learn about communication breakdowns by phase of flight.
3. The audience will learn about communication breakdowns by control function.

[195] AI IN SPACE HEALTHCARE: HOW, WHEN AND WHY

Ilaria Cinelli¹

¹Florence, Italy

(Education - Program / Process Review Proposal)

INTRODUCTION: Medical monitoring and health maintenance on the International Space Station (ISS) are carried by a system made of a series of individual components, not integrated for redundancy. Here, the ground control oversees and provides remote assistant to astronauts in space throughout the mission. In incoming missions beyond low Earth Orbit, the crew shall become Earth-independent or autonomous from the ground. The system providing healthcare and onboard medical capabilities shall be re-engineered when accounting of a different end-user, such as commercial astronauts (CAs) and space tourists (STs). **METHODS:** Onboard machines may replace part of the tasks executing by the ground if provided with intelligence. Here, the requirements for having a robust artificial intelligence (AI) are identified to highlight the existing gaps with current AI developed for Terrestrial applications when looking at the specific case of healthcare. Large discrepancies arise when considering the type of data, ethics and risk of medical conditions. Against this backdrop of limitations, an approach is proposed for generating data by running classified analogue missions (CAMs). Such classification aims at controlling operational stressors and stresses of adaptation to isolation in extreme environments. So, the deriving medical risk model of CAMs aims at giving insights into a possible medical scenario when CAs and STs will be onboard. Then, guidelines are suggested for including AI in already existing devices and for confining the impact of AI in decision making. **RESULTS:** The implementation of CAMs is shown for a short-duration mission run in the Utah desert. Then, an example of AI integration is shown in neuromodulation where an intelligent brain-stimulating device is designed to function as a brain countermeasure. **DISCUSSION:** The medical risk model, on which AI and ethics build on, shall include CAs and STs. Then, AI in space healthcare is going to be reliable if the system supporting the development of AI and the collection of data is robust. More research is needed for preserving health in commercial activities.

Learning Objectives

1. Understanding the importance of artificial intelligence (AI) in space healthcare.
2. The medical risk model of commercial astronauts and space tourists may be established by running classified analogue missions.
3. AI developed for terrestrial applications is not transferable to healthcare in space.

[196] HOW WEATHER, DISTANCE, FLIGHT TIME, AND GEOGRAPHY AFFECT CONSUMER WILLINGNESS TO FLY IN AUTONOMOUS AIR TAXIS

Nadine Ragbir¹, Stephen Rice¹, Scott Winter¹, Mattie Milner¹

¹Embry-Riddle Aeronautical University, Daytona Beach, FL, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Several studies have examined passengers' trust in human-operated systems versus autonomous systems. Prior studies have also examined consumers' willingness to fly on a fully autonomous airplane. Much of this research focused on autonomous vehicles and commercial aircraft. With the development of Urban Air Mobility (UAM), fewer studies have focused on how the public feels about this innovative revolution. Some studies have investigated consumer perceptions of UAM such as willingness to fly (WTF) in air taxis; while other studies focused on creating a prediction model on WTF in autonomous air taxis. However, to date, no study on UAM has examined consumers' WTF based on distance, flying over land versus flying over water, flying over urban or rural areas, and weather. Therefore, the purpose of this study was to investigate consumers'

WTF on an autonomous air taxi in various situations. **METHODS:** Participants included 50 volunteers. In 16 different conditions, participants were asked to rate their willingness to fly in an autonomous air taxi, given information about the weather (rain or no rain), where they are flying over (urban or rural), if they were flying over (land or water), and the flight time (5 minutes or 30 minutes). These conditions were presented randomly to each participant. Subsequently, participants were asked qualitative, open-ended questions. **RESULTS:** In general, results suggested that participants were more willing to fly on air taxis for a duration of 5 minutes as opposed to 30 minutes. Furthermore, participants were less willing to fly if the air taxi was flying over water instead of land. The results also indicated that participants were more willing to fly if there was no rain. Lastly, there were no differences between flying over a rural area versus an urban area. **CONCLUSIONS:** Willingness to fly on an autonomous air taxi depends on a variety of factors, such as weather, where passengers are flying over, if passengers were flying over land or water, and the flight time. In general, participants were less willing to fly for a duration of 30 minutes, if the air taxi was flying over water, and if it was raining. However, participants showed no differences in their willingness to fly over rural or urban areas.

Learning Objective

1. The purpose of this study was to investigate consumers' willingness to fly on an autonomous air taxi in various situations.

[197] HUMAN PERFORMANCE FACTORS ASSOCIATED WITH MEDICAL AUTOMATION: A LITERATURE REVIEW

Keith Ruskin¹

¹University of Chicago, Chicago, IL, USA

(Education - Program / Process Review Proposal)

INTRODUCTION: Automation has become an integral part of aviation, medicine, and other industries. Automated systems increase safety because they are not affected by physical and cognitive limitations that impair human performance. In the operating room and intensive care unit, systems such as monitors, anesthesia gas machines, and ventilators are now controlled by software, which is in turn managed by the clinician. Unlike operators in other industries, however, physicians seldom if ever receive formal training on the human performance challenges presented by automated systems. **METHODS:** A comprehensive literature review was conducted that included the keywords "automation," "medical equipment," "ergonomics," and "human performance." Articles were reviewed for relevance to the topic. **RESULTS:** A total of 39 articles were relevant to the topic of human performance and automation in the operating room and intensive care unit. These articles discussed advanced technology, alarm fatigue, automated checkouts, and failures. Several articles also discussed the implications of boredom and complacency that are associated with increasing levels of automation. **DISCUSSION:** Medical devices have become increasingly complex and can fail in unexpected ways. Increasing levels of automation in the clinical environment poses challenges that have been confronted in industries such as transportation and nuclear power. Reliance on automated systems can cause disuse of human skills, impairing a physician's ability to cope with system failures. Automation surprises can present confusing and sometimes contradictory information, making it difficult for the human operator to regain control of the system. This presentation will discuss similarities between medical automation and systems such as flight deck avionics. It will then suggest ways to apply human performance principles learned from aviation to automated systems in medicine.

Learning Objectives

1. The participant will understand similarities between automated systems in medicine and aviation.
2. The participant will learn how to apply human performance principles to improve safety of automated systems in the clinical environment.
3. The participant will understand how automation failures, automation surprises, boredom, and complacency can affect safety.

[198] OPTIMIZING HUMAN PERFORMANCE VIA CLINICIAN'S SELECTION OF REASONS FOR COGNITIVE AID NON-USE: A STEP TOWARDS USEABLE AUTOMATED COGNITIVE AIDS

Anna Clebone¹, Keith Ruskin¹

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(Education - Program / Process Review Proposal)

INTRODUCTION: Despite the established benefits of following the advanced cardiac life support (ACLS) guideline during cardiac arrest situations, it is not always accessed. Automating the appearance of a critical event cognitive aid during cardiac arrest and other critical events could lead to increased use of the aid if the reason for non-access was unavailability. Conversely, if the reason for non-access was that the clinician perceived that the aid was not needed, or that the clinician disagreed with the protocol, automating the appearance of the aid might not be as useful. We hypothesized that the rate of unavailability of the cognitive aid as a reason for cognitive aid non-use could be found with a self-reported survey. **METHODS:** After IRB exempt designation (Univ. Chicago IRB16-0718-AM001), incidences of and reasons for cognitive aid use and non-use during actual perioperative critical events were collected pre- and post implementation training. All anesthesia clinicians at a single academic medical center were surveyed, including 70 clinical faculty and certified registered nurse anesthetists, and 76 residents and fellows. The Chi Square test was used to compare data before and after implementation. **RESULTS:** The response rate was 64.5%. Over 80% of respondents encountered at least one critical event. Participants reported guideline non-use in 93% of reported events. Reasons for cognitive aid non-use were collected for both the control arm (before aid implementation) and the study arm (after aid implementation), with 334 reasons reported total. Reasons for non-use fell into six categories. Incidence in each category (control/study, category % of total) was: A = 'not available' (50/17, 50%), N = 'not needed' (60/57, 35%), T = 'no time' (14/19, 9%), P = 'another person running crisis' (25/13, 11%), H = 'used in another way' (15/16, 9%), O = no reason given (21/27, 14%). A difference between the control (before implementation) and study (after implementation) arms was found for reason A = 'not available'; Chi-Square, 12.55, $p < 0.001$.

DISCUSSION: Increased use of emergency guidelines during and perioperative critical events may improve patient care. The reason for cognitive aid non-use was unavailability in over 50% of cases. This finding supports the possibility that making cognitive aids automatically available may be found useful by clinicians. The authors would like to thank Barbara K. Burian, Ellen Choi, Allan Klock, and Avery Tung for their integral roles.

Learning Objectives

1. Understand the reasons for critical event cognitive aid non-use in one study in the peri-operative setting.
2. Gain additional insight into one way that looking at human factors can inform the creation of future automation.

Tuesday, 05/19/2020

4:00 PM

Centennial III

[S-42]: PANEL: OPERATIONAL CONSIDERATIONS FOR DEATH IN SPACE - PART 2**Chair: Philip Stepaniak****Co-Chair: Robert Patlach**

PANEL OVERVIEW: BACKGROUND: As human spaceflight increases in frequency and duration, the risk of a death in space increases as well. This is the second of two panels discussing operational considerations of a death in space. **OVERVIEW:** The tempo of flying in space is increasing, especially with the ongoing development of new, proposed NASA space programs working in participation with its international partners and commercial vendors involved in human space travel. Mishaps have occurred during launches and landings, while to date no catastrophic mishaps or deaths in space have occurred; nonetheless, the possibility certainly exists. The motion picture industry has somewhat trivialized this event on the big screen; conversely, in reality there are many challenges, impacts, and workarounds should a death occur. The goal of these panels is to highlight and outline the multiple operational considerations in responding to a death in space. **DISCUSSION:** This panel will discuss a proposed timeline of events for an on orbit death. The timeline includes pronouncement, forensic sampling, preparation of remains and options for storage. Interim events discussed will include behavioral health, crew and family issues with cultural and legal concerns. Other considerations discussed will be future low earth orbit, lunar, Mars and deep space programs.

[199] DEATH IN SPACE PROTOCOL CONSIDERATIONS: ISS, GATEWAY, ORION, LUNAR, MARS AND BEYONDAnn Tsung¹¹University of Texas Medical Branch - Galveston, TX, Houston, TX, USA*(Education - Program / Process Review Proposal)*

BACKGROUND: Despite the low probability of crewmember death in space, a body bag is on the International Space Stations (ISS) for contingency purposes. The body can be stored and returned in a visiting crew or cargo spacecraft depending on the circumstances. Gateway, Orion, Lunar, and Mars programs are the missions of the future. Specific contingency protocols should be established as the risk of death will rise with increasing number of missions. **OVERVIEW:** Aspects to be examined include mission length, mission profile, number of crewmembers, vehicle specifications, volume, mass, and time constraints. Also included are medicolegal jurisdiction, forensic sampling capabilities, body bag specifications, options for body disposition, cultural and religious customs, and behavioral health of the living crew. Spacecraft mass and volume constraints will determine if a forensic sampling kit and body bag will be present. For long-duration missions, the durability of the body bag is unknown. Current law does not define medicolegal jurisdiction if death occurs in space, or the party responsible for the death certificate. Body disposition options include re-entry cremation in an expendable vehicle, return in a crewed or reusable vehicle, jettison into space, tethered external vehicle placement, burial on the planetary surface, and perhaps in distant future, human composting in a colony ship greenhouse.

DISCUSSION: The time to construct a protocol for each mission and vehicle has come as the programs are ramping up. Having a systemized process will optimize the behavioral health of the living crew and ground personnel during a very traumatic situation. Procedural validation of the protocols will be vital. An integrated approach to protocol creation should be taken with the engineers, crew surgeons, crewmembers, behavioral health practitioners, and legal representatives. Ultimately, the preparedness will ensure the best chance of a successful mission and lay the groundwork for future commercial space participants.

Learning Objectives

1. Describe various aspects that play a role in developing a death in space protocol.
2. Understand various possibilities of body disposition in space.

[200] OPERATIONAL CONSIDERATIONS FOR DEATH IN SPACE: BEHAVIORAL HEALTH AND PERFORMANCE ASPECTSGary Beven¹, Albert Holland¹, James Picano¹, Rachel Passmore², Ronald Moomaw², Jacqueline Reese³¹NASA Johnson Space Center, Houston, TX, USA; ²University of Texas Medical Branch, Galveston, TX, USA; ³KBR, Houston, TX, USA*(Education - Program / Process Review Proposal)*

BACKGROUND: Human spaceflight presents an environment that contains inherent risks, some of which can be fatal. To date, there has not been an inflight space mission fatality with surviving crew members. Such an event would necessitate the remaining crew act as first responders, declare death, complete forensic sampling, consider options for remains disposition, honor the fallen colleague, grieve at a distance alongside family and friends, and safely continue the mission. If it were to occur, a death during a mission and the actions that the surviving crew would take afterward will present significant behavioral health and performance challenges. **OVERVIEW:** The death of a crewmember during a space mission will present unique challenges. These include the necessity of initially responding to the tragedy in a manner that allows for preservation of forensic samples and rapidly addresses pragmatic operational issues including remains disposition and crew duty replacement. These actions will require the initial suppression of grief in order to function dispassionately; however, natural human mourning and grief will occur and must be effectively addressed in order to carry on mission duties safely. Such an event will also affect the entire spaceflight community including crew, mission control, family, friends, governmental organizations, and countries of crew origin. This scenario will require an effective and organized response that addresses behavioral health and performance elements as well as operational exigencies. **DISCUSSION:** The Johnson Space Center's Behavioral Health and Performance

Operations Group alongside the JSC Employee Assistance Program would respond immediately to a death in space event. Aspects of response include: consultation with mission crew surgeons, flight directors and management; private psychological conferences with the mission commander and crew medical officer; consultation with NASA Astronaut Office family support providers; engagement with crew family members; initiation of center-wide Employee Assistance Program crisis response; consultation with International Partners; enabling virtual crew participation in funeral and memorial services; and monitoring/facilitating grief during the remainder of the mission as well as post-mission. This presentation will provide a template of such a response for consideration by other space agencies and programs to utilize as well as discuss relevant lessons learned from the Columbia mishap.

Learning Objective

1. The audience will become familiar with the predicted behavioral health and performance aspects of crew death in space, including the common stages of grief, as well as recommendations for response to such an event.

[201] TIMELINE OVERVIEW: PROCEDURAL APPROACH TO MANAGING INFIGHT FATALITY

Michael Barratt¹, Kjell Lindgren¹, Phillip Stepaniak¹, Gary Beven¹, Edward Mazucowski², Kathleen McMonigal¹, Randall Suratt¹, Travis Houser¹, Steven Uhl¹, Michael Misiora¹, Lorraine Benavides-Gibson¹

¹NASA Johnson Space Center, LEAGUE CITY, TX, USA; ²USAF, San Antonio, TX, USA

(Education - Program / Process Review Proposal)

BACKGROUND: A fatality onboard a spacecraft or space station, similar to that in analogous hazardous venues such as polar or other remote field stations, represents a tragic and highly disruptive event. Lack of preparedness for such an event can render a situation worse as stakeholders formulate real-time responses and actions. The resulting disruption can be mitigated by executing a coherent plan with procedural steps available to both crewmembers and ground support personnel.

OVERVIEW: A plan has been developed for the International Space Station (ISS) that prepares both onboard crewmembers and ground personnel to respond to an onboard fatality that does not prompt station evacuation. ISS capabilities support ample real-time audio and video channels which can be privatized, as well as sufficient volume that allows private spaces to perform post mortem actions. The plan developed for ISS involves onboard procedures and specialized hardware available to crewmembers, procedures and communication protocols for flight control team members, and actions for other stakeholders that ensure a ready and timely response. Just as in ground fatalities, certain actions are time and sequence sensitive. Onboard ISS procedures will guide crewmembers through the steps of pronouncement of death, forensic sampling, final preparation of remains, and short term storage. These steps are performed in the first 12 hours. Eventual long term disposition may include onboard storage and/or return to Earth. All steps and procedures must be precise, validated, and well documented during execution yet performed in a dignified manner. **DISCUSSION:** The new ISS plan for management of an onboard fatality ensures a mature and orderly response to a tragic event. It is understood that circumstances surrounding an onboard fatality, such as station damage or contamination, may significantly complicate such a scenario. A ready-made sequence of procedures forms the core of such a response to minimize real-time deliberation. As for other emergency response plans, this implies training of crew and flight control team and exercising elements of these procedures. Other space platforms will require similar plans customized to vehicle specific risk scenarios and resources.

Learning Objective

1. The audience will become familiar with the sequence of events and support elements required to respond to death on-orbit for the International Space Station.

[202] LEGAL AND ETHICAL CONSIDERATIONS FOR DEATH IN SPACE

Randall Suratt¹, Edward Mazuchowski², Phillip Stepaniak¹, Robert Patlach¹

¹NASA, Houston, TX, USA; ²US Air Force, San Antonio, TX, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Human spaceflight presents a challenging and unique environment that comes with inherent risks, some of which can be fatal. Anticipating crew death in space in context of the International Space Station operations (consisting of international vehicles and crew) and industry's entry into space exploration provides novel legal and ethical issues to already complex operational considerations. **OVERVIEW:** This presentation examines these issues in the context of the International Space Station, future multilateral vehicles and missions, and commercial spaceflight. First, the presentation will explore the existing international agreements and treaties that govern space exploration; identify where they provide guidance on these issues, and where reference may need to be made to national laws for guidance on issues such as declaration of death and remains jurisdiction disposal. The presentation will also briefly address maritime law examples of death at sea as an analogy to space exploration. Finally, we will examine the relevance of these issues for future commercial space activities, and identify any areas where additional law or policy may need to be developed.

DISCUSSION: This work is of broad interest to those pursuing human space flight and its operators. Planning for death during a mission is a critical piece of any mission operation. As space exploration transitions from continuous low earth orbit operations to deep space missions by both Governmental and Commercial actors, death of a crew member while in flight is inevitable. This inevitability underscores the need for those pursuing human space flight to understand the current framework of laws which may pertain to the issues discussed here and also the need for identifying and addressing gaps in the existing international law.

Learning Objective

1. The audience will become familiar with legal concerns involving the death of crew in space, including jurisdictional considerations aboard the International Space Station.

Tuesday, 05/19/2020

4:00 PM

Centennial IV

[S-43]: PANEL: FATIGUE AND SLEEP DEPRIVATION ASSOCIATED WITH EXCESSIVE USE OF ENTERTAINMENT PERSONAL TECHNOLOGY DEVICES IN AVIATION

Chair: Andrew Doan

Co-Chair: William McDonald

PANEL OVERVIEW: This panel presents an educational session on the problems with fatigue and sleep deprivation associated with entertainment personal technology use (PTU), particularly with video gaming, social media, and mobile devices. The first presentation will discuss a case of excessive online video gaming in a former active duty aviation mechanics instructor that resulted in significant fatigue, sleep deprivation, and self-induced injuries. The second presentation will review the current literature pertaining to social media and PTU associated with fatigue and mental health issues. The third presentation will cover the current knowledge in the field of sleep, fatigue, and human performance. The presentation will cover strategies to improve sleep quality and rest. The fourth presentation will discuss the current WHO and DSM-5 diagnostic criteria for "gaming disorder" and "internet gaming disorder." Addiction screening tools for gaming and PTU will be discussed. Future research directions and clinical concerns related to aviation readiness, resilience, and rest in a modern world with growing digital distractions will be discussed.

[203] SLEEP DEPRIVATION AND SELF-HARM ASSOCIATED WITH EXCESSIVE INTERNET GAMING, A CASE STUDY

Andrew Doan¹, Brendon Farrel¹, Daniel Miles¹, Stuart Glass¹, Christina Stromsness¹, Joseph McKinley¹, William McDonald¹

¹Naval Aerospace Medical Institute, Pensacola, FL, USA

(Education - Tutorial Proposal)

BODY: Personal technology use (PTU) for entertainment and internet gaming has been associated with health problems, particularly

with sleep. We discuss a case of an active duty aviation maintenance instructor who failed to report to work after a 72-hour period of binge gaming with a massive multiplayer online role playing game (MMORPG). An investigation revealed significant lack of cleanliness in his home, and the service member suffered a pneumothorax from a self-induced knife injury. The service member overslept his alarm due to severe sleep deprivation after playing for most of his 72-hour leave period. He admitted that excessive gaming with the MMORPG resulted in sleep deprivation and fatigue. To devise an excuse for missing work, he induced self-injury and fabricated a story of robbery and assault. The issue of sleep deprivation associated with PTU and excessive gaming will be discussed in regard to aviation aircrew and ground crew resilience and readiness.

Learning Objective

1. The participant will understand how excessive personal technology use may be associated with fatigue and sleep deprivation in aircrew and ground crew, affecting readiness and resilience.

[204] FATIGUE AND SLEEP DEPRIVATION ASSOCIATED WITH EXCESSIVE USE OF ENTERTAINMENT PERSONAL TECHNOLOGY DEVICES IN AIRCREW

Christina Stromsness¹, Landon McKinley¹, Andrew Doan¹, William McDonald¹, Emily Makhoul¹

¹Naval Aerospace Medicine Institute, Pensacola, FL, USA

(Education - Tutorial Proposal)

BODY: The literature was reviewed to evaluate the research pertaining to social media and personal technology use (PTU) associated with mental health issues. Research has shown that increased social media use was associated with higher depression and social anxiety symptoms. Age seems to be inversely related to social media and personal technology device use. The possible association between depression and anxiety symptoms in younger populations and social media use could suggest that the frequent use of social media may present a risk factor for mood disorders in youth and young adults. Additional research is needed to investigate the prevalence between mood disorders and PTU in young adults, particularly those who are involved with aviation ground crew and maintenance of aircraft. The combination of sleep problems and mood disorders associated with excessive PTU and social media use may result in significant reductions in resilience and readiness.

Learning Objectives

1. The audience will learn about the possible association between depression and anxiety symptoms with increased social media use.
2. The audience will learn how the combination of sleep problems and mood disorders associated with excessive personal technology devices and social media use may result in significant reductions in resilience and readiness.

[205] SLEEP DEPRIVATION AND STRATEGIES FOR IMPROVING SLEEP

Landon McKinley¹, John Cooper²

¹Naval Aerospace Medicine Institute, Pensacola, FL, USA

(Education - Tutorial Proposal)

BODY: This presentation reviews the stages of sleep and discusses the physical, cognitive, and emotional response to sleep deprivation with an emphasis on human performance. The current research on the effects of blue light emitted by digital screens on circadian rhythms will be reviewed. Finally, we will review the current medical interventions for the treatment of insomnia, including CBT, pharmacotherapy, sleep hygiene and the concept of earthing (grounding) as a possible intervention. As more digital distractions and personal technology use (PTU) increase, aerospace medicine specialists should be able to screen for, and assist patients in reducing PTU-induced sleep problems. Improving sleep and the quality of sleep will improve aircrew and aviation ground crew resilience and readiness.

Learning Objective

1. To familiarize the audience with the effects of sleep deprivation on human performance. current interventions for the treatment of insomnia.

[206] DSM-5 AND WHO CRITERIA FOR INTERNET GAMING DISORDER AND IMPLICATIONS FOR THE AVIATION COMMUNITY

William McDonald¹, Christina Stromsness¹, Joseph McKinley¹, Andrew Doan¹

¹Naval Aerospace Medical Institute, Pensacola, FL, USA

(Education - Tutorial Proposal)

The World Health Organization (WHO) included gaming disorder into the ICD-11 in 2019. The DSM-5 classifies internet gaming disorder as one of the "Conditions for Further Study." Both the WHO and DSM criteria for internet gaming disorder and the implications to aviation will be reviewed. We will discuss how to recognize internet gaming disorder and process addictions and currently available screening tools for internet gaming disorder. Finally, future research directions in this field will be discussed.

Learning Objectives

1. Recognize DSM-5 (American Psychiatric Association) and ICD-11 (World Health Organization) diagnostic criteria for Internet Gaming Disorder.
2. Discuss proposed exclusionary criteria.

Tuesday, 05/19/2020

4:00 PM

Regency 6

[S-44]: PANEL: SAFETY CENTERS YEAR-IN-REVIEW

Sponsored by Aerospace Safety Committee

Chair: Tyler Brooks

PANEL OVERVIEW: This panel presents the results of a review of 2019 aerospace safety programs and data. Representatives from military and civil aerospace organizations will present summaries and analyses of their programs and safety data collected in 2019. Cause factors including human factors will be explored, identifiable trends will be highlighted, and updates on risk mitigation strategies and will be discussed. Developments and initiatives in aviation safety-related policies and programs will also be shared. The panel discussion is a unique opportunity to review the collective experiences of safety programs from multiple organizations and consider a variety of risk mitigations solutions in the aerospace environment.

[207] TRANSPORT CANADA: YEAR IN REVIEW 2019

Tyler Brooks¹

¹Transport Canada, Ottawa, Ontario, Canada

(Education - Program / Process Review Proposal)

BACKGROUND: Transport Canada is the federal regulator responsible for policies and programs which promote safe, secure, efficient, and environmentally responsible transportation in Canada. This presentation will familiarize participants with the mission of the Civil Aviation Medicine (CAM) Branch of Transport Canada, and highlight topics of interest arising in 2019. **OVERVIEW:** The mission of the CAM Branch of Transport Canada is to ensure aircrew and air traffic controllers are medically fit, to close gaps in scientific knowledge of Canadian aviation medicine, to promote health and safety in the field of aviation, and to prevent aircraft accidents due to medically related human factors. The CAM Branch will present an overview of notable civil aviation medicine issues encountered in 2019, including Transport Canada's first year of experience with federal legalization of cannabis. **DISCUSSION:** Aviation medicine practices and policy respond not only to changes in medicine, but also to changes in society and politics. The CAM Branch of Transport Canada shares its experience responding to a variety of issues in 2019, including the federal legalization of cannabis in Canada.

Learning Objectives

1. The audience will learn about the mission of the Civil Aviation Medicine Branch of Transport Canada.
2. The audience will learn about Transport Canada's first year of experience in responding to the federal legalization of cannabis.

[208] NAVAL SAFETY CENTER YEAR-IN-REVIEW

Paul DeMieri¹, Michael Penny¹, Corey Littell¹, Andrew Miranda¹

¹Naval Safety Center, Norfolk, VA, USA

(Education - Program / Process Review Proposal)

BACKGROUND: The Naval Safety Center analyzes Navy and Marine Corps aviation safety investigation reports in order to identify mishap causal factors. **OVERVIEW / METHODS:** All Class A flight mishaps involving US Navy and Marine Corps aircraft during fiscal year 2019 (FY19) were reviewed using the Human Factors Analysis and Classification System (HFACS). **RESULTS:** During FY 19 there were 5 Class A Flight mishaps in the U.S. Navy (0.61 per 100,000 flight hours) and 7 Class A Flight mishaps in the US Marine Corps (2.92 per 100,000 flight hours). A review of Class A flight mishaps over the past 10 years demonstrated that human factors were the predominant causal factors. A review of current Physiological Episodes in Naval Aviation will also be presented. **DISCUSSION:** HFACS is a useful tool in safety investigation analysis and assists in identifying causal factors to focus mitigation strategies to prevent future mishaps. Its standardization across the Department of Defense facilitates cross-analysis and shared efforts to prevent future mishaps.

Learning Objectives

1. Review the overall trend in US Navy and Marine Corps flight mishaps and the most common human factors identified as causal factors.
2. Identify the most common Human Factors Analysis and Classification System (HFACS) categories for Naval Aviation mishaps.
3. Become familiar with emerging topics of discussion at the Naval Safety Center related to aviation, including physiologic events.

[209] ROYAL CANADIAN AIR FORCE FLIGHT SAFETY: YEAR IN REVIEW 2019Ajiri Ikede¹¹Canadian Armed Forces, Ottawa, Ontario, Canada*(Education - Case Study: Clinical / Human Performance)*

MOTIVATION: The Commander of the Royal Canadian Air Force (RCAF) is appointed as the Airworthiness Authority for all aviation in the Canadian Armed Forces (CAF). The Director of Flight Safety (DFS) is appointed as the Airworthiness Investigative Authority for all flight safety occurrences with the goal of preventing accidental loss of aircraft and personnel. Contributory or causal human factors are identified using the Canadian Forces Human Factors Analysis and Classification System (CF-HFACS). Statistics and analysis from 2019 are discussed. **OVERVIEW:** Accidents and incidents in 2019 were reviewed to identify human factors which may have caused or contributed to these occurrences. More specifically, the legalization of marijuana in Canada in 2018 has not adversely affected flight safety in the RCAF. **SIGNIFICANCE:** Fatigue, culture and substances hazardous to aviation continue to be relevant hazards in the RCAF. DFS has helped to propel several risk mitigation initiatives specifically aimed these factors, including the implementation of the RCAF Fatigue Risk Management System.

Learning Objectives

1. The audience will gain an appreciation of the overall trends in RCAF flight occurrences in 2019.
2. The audience will understand the effectiveness of having a clear CAF policy on marijuana.

[210] U.S. ARMY AVIATION SAFETY: FY 2019 YEAR IN REVIEWEric Olins¹, Jon Dickinson¹¹USA Army Combat Readiness Center, Fort Rucker, AL, USA*(Education - Program / Process Review Proposal)*

INTRODUCTION: Discuss (FY) 2019 statistics and analysis for USA Class A aviation mishaps including Human Factors Analysis. **METHODS:** FY2019 data was obtained from the USA Combat Readiness Center database (ASMIS) for Class A thru C aviation mishaps and reviewed for human factors as determined by the Accident Investigation Boards. **RESULTS:** In the manned aircraft category, Army aviation experienced 48 Class A-C aircraft Flight mishaps in FY19. This was a significant decrease of 33% from the 72 Class A-C aircraft Flight mishaps reported in FY18. The US Army experienced 10 Class A aviation Flight mishaps during FY19, the same number reported for FY18. The accident rate for Class A Flight mishaps (per 100,000 flying hours) was 1.23 in FY19, a slight increase from the 1.19 Class A rate recorded in FY18. There were 3 aviation mishap fatalities in FY19 compared to 6 in FY18. **DISCUSSION:** Human error was the primary cause factor in six of the 10 Class A Flight mishaps. The FY19 Class A Flight mishap rate of 1.23 was equal to the five year rate of 1.23.

There was a 2.6% decrease in flying hours from the previous year. Overall flying hours have been reduced approximately 5.6% since FY16.

Learning Objectives

1. Review the overall trend in US Army Flight mishaps and the most common identified causal factors.
2. Understand how human factors influenced the mishaps.

[211] U.S. CIVIL AVIATION IN 2019Richard Greenhaw¹, Joshua Davis²¹FAA, Oklahoma City, OK, USA; ²Venesco, Oklahoma City, OK, USA*(Original Research)*

INTRODUCTION: Trends in accident rates and performance data were analyzed for all types of civil aviation operations with emphasis on 2019 data. **METHODS:** U.S. civil aviation accident data was analyzed to determine trends from 1990 to 2019; whereas, safety performance measures were analyzed for various time periods, depending on available data. **RESULTS:** Fatal accident rates for all types of operations, except commuter airlines, significantly decreased for the period 1990 to 2019 ($p < 0.05$). During the same period, air carrier ($p < 0.001$), air taxi ($p < 0.05$), and general aviation ($p < 0.01$) non-fatal accident rates decreased more rapidly than their respective fatal accident rates. The general aviation fatal accident rates (1.03, 0.91, and 0.84 per 100,000 hours) were below the target rates (1.04, 1.02, and 1.01 per 100,000 hours) for 2015 through 2018. Actual safety performance measure rates were all below their respective target rates for 2018. **CONCLUSION:** An analysis of accident rates between 1990 and 2019 and trends in safety performance measures for all types of operations indicated steady improvements in civil aviation safety.

Learning Objectives

1. Understand the safety improvements to civil aviation made through 2019.
2. Understand the impact of 737 MAX on civil aviation.

Tuesday, 05/19/2020

4:00 PM

Regency 8

[S-45]: PANEL: BLIND FLIGHT: A VISUAL-VESTIBULAR CONUNDRUM

Chair: Leonard Temme

PANEL OVERVIEW: To fly blind means to control an aircraft safely with no vision outside the cockpit. This is usually called instrument flight today, a term that evokes a cockpit full of instruments a pilot has to learn to master. But the terms instrument flight and blind flight are different, so their emphases are different. The former focuses on the solution, the latter focuses on the problem. This is an important distinction for the Aerospace Medical Association because blind makes explicit the biomedical origin of the problem, a fact that took a long time and a lot of lives to clarify. The present panel reviews and brings together the series of medical, physiological, and technological discoveries that enabled the first safe, controlled, completely blind flight, which LT. Jimmy Doolittle performed on 24 September, 1929. This history typically begins with Barany's 1914 Nobel Prize in Medicine and Physiology, which suggests that a great deal was accomplished during the intervening 15 years, interrupted by the Great War. But this narrative misses the fact that Barany's work is part of a story that goes back to a time when no one really knew what the vestibular system was for, what it did, or even why it was there. This problem was solved definitively in 1874, with a set of simultaneous, independent publications that identified the vestibular system as a separate, independent sixth sense, which, in the context of human history, should be seen as a momentous discovery. The present panel reviews the development of blind flight from the discovery of the vestibular system to Doolittle's flight.

[212] THE OCKER - MYERS CONNECTIONWilliam R Ercoline¹, Brian P. Self²¹KBR, San Antonio, TX, USA; ²California Polytechnic State University, San Luis Obispo, CA, USA*(Education - Tutorial Proposal)*

INTRODUCTION: Around 1918 Elmer Sperry developed the Turn Needle Gyroscope (primarily for ship navigation), and about the same

time Major (Dr) Isaac Jones codified the use of the Barany Chair for medical examiners as an important part of a pilot's physical examination. Details of the use of the "Jones-Barany Chair" are contained in the War Department's first Air Service Medical document. Although Robert Bárány's rotating chair was well known within the medical profession by 1918, it wasn't until Jones' guidance on equilibrium and vertigo was published that the use of the chair for a pilot's physical became common practice. This opened the door for a more advanced way to show pilots that they need help when flying in weather or at night.

TOPIC: Unless you're a real student of early flight, you most likely never heard of either David Myers or Bill Ocker. It can be argued that the greatest aviation scientific discovery of the twentieth century - the one event most relevant to the safe use of airplanes - happened in 1926 at Crissy Field, CA. Myers, a flight doctor, and Ocker, a military pilot, discovered a way to show pilots that flying by the seat of their pants in degraded visual conditions does not always work. The demonstration using the Ocker-Myers Vertigo Stopper Box was proof positive that pilots could not do what many thought they could do...fly an airplane without seeing the ground. You might think that things would change after this demonstration - but they didn't. Many pilots were lost over the following decades, even after Jimmie Doolittle (with the help of the Sperry Gyroscope Company) in 1929 designed an instrument to use when he flew the first full flight without seeing outside. **APPLICATION:** Although more advanced motion-based flight simulators have since been developed, they are founded on the same principles of Myers and Ocker - create a vestibular sensation that is contrary to the expected attitude. The ability to convince pilots that blind flight is a problem, and the subsequent development of instrumented flight, resulted in safe flight even during "blind" conditions.

Learning Objective

1. To recount the unusual discovery that contrary to popular belief a person could not fly by relying solely on the seat-of-the-pants; a belief that lingered long after the discovery.

[213] HISTORICAL PERSPECTIVE ON THE KNOWLEDGE OF THE HUMAN VESTIBULAR SYSTEM

Bob Cheung¹

¹University of Toronto, Toronto, Ontario, Canada

(Education - Tutorial Proposal)

INTRODUCTION: The sense organs embedded in the temporal bone on each side of the head are known collectively as the labyrinths. They include the organ of hearing known as the cochlea, the three semicircular canals, the utricle and saccule. The non-auditory labyrinth is known as the vestibular apparatus. It is concerned with the detection of signals arising from the head and body. It provides an instantaneous registration of the head with respect to gravity without any need of conscious control, but it does not inform us about the state of the external world. We become aware of the effects of vestibular apparatus only when its mechanism is disturbed or malfunctions. **TOPIC:** Since the vestibular organs are hidden from view, it is not in our conscious prominence. It is not surprising that it was the most recent of the sensory systems of humans to be discovered. This presentation provides a historic perspective from the initial discovery of the true function of the vestibular apparatus made by Flourens (1824), Goltz (1870), von Cyon (1873), Stefani (1874), Brue (1874), Crun Brown (1874), Mach (1875), Ewald, (1887), Meniere (1861) and Barany (1906, 1907). They were concerned with the mechanics of the vestibular apparatus and studied the system at an entirely behavioral and theoretical level. Steinhausen (1931, 1933) formulated the first physical and mathematical model of the cupula-endolymph system of the semicircular canals known the torsion pendulum model. Lowenstein and Sand (1940) isolated single primary afferents to the vestibular receptors and recorded their electrical activity during responses to natural stimuli. Adrian (1943) established the field of central vestibular mechanisms by extracellular recording from the central vestibular neurons in the vestibular nuclei. **APPLICATION:** The continuing knowledge of the vestibular system exerted a great impact on aerospace medicine and military aviation. For example, the human in space program has further elucidated the functionality of the vestibular system terrestrially and its adaptive responses and imitations in altered gravity. The vestibular system plays an important

role in the modelling of spatial orientation starting with the "Observer model" to the current multi-sensory integration effort, and their limitations will be discussed.

Learning Objective

1. The participants will learn about the historical development of the functions and limitations of the vestibular system and future research requirements in order to provide an optimal human performance in the aerospace environments.

[214] THE SPERRY FAMILY GYROSCOPE CONTRIBUTIONS – THEY'LL MAKE YOUR HEAD SPIN

Brian Self¹, Leonard Temme²

¹California Polytechnic State University, San Luis Obispo, CA, USA;

²U. S. Army Aeromedical Research Laboratory, Fort Rucker, AL, USA

(Education - Tutorial Proposal)

INTRODUCTION: After aviation physiology pioneers like Bill Ocker and David Myers helped establish that blind flight was a major issue, engineers and scientists had to develop a way to combat this problem. Early attempts included tying string or ribbon to the front of an aircraft as well as pendulum based devices, but the eventual solution evolved from gyroscopic principles that had been used in boating applications. **TOPIC:** The use of gyroscopic principles was proposed for attitude indicators as early as the mid-eighteenth century. John Serson developed a whirling speculum to use as an artificial horizon on a boat during adverse visual conditions. One hundred and fifty years later, these same principles were used by Elmer Sperry. Called the "father of modern navigation technology" by some, Elmer founded the company on his patent (nearly simultaneously with Herman Anschütz-Kaempfe) of the gyrocompass. He then went on to produce a gyrostabilizer for larger sea vessels, and then he and his son Lawrence Sperry used these principles to develop a gyroscopic stabilizer on an airplane - the precursor to autopilot. At the 1914 Concours de la Securite en Aeroplane competition, Lawrence and his co-pilot dramatically walked out on the wings of the aircraft to demonstrate the gyroscope-equipped stabilizers (and won the 50,000 francs first place prize). During World War I, the Sperrys won a contract from the Navy to develop a gyroscopic artificial horizon similar to what they had developed for boats. Unfortunately, the aviation accelerations proved to be too large and they were unsuccessful (although a turn indicator was developed as part of the work). They continued their work on the gyroscope-based AI in the twenties (tragically interrupted by Larry's plane crash into the English Channel under poor visual conditions), and Bill Ocker used their instrumentation in his personal airplane. **APPLICATIONS:** Recognizing the significant contributions and astute engineering provided by Sperry and his other son Elmer, Jr, Jimmy Doolittle used a gyroscopic attitude indicator developed by the Sperry Gyroscope Company. This attitude indicator is the basis for the artificial horizon attitude indicator used in almost all aircraft today.

Learning Objectives

1. Describe two major contributions to navigation made by the Sperry family.
2. Explain the basic principles of how a gyroscope operates.

[215] THEORIES OF EARLY OTOLARYNGOLOGISTS AND FLIGHT SURGEONS REGARDING BLIND FLIGHT, FROM THE PERSPECTIVE OF A CURRENT OTOLARYNGOLOGIST/FLIGHT SURGEON

Steven Harris¹

¹School of Army Aviation Medicine, Fort Rucker, AL, USA

(Education - Tutorial Proposal)

INTRODUCTION: As the U.S. entered World War I, otolaryngologist Theodore Lyster, Chief Medical Officer of Army Aviation, asked fellow otolaryngologist Isaac Jones to set up medical standards for flight applicants. Jones began a series of training and testing steps that ultimately would contribute to "blind flight". **TOPIC:** Jones used the new Jones-Barany chair as a pass/fail nystagmus test for flight applicants, and set up the flight surgeon training school. By the early 1920's, physicians and physiologists fell into two camps on the solution to Blind

Flight. Jones felt that nystagmus was a reflex and thus could not be altered by training, so persons with superior balance ability should be selected for blind flight. Louis Bauer felt vestibular impulses were due to pressure on the labyrinth, not fluid circulation as Jones taught. Those promoting this theory felt pilots could be trained using the Ruggles Orientator so that their vestibular system could enable "flying blind". P.M. van Wulfften Palthe, otolaryngologist/flight surgeon for the Dutch Flying Corps theorized in 1922 that no pilot was capable of blind flight, but that gyroscopic instruments would be required. In 1926, Flight Surgeon David Myers used the Barany Chair for a new purpose: demonstrating vestibular illusions to pilots, as we do today. After experiencing the illusions, pilot William Ocker added a gyro instrument to the chair, and the research between Myers and Ocker which laid groundwork for blind flight began. Myers' article on blind flight was "rediscovered" in the 1936 Army Medical Bulletin by this author. In the article Myers provides his perspective on the research leading to development of blind flight. **APPLICATION:** The early theories of blind flight were partially correct, but ultimately failed. Harry Armstrong wrote in 1939 that the best understanding of the physiology behind blind flight was to read Myers' research article. Instrument Flight developed from this.

Learning Objective

1. Understand the various theories through which early physicians felt blind flight could be achieved.

[216] DISCOVERING THE SIXTH SENSE: THE VESTIBULAR SYSTEM BEFORE ROBERT BÁRÁNY

Leonard Temme¹

¹U. S. Army Aeromedical Research Laboratory, Fort Rucker, AL, USA

(Education - Tutorial Proposal)

INTRODUCTION: Arguably, after achieving heavier-than-air flight, aviation's next most important technological development was controlling aircraft with no visual references outside the cockpit. This has been called 'blind flight' or 'all-weather flight' historically, and has morphed into today's concerns for degraded visual environments (DVE). On Sept 29, 1929 at Mitchel Field, Long Island, the then Lieutenant 'Jimmy' Doolittle performed the first documented, completely blind flight from take-off through navigation to landing, using information obtained solely from cockpit instruments. The success of Doolittle's landmark flight depended on understanding the problems blind flight poses along with their solutions. A key component to blind flight and DVE solutions remains the vestibular system and its relation to spatial disorientation and vertigo. **TOPIC:** In 1915, Robert Bárány received the 1914 Nobel Prize in Physiology or Medicine 'for his work on the physiology and pathology of the vestibular apparatus'. The title of his Nobel lecture, presented 11 Sept. 1916, was "Some New Methods for Functional Testing of the Vestibular Apparatus and the Cerebellum." Given the extraordinary prestige afforded Bárány's work and the continued importance of the vestibular apparatus for aviation, it is useful to clarify the history that culminated in Bárány's work. This history is particularly curious since the anatomy and microanatomy of the inner ear's vestibular apparatus had been well described by the beginning of the nineteenth century, yet the function of this curious, labyrinthine structure remained completely unknown until about 1874. Until then it was thought to be involved somehow with hearing. The historic medical and neurosensory scholarly literature describes the development of vestibular science through the nineteenth century. Within months of each other, the Austrian physician Josef Breuer, the Scottish chemist Alexander Crum-Brown, and the Czech physicist Ernst Mach, each working completely independently, published separate papers near the end of 1874 identifying the vestibular apparatus as a gravito-inertial receptor end organ system, identifying it as a newly-discovered, independent sixth sense.

APPLICATION: The independent insights of these three scientists about the vestibular system led directly to Doolittle's blind flight fifty-five years later.

Learning Objective

1. To describe the extraordinary discovery of the vestibular sensory system, a sixth sense, overlooked for about 2500 years after Aristotle said there were obviously five senses. Isn't that amazing; almost like discovering a new continent?

Tuesday, 05/19/2020

4:00 PM

Regency 5

[S-46]: PANEL: IMPACTS OF DIVERSITY IN ASTRONAUTICS & AEROSPACE MEDICINE

Sponsored by Aerospace Medicine Student and Resident Organization (AMSRO)

Chair: Nicolas Nelson

PANEL OVERVIEW: This panel will explore the impacts of diversity and inclusion as they relate to the past, present, and future of human spaceflight and aerospace medicine. As a branch of preventative medicine, aerospace medicine promotes robust outcomes by developing countermeasures based on thoughtful examination of complex factors. Our panel will review evidence-based costs and benefits of supporting diverse astronaut crews, medical teams, and other high-performing groups. We focus on a select set of demographic dimensions: nationality, residence, socioeconomic status, sexual orientation, gender, and physical and mental health. We will examine how past and current selection and training practices mutually relate to diversity within and between astronautical professions, and we will discuss implications for optimizing human performance in operations and mission execution. Our examination will include policies and precedents for flight in air and space as well as some physiologic implications and rationales. We will outline current barriers and knowledge gaps about existing attitudes, readiness, disparities, and representation in the field. Additionally, we will propose areas for follow-up and future research as well as ongoing initiatives addressing diversity and inclusion. As access to space continues to expand, so will the purview of aerospace medicine, and the considerations outlined in this panel will become increasingly crucial.

[217] SEXUAL AND GENDER MINORITY KNOWLEDGE GAPS IN ASTRONAUTICS AND AEROSPACE MEDICINE

Nicolas Nelson¹, Kseniya Masterova², Kristi Ray³, Brent Monseur¹

¹Thomas Jefferson University, Philadelphia, PA, USA; ²University of Texas Medical Branch, Galveston, TX, USA; ³Philadelphia College of Osteopathic Medicine, Philadelphia, PA, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Sexual and gender minority populations have specific health risks to consider in preventative medicine, but there is a total lack of published literature on lesbian, gay, bisexual, transgender, or queer/questioning (LGBTQ) considerations in spaceflight. The aerospace medicine community's obligation to address this gap is imminent as modern spaceflight leads toward longer-duration space missions for professional astronauts and increased opportunities for space tourism. In addition to addressing systemic underrepresentation in astronautics and aerospace medicine, this presentation aims to introduce specific health needs and existing precedents regarding sexual and gender minorities in space. **OVERVIEW:** A body of research has characterized specific, measurable, significant biological variations and neurobehavioral profiles for LGBTQ individuals, as well as well-established health risks in these populations. However, astronautical literature is devoid of LGBTQ-related discourse, and there are no published data on attitudes, readiness, and representation in the field of aerospace medicine. To date, no active astronaut has freely and publicly identified with the LGBTQ community—potentially confounded by national and/or institutional policies. In addition to established decrements in performance and mental wellness associated with concealing one's sexual or gender identity, the inability to identify oneself is a barrier to equitable provision of resources like family support, and it is a missed opportunity for valuable data collection. Furthermore, there are well-documented benefits to building diverse high-performance teams, and exclusionary precedents may cause space agencies to lose candidates with unique skillsets. Finally, as access to space continues to expand, sexual and gender minority health needs will need to be considered. **DISCUSSION:** Knowledge gaps in aerospace medicine regarding sexual and gender minorities create unnecessary barriers to advancements in human performance; key insights for long-duration spaceflight; and potential discoveries in the fields of human sexuality, sex

and gender development, and reproductive biology on Earth. Closing these gaps is a population health task that may entail cultural reform in the space industry. If successful, this would directly benefit flight surgeons and their patients by informing rational improvements in space medicine research, astronaut performance, and cross-cultural collaboration.

Learning Objectives

1. The audience will learn about specific health needs of women, other gender minorities, and non-heterosexual persons in space, and we will critically review existing policies and precedents regarding these populations.
2. The audience will learn about current knowledge gaps within aerospace medicine specifically regarding sexual and gender minorities.
3. The audience will learn about considerations regarding the support of LGBTQ individuals in spaceflight and their families on Earth by expanding on prior research on sex, gender, and sexuality.

[218] CONSIDERATIONS OF INTERNATIONAL DIVERSITY IN SELECTION & TRAINING FOR ASTRONAUTS & AEROSPACE PHYSICIANS

Benjamin Johnson¹

¹King's College London, London, United Kingdom

(Education - Program / Process Review Proposal)

BACKGROUND: The fields of astronautics and aerospace medicine have diversified significantly since their roots in the 1950s and 60s. Today, people of different races, genders, nationalities, and sexual orientations regularly form successful aerospace teams. This conference's focus on selection and training prompts examination of the benefits and considerations to be accounted for when building a diverse, multinational team. To optimize human performance, the effects of diversity cannot be overlooked. **OVERVIEW:** The habitation of the International Space Station by people of 18 nations marks a high point in aerospace history for international collaboration. Yet literature is mixed on the effects on multinational diversity in high-pressure environments such as spaceflight, and multiple studies conclude it can strain teams, decrease cohesion, and create conflict. However, in medicine, workforce diversity is seen as crucial to providing competent care to diverse patient populations. **DISCUSSION:** Increasing national and cultural diversity in astronautics needs to be met with the selection of increasingly diverse aerospace medical trainees. In space, and on Earth, this increased diversity will increase viewpoints and solutions to challenges that high-performing teams address. Increased national diversity will also increase inter-personal conflict, but conflict can be minimized through adequate training and the promotion of cohesive, team-forward mindsets. Successful integration of team diversity literature will increase team and task performance in astronauts and aerospace physicians alike.

Learning Objectives

1. The audience will learn about specific considerations for building multinational teams.
2. The audience will learn about international collaboration and cross-cultural interfaces in space.

[219] GEOGRAPHICAL & SOCIOECONOMIC FACTORS IN AEROSPACE MEDICINE

Jevons Wang¹, Ste'Von Voice²

¹McGovern Medical School at UT Health Science Center Houston, Houston, TX, USA; ²University of the Incarnate Word School of Osteopathic Medicine, San Antonio, TX, USA

(Education - Program / Process Review Proposal)

BACKGROUND: There are well-established advantages to building diverse teams in high-performing occupations, but several factors may contribute to underrepresentation of some ethnic, racial, and socioeconomic populations in aerospace medicine. The field could benefit from elucidating these disparities, bridging identified gaps, and leveraging the existing diversity to promote inclusion and optimize team performance. **OVERVIEW:** Presently, there are no consistent means for demographic data collection and publication in place for aerospace medicine physicians. Current barriers to academic advancement in aerospace medicine include lack of awareness, geography, lack of support systems, and cost. Potential interventions for assessing any disparities include anonymous demographics surveys within preventative medicine against the field of medicine at large. This information

could then be applied to outreach initiatives for underserved students, including those from backgrounds of ethnic minority and/or socioeconomic disadvantage. **DISCUSSION:** This presentation takes a closer examination at barriers to entering aerospace medicine as well as taking an approach to ethnic diversity and disparities in the field. We describe existing resources and envision avenues for further improvement. The perspectives and support to be gained have the potential to form a more robust community of aerospace medical professionals, aviation crew, and astronaut corps while serving as public examples of the benefits of equitable inclusion.

Learning Objectives

1. The audience will learn about barriers to entering the fields of astronautics and aerospace medicine, including lack of awareness, geographical obstacles, financial hardship, and minority status.
2. The audience will learn about resources and suggestions for increasing inclusivity in the field and supporting ethnic and racial diversity.

[220] MENTAL HEALTH IN SPACE

Linh-An Cao¹

¹Michigan State University - College of Human Medicine, Flint, MI, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Mental health is a vital component of human performance in space. Existing selection criteria—and indeed diagnostic questionnaires—are predominantly based in subjective interpretations or self-reported responses. Training for space missions entails a paradigm of evidence-based psychiatric strategies for maintaining behavioral health and wellness. This presentation explores the development and evolution of mental health standards for commercial and military pilots compared with astronauts. It also looks into current literature either in favor of or against existing practices. **OVERVIEW:** While there are barriers to reporting mental illness (including symptoms, diagnoses, medication(s)), supporting a more well-rounded outlook on mental health and wellness may improve accurate data collection and healthier coping strategies. **DISCUSSION:** We will discuss general psychiatric and selection-based countermeasures and potential directions regarding mental health and substance use in astronaut populations. By thoughtfully aligning screening and training practices to the highest quality and most up-to-date evidence, and tailoring these practices for individual crews and astronauts, aerospace medicine practitioners can promote healthier team structures and effective coping strategies without unnecessarily excluding qualified candidates.

Learning Objectives

1. The audience will learn about the development and evolution of mental health standards for commercial and military pilots, as compared to astronauts.
2. The audience will learn about general countermeasures and potential directions regarding mental health in astronaut populations, including pharmacotherapy and tailored substance abuse programs.

[221] HEALTH STATUS AND FLIGHT USING DIABETES AS A MODEL OF DISCUSSION

Lynda Chowdhury¹, Andrew Zeiger²

¹Methodist Dallas Medical Center, Dallas, TX, USA; ²Thomas Jefferson University, Philadelphia, PA, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Historical premises of aeromedical research have largely presumed subjects to be utterly free of any organic diseases either overtly known or assumed to interfere unduly in an aviator's performance of flight duties. Under its most traditional definitions, therefore, aerospace medicine pertained exclusively to analyzing the sordid effects of an abnormal environment on the otherwise normal-functioning physiology of the supremely-fit. Even where regulations have allowed for issued exemptions, individuals with well-mitigated chronic medical conditions are at least partially-excluded from space and aviation endeavors under possibly unfounded fears of sudden and severe incapacitation jeopardizing mission objectives. **OVERVIEW:** Traditionally, a diagnosis of insulin-dependent diabetes has been rendered a disqualifying condition keeping many individuals out of the cockpit given worries of acute-onset hypoglycemia and associated complications. Recent studies conducted by the U.K. Civil Aviation Authority and the Irish Aviation Authority with 26 insulin-dependent commercial airline pilots, however, outline the relative safety of allowing insulin users to fly under the regulations of standard operating procedures.

Such clinical investigations, however, have yet to inform the practices of other nations, namely the USA, where insulin-dependent diabetics are only granted a Class-III medical certificate if approved for receipt of a Special Issuance. **DISCUSSION:** Commercial spaceflight passengers predicted to have several common comorbidities, including insulin-dependent diabetes, utilizing the latest advances in continuous glucose monitoring and insulin delivery will necessarily force industry-driven clinical evaluations of standard-of-care therapies in both microgravity and under hyper-G forces. In minimizing, if not entirely eliminating, certain selection disparities with re-evaluation of current aviation standards, the systematized under-representation of individuals otherwise able to complete all assigned flight tasks with appropriate medical technologies can be undercut to the ultimate benefit of the aerospace industry at-large.

Learning Objectives

1. The audience will learn about regulations and guidelines related to both health and flight status using diabetes as a model for discussion.
2. The audience will learn about potential spaceflight considerations for persons living with well-controlled diabetes including possible metabolic fluctuations given the unique constraints of a microgravity environment.

WEDNESDAY, MAY 20, 2020

Wednesday, 05/20/2020

8:30 AM

Centennial I

[S-47]: PANEL: SPECIFIC ASPECTS OF CIVILIAN AND MILITARY AVIATION MEDICINE IN GERMANY

Sponsored by DGLRM, German Society of Aerospace Medicine

Chair: Jochen Hinkelbein

PANEL OVERVIEW: This session is sponsored by the German Society of Aerospace Medicine (DGLRM). This session is traditionally presented in German language with English slides. Several topics for both civilian and military aviation medicine are presented by five speakers.

[222] CHALLENGING REQUIREMENTS FOR FLIGHT STUDENTS, PILOTS AND ASTRONAUTS – A RADIOLOGIC PROSPECT ABOUT THE NEXT GENERATION MISSIONS

Hans-Jürgen Noblé¹, Sven-Erik Sönksen¹, Josef Ehling¹, Heinz Knopf¹, Sven Kühn²

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(Education - Program / Process Review Proposal)

BACKGROUND: Early detection of clinically relevant variations and abnormalities can save lives. To prevent fatal complications in aerospace due to heart attacks or spontaneous intracranial hemorrhage, it is crucial to minimize the risk by regulated screening. **OVERVIEW:** Every year over 340,000 people die from cardiovascular diseases and about 16,000 from spontaneous subarachnoid hemorrhages in Germany. Many result in sudden incapacitation with immediate unconsciousness and the resulting inability to act. Since it can be assumed that the number of unrecognized coronary heart disease, aneurysm carriers in aircrews or unknown malignancies is comparable to the normal collective of the population, it is highly relevant to detect these pathologies in advance. This applies especially to first time applicants for flight duty and to active pilots or astronauts before a longtime space mission, both for safety reasons to avoid disastrous aircraft accidents and from an economic and preventive point of view. **DISCUSSION:** In the German Air Force Center of Aerospace Medicine Department of Radiology, we challenge these in the screening program performed in Fürstentfeldbruck. We have to balance between medical assessment, clinical aviation medicine and prevention. With the 3T MRI scanner we can easily produce a high-resolution non-invasive overview of the skull base arteries (Time of flight – MR-Angiography), functional heart diagnostics or screening of the prostate. Preformed aneurysms, malignancies, bleedings or other findings can thus be detected very reliably. However, with new sequence protocols it has been possible to find acoustic neuroma, aneurysm and cavernoma carriers in a cohort of approx. 1500 examinations within the scope of applicant screening

over the last three and a half years. “Going to extremes” is a statement about the new challenging requirements for Human Performance Optimization. Other techniques like low-dose computer tomography are necessary to investigate non-invasive coronary heart disease. We cannot disregard safety reasons in the changed spectrum of clinical assessment. Furthermore, this may also affect manned spaceflight considerably, especially since an increased vulnerability of aneurysms or tumor growing in microgravity cannot be excluded.

Learning Objectives

1. The audience will learn about possible methods for visualizing relevant pathologies at early stages, which may lead to sudden incapacitation.
2. The audience will learn about MRI techniques.

[223] EFFECTS OF ACUTE HYPOBARIC HYPOXIA ON HUMAN PLASMA PROTEOME PROFILE

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(Original Research)

BACKGROUND: Increasing altitude results in Hypobaric Hypoxia (HH) characterized by a decreased oxygenation of the human body. Current data reveals that hypobaric hypoxia during airline travel induces several (patho-) physiological reactions in the human body and protein expression is altered. **OBJECTIVE:** The aim of this narrative review is to provide an overview on cell function responses to acute hypobaric hypoxia. **METHODS:** Retrospective analysis. Recent data was gathered by using the PubMed/MEDLINE® database and the following search string: “hypobaric hypoxia”. Papers were screened by two experienced colleagues independently. **RESULTS:** A total of 2733 studies were identified by the applied search strategy. Data of 20 relevant papers were included. The relevant data demonstrated mild to moderate changes with increase in duration of hypobaric hypoxia exposure. Proteomic analysis showed differential expressed spots, out of which spots were either down regulated or up regulated compared to normoxia control. Bioinformatic analysis revealed an association of the altered proteins especially with the signaling cascades “regulation of hemostasis”, “metabolism, and “leukocyte mediated immune response”. **CONCLUSIONS:** Even though hypobaric hypoxia was short and moderate in many of the studies, analysis of protein expression in human subjects revealed an association to immune response, protein metabolism, and homeostasis. Further investigation is needed to determine protein changes due to hypobaric hypoxia in dependence of the exposed time.

Learning Objectives

1. The audience will learn about the basics of hypobaric hypoxia.
2. The participant will be able to describe the alterations in protein function due to hypobaric hypoxia.
3. The audience will learn about future investigations in hypobaric hypoxia.

[224] GENOMIC REPRESENTATION OF SENSITIVITY TO GRAVITATIONAL FORCES

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(Original Research)

INTRODUCTION: The immune system deteriorates during long-term space flights, probably contributing to an increased susceptibility to infection, autoimmunity, and cancer during exploration class missions. Thus, it is a need to understand the cellular and molecular mechanisms by which altered gravity changes the genomic stability and gene regulation homeostasis and to assess the cellular capacity and mechanisms for adaptation to a new gravitational environment. **METHODS:** In our studies, we investigated signal transduction cascades, adhesion molecules, metabolism, functional parameters, gene expression responses and cytoskeletal dynamics in human lymphocytes and macrophages in different gravity environments through multi-platform approaches (parabolic flights, suborbital ballistic rockets, International Space Station and 2D clinostat and centrifuge experiments), including rigorous control experiments. A multi-platform approach not only allows for cross-validation of findings in independent experiment platforms, but also for understanding the time-course of mechanisms. Our aim was to