p=0.005) and efficiency (r(28)= .48, p=0.043). The application on the Ticwatch (Bwell) included a biomathematical model (FADE) that used sleep timing and duration to predict a sleep quality term and fatigue values throughout wakefulness, which was displayed on the Ticwatch in real time. The Ticwatch captured subjective fatigue scores (Karolinska scale) from the wearer every 2-3 hours while awake. This score was compared to the FADE estimate of fatigue at the same time by Spearman's rho (r(28) .73, p< .0005). **DISCUSSION:** These results argue that the IMU on a commercially available wearable can monitor sleep duration and efficiency comparable to the more expensive, time consuming actigraph. Coupling sleep timing measures with fatigue models can display the impact of daytime fatigue on cloud based smartwatches. This creates a near real-time fatigue management system to determine fitness for duty.

Learning Objectives

1. The audience will learn about the history of actigraphy and current smart wearable approaches to sleep management.
2. The audience will learn that movement detection, commonplace on smart wearables for assessing sleep, can be combined with biomathematical models of fatigue to create a powerful tool for assessing a wearer's health and readiness for duty.

[170] US ARMY AVIATION MISSION TYPE AND MENTAL HEALTH SYMPTOMS

Aric Raus[1], Fred Volk[2], Sarah Spiridigliozzi[2]
[1]*U.S. Army University, Fort Leavenworth, KS, United States;* [2]*Liberty University, Lynchburg, VA, United States*

(Original Research)

INTRODUCTION: Aviation flight operations require constant vigilance where pilots must perform under significant physical and psychological stress. Prolonged or intense stress events can lead to mental health issues, even among those with formal resilience training. While the impact of stress within the aviation community has undergone increased scrutiny, little is known about the effects of specific aviation mission sets on mental wellness. **METHODS:** Quantitative survey responses were collected from a larger study of current and former U.S. Army Aviation personnel recruited via social media and snowball sampling between October 2023 and February 2024. This study utilized the four-question Public Health Questionnaire (PHQ-4) and the four-question Posttraumatic Stress Checklist for DSM 5 (PCL4-5) to determine pilots meeting the screening criteria for Generalized Anxiety Disorder (GAD), Major Depressive Disorder (MDD), and Posttraumatic Stress (PTSD) by the aircraft mission types of Unmanned Aerial Systems (UAS; N=60), Cargo (CH; N=33), Utility/MEDEVAC (UH; N=142), and Attack/Reconnaissance (AH; N=59). **RESULTS:** A total of 294 valid responses were received to determine the selected mental health screening criteria. Among pilots, UAS operators had the highest propensity for meeting screening criteria for all three conditions (61.7% ≥ one condition), followed by Cargo (42.4%), Attack/Reconnaissance (40.7%), and Utility/MEDEVAC (33.1%) aviators. When compared by individual conditions, UAS operators' responses were statistically more likely to meet the anxiety (55.0%) and PTSD (31.7%) screening criteria than all other mission types. **DISCUSSION:** The results indicate a high percentage of current and former US Army flight crews experience discernable levels of anxiety, depression, and PTSD. UAS operators' symptom levels were statistically higher than other pilots for anxiety, PTSD, meeting any condition, and meeting all three screening criteria. UAS operators undergo unique stressors from other mission sets. Some missions require operators to follow targets' patterns of life for days before conducting kinetic operations, allowing pilots to see them as individuals. Additionally, operators are not at personal risk, which may increase moral injury. Finally, distinctive barriers to care may impact mental health seeking among this career field. Future research should focus on specific causes for these increased mental health symptom rates and methods for reducing them.

Learning Objectives

1. Participants will gain additional insight into the prevalence of GAD, MDD, and PTSD symptoms among U.S. Army Aviation Pilots.
2. Attendees will be familiar with the higher prevalence of mental health symptom levels among UAS operators when compared to other US Army aviators.
3. Participants will better understand the gaps in knowledge that need to be researched regarding mental wellness among military aviators.

[171] WITHDRAWN

WEDNESDAY, JUNE 04, 2025

Wednesday, 06/04/2025 ***8:30 AM***
Centennial Ballroom I

[S-32] PANEL: INSULIN TREATED DIABETES - REGULATORY AND IN-FLIGHT PERSPECTIVES

Chair: Mark Cairns
Co-Chair: Declan Maher

Panel Overview: *With the advent of new technologies such as insulin pumps and continuous glucose monitoring devices, the management and monitoring of insulin treated diabetes has evolved to a point where it is possible to consider medical certification for those who wish to operate as commercial pilots. There are now a few national aviation authorities operating programmes that permit such certification under tight scrutiny and generating data to demonstrate that this can be done safely. This session will look at the experiences of some of those national aviation authorities, discuss data that their research is generating and also learn from a commercial pilot about how this works from a practical perspective.*

[172] CERTIFICATION OF PILOTS WITH TYPE 1 DIABETES IN NEW ZEALAND

Tim Sprott
Civil Aviation Authority of New Zealand, Wellington, New Zealand

(Education - Tutorial / Review)

INTRODUCTION: This presentation outlines the development of a protocol for the aeromedical certification of pilots with type 1 diabetes mellitus in New Zealand. **TOPIC:** Type 1 Diabetes Kiwi Style **APPLICATION:** The safe aeromedical certification of pilots is a significant challenge for regulators. In New Zealand a certification protocol was developed based on an extensive review of the literature, benchmarking with other regulatory authorities, a review of published data from the CAA UK Study, and specialist peer review by the New Zealand Society for the Study of Diabetes (NZSSD). This presentation outlines the key elements of the NZ protocol and the outcomes to date since 2019.

Learning Objectives

1. The audience will learn about the risk management undertaken to implement medical certification of pilots with type 1 diabetes.
2. The audience will learn about how the medical certification of pilots with type 1 diabetes can meet the requirements for acceptable levels of safety.

[173] WITHDRAWN

[174] PIONEERING ASPECTS IN THE USE OF CONTINUOUS GLUCOSE MONITORING SYSTEMS FROM THE PERSPECTIVE OF CAA AUSTRIA

Peter Metzger[1], Gerd Koehler[2], Vijay-Mohan Sharma[1], Daniela Flechl[1], Natalie Schmuck-Chmelik[1]
[1]*Austro Control, Wien, Austria;* [2]*Medical University of Graz, Graz, Austria*

(Education - Tutorial / Review)

INTRODUCTION: According to European Regulation, a pilot with diabetes requiring insulin is deemed unfit to fly. In Ireland and Austria, a Diabetes Protocol has been implemented. This started in the UK in 2015 and allows commercial pilots who develop insulin-dependent diabetes during their career to continue flying. Austria joined the Protocol at the end of 2016. Austro Control GmbH currently manages ten pilots in the protocol; four Class 1 ATPL pilots, three Class 2 private pilots and three Light Aircraft Pilot Licence (LAPL) pilots. **TOPIC:** Medical certification through the Diabetes Protocol is subject to strict criteria. In addition to general medical eligibility, cardiovascular, endocrinological and ophthalmological parameters must be met. Non-compliance with the protocol results in exclusion or non-inclusion. Pilots in the protocol experience very few out of range glucose measurement and in the last years these have steadily decreased. The risk-optimised use of the Diabetes Protocol was made possible due to the latest medical technologies and therapy methods, including the use of insulin pumps with automated insulin delivery (AID) and the latest generation of continuous glucose monitoring (CGM) devices. The accuracy of CGMs has been shown to be comparable with finger prick testing. Atmospheric pressure changes during flights can affect insulin delivery from pumps. Ambient pressure reduction during simulated flights results in bubble formation and expansion within insulin cartridges. This causes unintended delivery of small insulin doses. In one study performed in a hypobaric chamber 0.60 U of insulin were over-delivered during ascent. However, in vivo, pilots did not experience a fall in blood glucose or episodes of hypoglycaemia during these atmospheric pressure changes. Further studies are in progress to assess the effectiveness of hybrid closed-loop systems and different sensors during commercial airline flights. **APPLICATION:** The experiences with implementing and running a diabetes protocol in Austria may help other national aviation authorities who wish to provide medical certification to pilot with insulin treated diabetes. The research shared in this presentation provides assurance of the safety of such a protocol.

Learning Objectives

1. The audience will learn that about a protocol for pilots with insulin treated diabetes that has been implemented in Austria.
2. The audience will learn that hybrid close loop insulin pump systems can handle pressure changes and do not lead to unintended metabolic consequences in people with insulin dependent diabetes.

[175] FAA OFFICE OF AEROSPACE MEDICINE EXPERIENCE WITH USE OF CONTINUOUS GLUCOSE MONITORING TO ASSURE SAFE CERTIFICAITON OF PROFESSIONAL PILOTS WITH DIABETES TREATED WITH INSULIN

Richard Murphy
FAA, Washington, DC, United States

(Education - Tutorial / Review)

INTRODUCTION: New technology has transformed the clinical management of Insulin Treated Diabetes Mellitus (ITDM), with the advent of wearable Continuous Glucose Monitoring (CGM). This has redefined the overall risk as well as the parameters for risk stratification and allows safe certification of many professional pilots with this condition. **TOPIC:** Insulin-Treated Diabetes Mellitus (ITDM) is a specifically disqualifying condition for aeromedical certification by the FAA under the Code of Federal Regulations: 14 CFR part 67. As of 1996 3rd class (non-professional) pilots with ITDM may be issued under the Special Issuance (SI) protocol, however it was not until late 2019 that FAA certification of first and second class professional pilots became possible, due in large part to the advancement in CGM technology. The first CGM system was approved by the US Food and Drug Administration (FDA) in 1999. Further improvements have allowed for greater accuracy, longer wear times and more reliable data transmission. Most modern devices are easy to use, reliable and do not require calibration by fingerstick testing. Initial criteria for certification and parameters for ongoing monitoring were derived from current clinical guidelines along with expert review by a panel of clinical endocrinology and aerospace medicine physicians. The ITDM certification process has been subject to continual review for safety and quality assurance since. Pilots granted an SI were found to have significantly better diabetic control and to meet ADA standards compared to those denied certification. After more than 2 years of successful program implementation, and with data of our cumulative experience, the program requirements were updated to better reflect contemporary clinical practice and simplify the requirements for pilots. This program remains under close quality assurance review by the FAA. Very few pilots initially certified were eventually denied recertification. No serious or in-flight safety events have been observed in the 5-year history of the program. **APPLICATION:** The application to the safe certification of professional pilots with ITDM through this program is clear, however there are wider ranging concepts of the use of new technologies that allow for continuous monitoring of a medical condition to assure ongoing stability. This includes monitoring in the cockpit and may provide early warning of a potential problem. **RESOURCES:** https://www.faa.gov/go/itdm

Learning Objectives

1. Attendees will learn about the use of continuous glucose monitoring to demonstrate stable and safe glucose control and allow for safe aeromedical certification under a time limited special issuance.
2. Attendees will understand how parameters are selected, reviewed and updated to assure ongoing efficiency and safety of the certification process.
3. Attendees will consider the potential for emerging monitoring and wearable technologies to improve aviation safety.

[176] INSULIN TREATED DIABETES IN FLIGHT: A PILOT'S PERSPECTIVE

Jeremy Robertson
Qantas, Mascot, New South Wales, Australia

(Education - Tutorial / Review)

INTRODUCTION: A practical user's perspective of the in-flight management of insulin dependent diabetes using the Australian/UK protocol, a hybrid closed-loop insulin pump, and continuous glucose monitor. **TOPIC:** For several years now, certain regulatory authorities have had in place protocols to allow people with insulin dependent diabetes to fly as commercial pilots. Previous presentations at this and other scientific meetings have focused on design of these protocols, their requirements for certification, as well as outcomes of monitoring and evaluating these protocols. This presentation aims to add the viewpoint of the user, a commercial pilot with type 1 diabetes, on how one of these protocols is applied to domestic and international airline operations whilst operating as a Boeing 737 pilot. This pilot uses a hybrid closed loop pump and continuous glucose monitor, the specific types of which are included in an ongoing EASA research project into this topic. **APPLICATION:** An understanding of the practical application of any protocol for insulin dependent diabetes will allow aeromedical examiners more targeted conversation with pilot applicants they assess. For regulators it will continue to guide ongoing development and improvement of new and existing protocols. **RESOURCES:** UK Aircrew Regulation ARA. MED.330. Medical Assessment Protocol for Pilots with Diabetes Treated with Insulin and/or Potentially Hypoglycaemic Medication. UK Civil Aviation Authority, June 2023. https://www.caa.co.uk/media/axmpaid1/20230608-uk-v4-2-ara-med-330-content.pdf Garden GL et al. An Evaluation of the Safety of Pilots With Insulin-Treated Diabetes in Europe Flying Commercial and Noncommercial Aircraft. Diabetes Care, 1 December 2020; 43 (12): 2923–2929. https://doi.org/10.2337/dc20-0277 EASA Research Projects, Diabetes Mellitus (DM). European Union Aviation Safety Agency, October 2024. https://www.easa.europa.eu/en/research-projects/diabetes-mellitus-dm

Learning Objectives
1. The audience will learn the practical aspects of operating to an insulin dependent pilot protocol.
2. The audience will learn relevant topics for discussion with insulin dependent pilots.

Wednesday, 06/04/2025 ***8:30 AM***
Centennial Ballroom II

[S-33] PANEL: FATIGUE IN MILITARY AVIATION

Chair: Ryan Mayes
Co-Chair: Richard Arnold

Panel Overview: *The military aviation environment poses multiple physiologic challenges to aviators; tactical/high-performance aviation in particular presents physiologic burdens during the flight, as well as additional stressors from operational tempo. Recent studies have highlighted the impacts of these exposures on both sleepiness and fatigue. This panel will present the results of studies examining the impact of flight on physical and cognitive fatigue. In addition, biomarkers associated with fatigue will be discussed; a better understanding of these biomarkers may help advance knowledge of the physiologic impacts of tactical aviation. The first presentation will describe cognitive fatigue modeling of mobility pilot performance during a long duration 24-hr simulated mission. The following three presentations will present results from an in-flight study of instructor pilots, beginning with the results of flight-related fatigue and associated biomarkers. This will be followed with a presentation comparing the fatigue results between the two bases involved in the study. The third presentation from the in-flight study will examine the biomarker results and provide a comparison between bases to better understand the differences due to operational tempo. The final presentation in the panel will present an animal model to examine individual exposures from the aviation environment and their resultant impacts on biomarkers, to include impacts at the blood-brain barrier.*

[177] FATIGUED PERFORMANCE COGNITIVE MODELING IN MOBILITY PILOTS

Megan Morris[1], Garrett Swan[2], Bella Veksler[3]
[1]*711th Human Performance Wing, Wright-Patterson AFB, OH, United States;* [2]*Aptima, Wright-Patterson AFB, OH, United States;* [3]*TiER1 Performance, Wright-Patterson AFB, OH, United States*

(Original Research)

INTRODUCTION: Maximum endurance operations will be critical to our military's success, but these missions will further exacerbate crew's fatigue given decreased sleep, circadian desynchrony, and high operations tempo. Hence, we need enhanced fatigue risk management capabilities to reduce safety risk and increase performance. Predictive models of fatigued performance can be beneficial in identifying outcomes at risk and helping target countermeasure timing. This effort focuses on developing cognitive models of mobility pilot performance during a long-duration 24-hr simulated mission, with the aim of being able to predict performance based on individualized sleep information. **METHODS:** Thirty-nine mobility pilots (Mage = 28.00; SDage = 3.01; 32 men) provided usable data in the study. Pilots wore an actigraph watch to assess sleep throughout the study and completed a 24-hr simulator session with various mobility mission tasks of different complexity levels in augmented crews. During the simulated mission, pilots also completed a cognitive task suite that included a Psychomotor Vigilance Test (PVT), which assesses attention, a N-back task (2-back), which assesses working memory processes, and a Change Signal Task (CST), which assesses executive functioning processes, all critical cognitive processes for mission performance. Cognitive models of the PVT, N-back, and CST were further developed and sleep data from actigraph analysis was included to individualize the models. Model fit (root mean squared error [RMSE]) was assessed between pilot performance and model predictions on each of the cognitive tasks' performance metrics. **RESULTS:** Integrating sleep data into the models resulted in predictive fits: PVT median reaction time (RT) (RMSE = .01), lapses (RMSE = 1.98), and false starts (RMSE = 1.74); N-back median RT (RMSE = .04), false alarms (RMSE = .02), and accuracy (RMSE = .03); CST median RT (RMSE = .05,) and accuracy (RMSE = .02). **DISCUSSION:** The effort provides evidence of increased predictive performance of models given the integration of individual sleep information. This work relates to the Fatigue in Military Aviation panel by showing advances in cognitive modeling individualization that can be implemented during military operations to help reduce safety risk and increase performance.

Learning Objectives
1. The audience will learn about the predictive ability of cognitive models with sleep information in realistic long-duration mobility missions.
2. Audience members will be able to describe potential applications of fatigue models on cognitive performance.

[178] THE IMPACT OF TACTICAL AVIATION ON FATIGUE AND SERUM CYTOKINES.

Ryan Mayes[1], Niveta Ramakrishnan[2], Elizabeth Damato[2], Hannah Boehringer[2], Seunghee Margevicius[2], Michael Decker[2]
[1]*USAFSAM, Wright-Patterson AFB, OH, United States;* [2]*Case Western Reserve University, Cleveland, OH, United States*

(Original Research)

INTRODUCTION: The tactical aviation environment presents numerous physiologic challenges. A previous study (2020, n=22) demonstrated a potential connection between increased levels of fatigue among some instructor pilots and flight operations over a 1-week study period. The pilots who experienced increased fatigue did not have differences in sleep or sleepiness, but did have changes in blood serum proinflammatory cytokines; these serum marker changes were absent in pilots who did not have increased fatigue. This 2022 study was undertaken to better understand these associations in a larger sample across a 2-week study period. **METHODS:** 45 USAF instructor pilots (IPs) at two different bases were studied on 6 separate days across a 2-week flying schedule: Sunday (baseline), Tuesday, and Thursday. Data included fatigue levels using the Multidimensional Fatigue Inventory, a physical exam, and venous blood samples. **RESULTS:** Participants were 91% male, 34.02 ± 5.55 years, with BMI of 27.55 ± 3.65 kg/m2. At baseline, 36 IPs reported elevated General Fatigue (GF) scores ≥ 10, a level representing "unwellness." By Thursday, 37 IPs endorsed GF scores ≥ 10. Multiple serum markers displayed the same pattern as the 2020 study; for example, monocyte chemoattractant protein 1 levels were 309.58 ± 130.49 pg/ml for participants with GF ≥ 10 at baseline and remained elevated at 299.55 ± 131.26 on Thursday (p = 0.757). Increased fatigue severity paralleled increased blood serum proinflammatory cytokine levels. In comparison to the 2020 study (GF 8.65 ± 0.67), fatigue levels were markedly higher in 2022: GF 9.73 ± 0.58 at the same base as 2020, and GF 13.34 ± 0.36 at a second base. **CONCLUSION:** As a performance degrader, understanding causes of fatigue is important to minimize operational risk; potential causes of the higher levels of fatigue, such as flight duration and frequency, will be discussed. Serum proinflammatory cytokine levels may be objective markers of fatigue.

Learning Objectives
1. The audience will understand the emerging evidence to explain the variation in fatigue levels observed in military tactical aviators at Air Force training bases.
2. The audience will understand the evidence supporting proinflammatory serum cytokines as an objective marker of fatigue.

[179] INSTRUCTOR PILOT FATIGUE LEVELS DIFFER BETWEEN MILITARY TRAINING BASES

Hannah Boehringer[1], Koyal Ansingkar[1], Ryan Mayes[2], Anthony Turner[2], Seunghee Margevicius[1], Michael Decker[1], Elizabeth Damato[1]
[1]*Case Western Reserve University, Cleveland, OH, United States;* [2]*USAFSAM, Wright-Patterson AFB, OH, United States*

(Original Research)

INTRODUCTION: Cognitive and physical fatigue are consequences of unprecedented challenges imposed by tactical aviation. Multiple studies have quantified fatigue during a single point in time. However, a dearth of data exists to characterize fatigue levels in tactical aviators across weekends when flying is reduced, and across weekdays when flying times are maximal. This study aimed to fill that knowledge void and provide an overview of fatigue levels in separate cohorts of instructor pilots (IPs) located at two military training bases. **METHODS:** Institutional Review Board approval was obtained from the collaborating university and the US Air Force. T-6 Texan II (n=38), T-38 Talon (n=5), and T-1 Jayhawk pilots (n=1) were studied, in addition to 2 IPs who did not log flying hours (Total N = 42 males + 4 females). Data were collected in May 2022 at Base #1 and June 2022 at Base #2. The Multidimensional Fatigue Inventory (MFI) assessed five domains of fatigue at six time points over a two-week period at each base. The MFI has been used in population-based studies of fatigued and non-fatigued persons. **RESULTS:** Participants from the two sites differed significantly on age (38.14 ± 4.44 vs. 29.83 ± 3.31 years, p<0.001), years as a military pilot (13.55 ± 4.27 vs. 6.36 ± 3.83 years, p<0.001), and years as an instructor pilot (8.36 ± 3.89 vs. 2.44 ± 2.45 years, p<0.001). Base #2 IPs were younger and reported fewer years as a military pilot and instructor pilot than Base #1 IPs. During each of the six time points, IPs from Base #2 reported consistently reported higher fatigue. Of the five fatigue domains, "General Fatigue" was markedly elevated in this cohort, with a mean score of 13.34 ± 0.36, exceeding the mean score of 9.73 ± 0.58 reported by IPs from Base #1. This pattern emerged across all five domains of fatigue. **DISCUSSION:** While General Fatigue scores for Base #1 IPs were within range of published norms for healthy "well" persons in the general population, General Fatigue scores for Base #2 IPs were markedly higher and consistent with values for persons defined as "chronically unwell."

Learning Objectives

1. The audience will understand the variation in fatigue levels among military aviators at Air Force training bases.
2. The audience will describe the range of fatigue domain scores of US Air Force instructor pilots across time following successive training flights.

[180] INSTRUCTOR PILOT BLOOD SERUM CYTOKINE AND INTERLEUKIN PROTEIN CONCENTRATIONS ARE INCREASED IN THOSE WITH GREATER FATIGUE LEVELS.

Elizabeth Damato[1], Seunghee Margevicius[1], Ryan Mayes[2], Anthony Turner[2], Hannah Boehringer[1], Michael Decker[1]
[1]*Case Western Reserve University, Cleveland, OH, United States;* [2]*USAFSAM, Wright-Patterson AFB, OH, United States*

(Original Research)

INTRODUCTION: We have previously identified cytokines and interleukin proteins within the peripheral bloodstream that concomitantly increase with the onset of fatigue. It was unclear whether those serum protein concentrations corresponded with fatigue severity or only the presence/absence of fatigue. Additionally it was unclear whether those findings, derived from one study at one USAF base, could be replicated and representative of other fatigued personnel. The purpose of study was to address those knowledge gaps by studying personnel at two separate locations and determine if serum cytokine and interleukin proteins concentrations corresponded with fatigue levels. **METHODS:** Institutional Review Board approval was obtained. Data were collected in May 2022 at Base #1 and June 2022 at Base #2. Venous blood was collected on six separate days across a two-week flying schedule: Sunday, Tuesday, and Thursday while the Multidimensional Fatigue Inventory (MFI) assessed five domains of fatigue. Serum was analyzed with multi-array electrochemiluminescence technology using preconfigured 96-well plates. **RESULTS:** A total of 46 USAF instructor pilots were studied (42 males + 4 females). Serum concentrations of cytokines and interleukins previously identified as being associated with the onset of fatigue were also associated with fatigue in this study. These included monocyte chemoattractant protein 1 (MCP-1) and brain derived neurotrophic factor (BDNF). In addition, serum concentrations were significantly increased over prior study values observed in 2020. Concentrations of eight cytokine and interleukin proteins differed significantly between the two bases. MCP-1, for example, was significantly increased in participants from Base #2 (Mean ± 1 SD of 320.40 ± 129.60 pg/ml vs. 204.80 ± 93.40 pg/ml, p=0.001). Base #2 participants also reported significantly greater fatigue levels. Similar relationship patterns emerged between seven other serum protein concentrations and fatigue scores. **DISCUSSION:** Findings presented here suggest that blood serum concentrations of cytokines and interleukins were increased in pilots from Base #2, who also reported greater fatigue levels. Both serum concentrations of cytokines and interleukins as well as fatigue scores were significantly elevated in this 2022 study over prior 2020 study values. Mechanisms contributing to the increased values we observe remain unclear at this time.

Learning Objectives

1. The audience will understand the variation in blood serum cytokines and interleukin levels among military aviators at Air Force training bases.
2. The audience will describe the relationship between fatigue levels and blood serum cytokine and interleukin levels in military aviators at Air Force training bases.

[181] FLUCTUATIONS IN CYTOKINES IN THE BRAINS OF MICE AFTER EXPOSURE TO HYPOXIA, HYPOBARIA AND HYPEROXIA

Michael Decker, Koyal Ansingkar, Tristan Nunley, Elizabeth Damato
Case Western Reserve University, Cleveland, OH, United States

(Original Research)

INTRODUCTION: Hypobaria, hypoxia, and hyperoxia are among the inherent risks of high-altitude aviation. All three of these stressors contribute to generalized central nervous system fatigue via various, unclear mechanisms. To address those knowledge gaps, the objective for this study was to determine systemic biochemical outcomes following exposure to hypobaric hypoxia, isolated hypobaria, and concomitant hyperoxia. An array of proinflammatory and anti-inflammatory cytokines were measured in this study through analysis of mouse brain homogenates. **METHODS:** Mice were maintained within either 760 mmHg, 564 mmHg, or 429 mmHg barometric environments for three 90-minute sessions per day for five consecutive days. Some experimental groups also received supplemental oxygen to maintain an expected arterial partial pressure of oxygen of 100 mmHg. This corresponded to 29% FiO2 for the 564 mmHg condition, and 39% FiO2 for the 429 mmHg condition. Hyperoxic exposure was achieved by increasing the FiO2 to 60%. Mice were euthanized, and brains were extracted and flash frozen. Tissue levels of 10 cytokines were measured using electrochemiluminescence technology. **RESULTS:** At 564 mmHg, without additional oxygenation, the only analyte to change was IL-4 (p=0.01), an anti-inflammatory cytokine responsible for angiogenesis. At 564 mmHg with supplemental oxygen, significant increases in IFN-γ (p=0.03), IL-1β (p=0.001), and TNF-α (p=0.01) were noted, all of which are pro-inflammatory. When the FiO2 was increased to 60%, the hyperoxic exposure produced significant increases in several pro-inflammatory markers [IFN-γ (p=0.01), IL-12p70 (p=0.01), IL-1β (p=0.02), IL-2 (p=0.01), IL-6 (p=0.02), and TNF-α (p=0.03)] as well as two anti-inflammatory markers [IL-10 (p=0.02) and IL-5 (p=0.02)]. At 429 mmHg, the only analyte to increase was IL-2, and with supplemental oxygenation, all of the cytokines were found to increase with decreased barometric pressure. **DISCUSSION:** The rise of pro-inflammatory cytokine levels in brain homogenates following exposure to supplemental oxygen suggests that the role of supplemental oxygen in a high-altitude environment may produce more adverse effects than previously thought. The isolation of hypobaria without hypoxia, a man-made physiological insult, produced a unique systemic response of the immune system. These findings and potential implications highlight the need for further investigations to confirm the results of this study.

Learning Objectives
1. The audience will describe the biochemical pathways through which hypoxia, hypobaria, and hyperoxia contribute to aviator fatigue.
2. The audience will understand a potential methodology for isolating physiological insults and measuring the outcomes in a mouse model.

Wednesday, 06/04/2025 ***8:30 AM***
Centennial Ballroom III

[S-34] SLIDE : FLY GIRLS

Chair: Dragana Dragic Ranisavljevic
Co-Chair: Lydia Johnson Kolaparambil Varghese

[182] VULVOVAGINAL INFECTIONS IN SPACE: A REVIEW

Kira Rienecker[1], Amelia Espinosa[1], Prasanna Tati[2], Kadambari Suri[3], Begum Mathyk[4], Amber Paul[5], Jonathan Steller[6]
[1]*Blue Marble Space Institute of Science, Seattle, WA, United States;* [2]*Robert Wood Johnson Monmouth Medical Center, Long Branch, NJ, United States;* [3]*Texas A&M University College of Medicine, Bryan, TX, United States;* [4]*University of South Florida, Tampa, FL, United States;* [5]*Embry-Riddle Aeronautical University, Daytona Beach, FL, United States;* [6]*University of California Irvine, School of Medicine, Irvine, CA, United States*

(Original Research)

INTRODUCTION: Vulvovaginal infections (VVI) such as bacterial vaginosis and vulvovaginal candidiasis are common medical comorbidities affecting millions of people in the United States every year. We now have a robust understanding of the terrestrial vaginal microbiome and VVI management, but there is a lack of data about spaceflight effects on the vaginal microbiome and VVI risk. While such an infection has not yet been reported in space, we hypothesize the likelihood of VVI affecting crew health and performance during long-duration exploration spaceflight may be elevated. This study will review VVI incidence in analog populations, and evidence of how spaceflight alters human immune function, disrupts other human microbiomes, and affects pathogen virulence and antibiotic resistance, while dysregulating innate and adaptive immune cells critical to barrier immune systems such as in the vagina. **METHODS:** The literature search was conducted in PubMed, NASA Technical Reports Server, and the NASA Life Sciences Portal. Search terms included, but were not limited to: spaceflight, vulvovaginal infection, vulvovaginitis, vulvovaginal candidiasis, bacterial vaginosis, Candida albicans, Lactobacillus, innate and adaptive immunity, microbiome, resistance, and immunosuppression. Analog studies from servicewomen on deployment, Antarctica research stations, and spaceflight analogs such as HERA, HI-SEAS, and Aquarius were examined for VVI incidence reports. **RESULTS:** While VVI incidence were not readily available in all spaceflight analogs analyzed, incidence rates of infection in deployed servicewomen have been previously reported, and in one study 1 of 4 reported inadequate support for women's primary care [1,2]. In spaceflight, astronauts experience heightened infections and dysregulated Type 1 immunity. Spaceflight reduced gut Lactobacilli abundance, an important protective vaginal bacteria. Pathogenic bacteria (and C. albicans) became more virulent and resistant to antibiotics/antifungals in microgravity. **DISCUSSION:** This manuscript promotes women's health in space by introducing the vaginal mucosal barrier and microbiome, reviewing known impacts of spaceflight on immunity and analogous microbiomes, and suggesting pre-, in-, and post-flight management strategies to mitigate VVI. Finally, our authors call for research supporting the Human Research Program Gaps and the aims of the Decadal Survey on Biological and Physical Sciences Research in Space 2023-2032.

Learning Objectives
1. While there is a paucity of data on VVI incidence in spaceflight, indicators from related studies on immunity, pathogen virulence and antibiotic resistance, and the gut microbiome suggest prolonged spaceflight may increase recurrent or treatment-resistant VVI.
2. Current diagnostic capabilities to distinguish VVIs onboard the ISS are severely limited, and may become a greater issue in long-duration deep space missions with limited resourcing and increased remoteness.

[183] FIBROIDS AND ASTEROIDS: CONTEMPORARY REVIEW OF GYNECOLOGICAL HEALTH RISKS IN SPACE

Kwasi Nkansah, Jr.[1], Darshankumar Raval[2], Wanyao Chen[1], Wiaam Elkhatib[3]
[1]*University of Toronto, Toronto, ON, Canada;* [2]*Western Reserve Health Education, Northeast OH Medical University, Warren, OH, United States;* [3]*Mayo Clinic, Rochester, MN, United States*

(Education - Tutorial / Review)

OBJECTIVE: While women have been part of space exploration since the 1960s, they make up only 11% of the astronaut population—a number that's increasing but still limited. As we aim for extended and recreational space travel, understanding how spaceflight impacts gynecological health is crucial for safer missions. This project compiles current research on how space's unique environment influences the female reproductive system, highlighting areas for improved wholistic health support for female astronauts. **METHODS:** We conducted a scoping literature review, using PubMed to identify relevant studies published from 1950 to 2024. Keywords such as "women," "reproductive health," and "spaceflight" were used alongside terms related to specific space hazards, like "microgravity," "radiation," and "sleep." We organized findings by primary environmental factors affecting gynaecological health, namely, microgravity, radiation, and other spacecraft living conditions. **RESULTS:** Out of 7,432 identified articles, 30 were analyzed in detail. The data, covering human and animal studies on Earth and in-flight, indicate that microgravity, radiation, and spacecraft conditions significantly impact female reproductive health. Documented changes include higher risks for tumor growth, reactivation of latent STDs, menstrual irregularities, and hormonal imbalances. Potential protective measures may include oocyte cryopreservation, dietary adaptations, sleep hygiene improvements, and more comprehensive radiation shielding. **CONCLUSION:** The unique conditions of spaceflight pose specific health risks to the female reproductive system, particularly relevant given the typical age of female astronaut recruits. With minimal research available on gynecological health in space, we face a critical knowledge gap. As space exploration becomes more inclusive and missions extend longer, this research underscores the need to address these health concerns proactively, supporting the well-being and mission readiness of all astronauts.

Learning Objectives
1. The participants will be able to understand the effect of spaceflight missions on female reproductive system.
2. The audience will be able to quantify the importance of cryopreservation for the upcoming long duration spaceflight missions.

[184] TO FLY OR NOT TO FLY WHILE PREGNANT: CANADIAN OPERATIONAL MILITARY PILOTS

Joelle Thorgrimson[1], Karen Breeck[2]
[1]*Canadian Armed Forces, Winnipeg, MB, Canada;* [2]*University of Toronto, Ottawa, ON, Canada*

(Original Research)

INTRODUCTION: Women continue to remain a minority of Canadian Armed Forces (CAF) operational pilots equalling <2% in 2000 and <6% in 2022. Limited research has been completed on pregnancy experience of military pilots. **METHODS:** This mixed-methods epidemiological study involved semi-structured interviews with CAF operational female pilots. Interviews included a medical questionnaire and medical records review. A community based participatory research approach was

used throughout. **RESULTS:** 50 (57%) of current CAF operational female pilots from 15 different platforms with a wide range of ranks completed interviews. 28 (56%) had one or more pregnancies with the mean age of having their first child 32+/-4 years, ranging from 29-42 years. Pregnancy experience was thoroughly explored including pregnancy intention and outcomes. For example, at time of pregnancy, 22 (79%) were in an operational posting, 20 (91%) had a planned pregnancy, and 9 (32%) had miscarriages, abortions, and still births. Furthermore, medical care, fertility treatment, parental leave, breast feeding, childcare, institutional support, and career implications were discussed. For example, 16 (57%) felt they did not have enough information on occupational risks and hazards to make an informed decision about flying if pregnant, and 16 (57%) felt their career was negatively impacted. **DISCUSSION:** Examining the pregnancy experience of miliary pilots revealed that they are conceiving later and feeling as though more information is needed to make informed decisions surrounding flying. As this population continues to increase in the CAF, it is imperative that more research in this area is completed to optimize health outcomes and experiences.

Learning Objectives

1. Understand the pregnancy experience and outcomes of Canadian operational military pilots.
2. Identify areas for future research in pregnant pilots as well as aircrew.

[185] EVALUATION OF RECENT TRENDS IN FEMALE AVIATOR HEALTH

Samantha Wolf, Amanda Kelley
U.S. Army Aeromedical Research Lab, Fort Novosel, AL, United States

(Original Research)

INTRODUCTION: The role of female aviators in the Army has evolved significantly since their introduction into Army aviation. Understanding the morbidity specific to women associated with a career in aviation service is key to a comprehensive understanding of occupational risk, and can inform preventative health maintenance for the purpose of maximizing occupational readiness. **METHODS:** Data were retrieved on 12,132 female aircrew, limited to officers and warrant officers, from the Aeromedical Epidemiological Data Repository (AEDR) from the years 2015 to 2023. The dataset yielded 3,894 female Soldiers with a total of 50,189 cases containing variables: age, rank, diagnosis code, waiver/suspension recommendation, and aeromedical disposition. The top ten most frequently occurring diagnoses overall, as well as those associated with each waiver/suspension recommendation, were calculated. Any given diagnostic code was only counted once per patient per aeromedical disposition type. **RESULTS:** All the 4,873 waivers recommended with a disposition indicated were granted. The top conditions concurrent with a waiver approval were hypothyroidism (1.3%), low back pain (1.2%), repair right cornea (1.1%), repair left cornea (1.0%), allergic rhinitis (0.5%), migraine (0.5%), adjustment disorder (0.5%), hypertension (0.5%), anxiety disorder (0.4%), and depressive disorder (0.4%). All 806 recommendations for suspension were granted. The top conditions concurrent with permanent suspension were post-traumatic stress disorder (2.2%), adjustment disorder (1.5%), lumbago (1.1%), cervicalgia (1.0%), cyclobenzaprine (1.0%), depressive disorder (1.0%), flight surgeon recommendation (1.0%), low back pain (1.0%), major depressive disorder single episode unspecified (1.0%), and migraine (1.0%). Additionally, in the list of top ten all-cause diagnoses, four codes were related to women's health, three to vision health, and two were administrative codes. **DISCUSSION:** Overall, the findings were consistent with a similar analysis of female aircrew data from 2005-2015. This indicates that major changes to the healthcare environment likely have not affected the overall health of the aviation community. One of the limitations of the dataset is the availability to use International Classification of Disease (ICD) 9 and 10 codes. The U.S. transitioned to ICD-10 in 2015. The investigators will continue to analyze the dataset by systems-based diagnosis category and analogous ICD codes.

Learning Objectives

1. The audience will learn about the process by which US Army aviators are cleared for flight duties.
2. The audience will learn about health trends specific to female aircrew.

[186] PREGNANCY AND SIMULATOR FLYING

Elaine Rutland[1], Erica Jackson[2], Claire Goldie[3]
[1]*RAF, Sleaford, United Kingdom;* [2]*RAF, Centre of Aviation Medicine, Henlow, United Kingdom;* [3]*Army, Consultant Advisor in Aviation Medicine (UK), Middle Wallop, United Kingdom*

(Education - Program / Process Review)

BACKGROUND: Despite the UK Ministry of Defence (MOD) accepting the first female aircrew in the 1990's, female aircrew remain a small minority of serving aircrew. Across the MOD, women comprise less than 5% of aircrew. North Atlantic Treaty Organisation (NATO) data indicates that across international members, general military populations are ~13% female. There have been multiple workstrands which have targeted optimising employment of women in the UK Armed Forces. Ensuring all talented individuals are given the optimal opportunity to serve increases the talent pool from which Defence can draw. **OVERVIEW:** Fitness for pregnant aircrew to fly has been a hot topic for discussion and review over the last few years across military and civilian flying contexts with a variety of approaches being taken to fitness to fly certification in pregnancy. To mitigate for time away from flying duties, simulator flying across a multitude of platforms is being increasingly employed. From our investigations, it is evident Australia, NZ, and the US Army permit their pregnant aircrew to fly in simulators, but the approach elsewhere differs. In the UK, military pregnant aircrew may occasionally fly in simulators subject to local risk assessment, but local approaches vary and it is clear from operating authorities' feedback that the data upon which to make risk decisions is lacking and cohesive guidance is not available. Female aircrew experience this as a further barrier to career progression and retention. Provision of the Executive, and Aviation Medical specialists with policy and guidance to provide clarity of the actual risks associated with simulator flying in pregnancy will optimise employability of pregnant aircrew, enhance retention, and improve Operational Effectiveness of the force as a whole. **DISCUSSION:** To address this, we have reviewed the variety of simulators across UK Defence and civil sectors and further investigated the various factors affecting safe simulator flying in pregnancy such as vibration, noise, shift work, anthropometrics and access and egress. This has led to the development of evidence-based guidance for duty holding representatives and Aviation Medical specialists to conduct their simulator risk assessments, thus optimising employability of pregnant aircrew wherever possible.

Learning Objectives

1. The audience will learn about the factors that should be considered within risk assessments for pregnant aircrew to fly in simulators.
2. The audience will learn about the evidence regarding specific simulator flying-related hazards in pregnancy including, but not limited to vibration, noise, anthropometry, circadian rhythm / shift work and simulator / motion sickness.

[187] IMPLICATIONS OF RECURRENT DEEP VEIN THROMBOSES IN AN ACTIVE-DUTY AVIATOR

Kevin Anderson, Maxwell Cheng, Briana Middel
U.S. Air Force, Ellsworth AFB, SD, United States

(Education - Case Study)

INTRODUCTION: This case report describes a B-1B Weapon Systems Operator with several comorbidities who developed multiple deep vein thromboses while in the Middle East requiring medical evacuation. **BACKGROUND:** Deep vein thrombosis (DVT) is a consequential and life-threatening disease, with even further professional ramifications in the flying community. Numerous risk factors exist but despite the prevalence, there are few reported cases of commercial or

military airmen highlighting the development of DVT post-flight. **CASE PRESENTATION:** We present a 34-year-old female with several pre-existing comorbidities who developed ipsilateral proximal and distal DVT's while in Oman that required medical evacuation back stateside. Prior to her long-haul flight overseas, she presented to the local emergency department with lower-extremity pain similar to a prior DVT in 2018 and after negative work-up was subsequently discharged. Days later, she was evaluated by plane-side emergency medical technicians after painful ambulation through the airport. After being symptomatic for over a week, she was admitted to an Omanian hospital, and a formal diagnosis was made. Initial oral anticoagulation was started; however, she developed an exanthem likely attributed to subtherapeutic dosing while in her medical evacuation but ultimately returned home stable. **DISCUSSION:** This case highlights several key points, particularly as it pertains to a thorough medical clearance process in conjunction with closed loop communication between the aviator and their entire care team. A prior case of DVT with a known genetic mutation and additional susceptibilities requires in-depth education and counseling prior to long distance air travel, especially when little national help exists in the country. Additionally, a thorough record review should be conducted on a high-risk servicemember to ensure they are medically optimized before traveling to a region with limited resources. Finally, this case illustrates the importance of medical evacuation resources to ensure proper medical management is completed to avoid further complications in air.

Learning Objectives

1. The audience will learn the importance of pre-travel counseling for high risk individuals from their flight medicine team and the limitations in the current healthcare system with resource-capped military treatment facilities.
2. This case highlights the importance of knowing all available resources to transport a medically complicated patient stateside from a country with minimal national assistance to ensure safe return of an active-duty service member.
3. The audience will take home the ramifications of thrombophilic disease in the aerospace community and how recurrent issues can lead to disqualification.

Wednesday, 06/04/2025 ***8:30 AM***
Centennial Ballroom IV

[S-35] PANEL: LIFE SUPPORT CHALLENGES FOR EXPLORATION CLASS SPACE MISSIONS: HUMAN HEALTH AND SURVIVABILITY

Chair: Douglas Hamilton
Co-Chairs: Gabrielle Caswell, Benjamin Eshelby

Panel Overview: BACKGROUND: *Complex organisms, such as humans, have a resident biome of microorganisms called a microbiome, contributing to their health and well-being. While a terrestrial biome can span vast areas of Earth, a 'macrobiome' is a community of organisms that coexist within an enclosed, biologically limited, intimate habitat, such as a submarine or a spaceship.* ***PANEL DESCRIPTION:***

- *Current and proposed ECLSS technologies for ECDSMs.*
- *The 'Omics' of the ECDSM Macro- and Microbiome organisms (including the Human system)*
- *MPV requirements for sustaining a macrobiome in space*
- *Can these ECLSS macrobiome concepts be validated on Lunar missions?*

ISSUES: *An Exploration Class Deep Space Mission (ECDSM) requires an Environmental Control Life Support System(ECLSS) that can maintain a macrobiome for the Human System. Current International Space Station (ISS) missions use regenerative physical/chemical (Phys/Chem) ECLSS processes. The recovery of water and oxygen from human waste has reduced the operational and logistical Mass/Power/Volume (MPV) footprint of the ISS ECLSS. The ECLSS for a Mars mission will include the modalities needed to support the astronaut's activities of daily living (ADL) and health maintenance strategies and address the unique space hazards (altered gravity, radiation, GCR, SPEs, etc..). The ECLSS MPV burden on these prolonged penetrations into deep space predicates that living organisms (plants, bacteria and fungi) should be conscripted to assume a 'mission critical' role in sustaining the macrobiome. Sustaining a closed biological regenerative ECLSS for ECDSMs needs to consider radiation, plant yield and fruits, light flux and spectrum, CO2 and Oxygen mass balance, water recovery, nutrient quantity and quality, temperature, relative humidity, altered gravity, composting organic matter, air revitalization, etc. As these closed ECLSS systems become more stable and predictable, adding animal life forms to the macrobiome might complement the Human System's nutritional requirements and the regenerative ECLSS's synergistic husbandry. Given that any ECDSM ECLSS is considered 'mission-critical,' all hazards that could potentially embarrass its function and survivability must be controlled. Will a biological ECLSS have a Mean Time Between Failure similar to PhyChem ECLSS? How much bridging Phys/Chem ECLSS is needed until an existing or alternative backup biological ECLSS can be healed or 're-started'?*

[188] HUMANS, ECOLOGY, MICROBES AND SPACE

Benjamin Eshebly
Formulae Pty Ltd, Albury, Australia

(Education - Tutorial / Review)

INTRODUCTION: Nestled amongst the estimated 30 trillion human cells in the body, are more than 38 trillion cells belonging to various forms of microbes. The human microbiome consists of predominantly bacteria, but also has communities of yeasts and viruses. Thus, when we consider human health, the microbiomes of the body and their relationships with human physiology must be considered. Special care must be taken when using antibiotics as these have the potential to destabilise the microbiome. What techniques can be employed to optimise the health of the microbiome and restore it if damaged? Such microbiological questions are as important as that of human physiology when considering health in a space setting. **TOPIC:** Human microbiome studies, though gathering pace are still in their infancy and have largely focussed on earthbound subjects. What other considerations are there for space travel for ensuring homeostasis of these commensal microorganisms? **APPLICATION:** What techniques can be employed to optimise the health of the microbiome and restore it if damaged? Such microbiological questions are as important as that of human physiology when considering health in a space setting.

Learning Objectives

1. The participant will be able to appreciate the symbiotic relationship between humans and their microbiome.
2. The audience will learn about begin to understand the complex population of the human microbiome.
3. The audience will appreciate the failings of modern medicine, such as antibiotics, and how their use becomes ineffective in the space environment.

[189] PART ONE: EXPLORATION SPACE MISSIONS AND HUMAN HEALTH STABILITY: INTRODUCING THE MICROBIOME

Gabrielle Caswell
Space Port Australia, Moree, New South Wales, Australia

(Education - Tutorial / Review)

INTRODUCTION: Complex organisms, such as humans, have a resident biome of microorganisms called a microbiome, contributing to their health and well-being. While a terrestrial biome can span vast areas of Earth, a 'macrobiome' is a community of organisms that coexist within an enclosed, biologically limited, intimate habitat, such as a submarine or a spaceship **TOPIC:** Human concomitant resident microbiomes . Introduction to microbiome concepts and contribution to human health.

APPLICATION: Microbiome imbalance and impact on human health in space (What we know, what we don't know, and why our tools on earth [antibiotics] may not help); in addition changed microbiome impacts on the human immune system, nutrient uptake, skin and cognition. It is anticipated that long haul explorations, outpost settlements and enclosed environments may create impacts on human health, detrimental to the humans undertaking the mission.

Learning Objectives

1. The audience will learn about the human resident biome of microorganisms called a microbiome, contributing to their health and well-being.
2. The participant will be able to define the human microbiome and macrobiome and understand how these two ecological zones biology related to one another and contribute to human health.
3. The audience will appreciate the anticipated challenges to human health that long haul explorations, outpost settlements and enclosed environments may create, and begin to concern themselves with creating ideal human environments in space flight and colonization that lead robust human health outcomes in the space environment.

[190] MORTALITY AND MORBIDITY OF DEEP SPACE MISSION BIOLOGICALLY BASED LIFE SUPPORT SYSTEMS

Douglas R. Hamilton
General Internal Medicine, University of Calgary, Canada

(Education - Case Study)

INTRODUCTION: The recent successful launch of NASA's Artemis and SpaceX heavy-lift launch vehicles and the plan to use the Gateway Space Station in a Near Rectilinear Halo Orbit (NRHO) to explore the Moon represent the next technological hurdles to Humans eventually living on Mars. **BACKGROUND:** While a terrestrial biome can span vast areas of Earth, a 'macrobiome' is a community of organisms that coexist on a much smaller scale within an enclosed, biologically limited habitat, such as a submarine or a spaceship. A successful Exploration Class Deep Space Mission (ECDSM) requires a macrobiome that supports the life cycle of complex organisms (plants and animals) and their concomitant microbiomes. This new Environmental Control Life Support System (ECLSS) macrobiome may be the only effective solution for ECDSMs compared to the basic physical/chemical (PhysChem) ECLSS used to support current space missions. The ECLSS for a Mars mission includes the modalities needed to support the astronaut's activities of daily living and the health maintenance strategies (exercise, nutrition, medical monitoring, medical hazard prevention and treatment, social interactions) required to control the environmental hazards (altered gravity, radiation, etc.). As these closed regenerative ECLSS systems become more stable and predictable, adding animal life forms to support the macrobiome might complement the Human System's nutritional requirements. **CASE PRESENTATION:** Given that any ECDSM ECLSS is considered 'mission-critical,' controlling all hazards that could potentially jeopardize its function and survivability is of utmost importance. **DISCUSSION:** The probability of experiencing a lethal solar particle radiation event (SPE) on Mars similar to the 1972 lunar event is approximately 5% using Apollo-like shielding. The characteristics of previous SPEs can be derived from ice-sheet measurements. Without effective shielding, the 1859 Carrington SPE had doses of 60Gy outside the Earth's magnetosphere and would be genetically damaging and probably lethal to most life forms on Mars. Therefore, space flight poses significant hazards to the mortality or morbidity of a biological ECDSM ECLSS and, ultimately, the crew. Would we fly a PhysChem ECLSS as a mission backup or to sustain the macrobiome until the biological ECLSS can be replaced or 'healed'? Can these biological ECLSS concepts be tested and validated on NRHO Lunar missions?

Learning Objectives

1. The participant will understand the difference between 'biological regenerative' and 'physical chemical' Environmental Control Life Support Systems.
2. The participant will understand the challenge of converting various exploration class space mission Environmental Control Life Support System designs into Mass/Power/Volume mission requirements.
3. The participant will understand the effects of Solar Particle Events and Galactic Cosmic Radiation on Physical/Chemical and Biological Regenerative Life Support Systems.

[191] PART TWO: CLINICAL INSULTS: HUMAN HEALTH, RADIATION, MICROGRAVITY AND THE MICROBIOME

Gabrielle Caswell
Space Port Australia and Eyra Medical Pty Ltd, Moree, New South Wales, Australia

(Education - Tutorial / Review)

INTRODUCTION: The microbiome will be prone to insult form ionizing radiation, Galactic Cosmic Radiation, microgravity and environmental (habitat) macrobiome structure. A multitude of insults will create change within individual microbiomes, with a predicted clinical affect. **TOPIC:** Expected changes to the microbiome include physical (cellular replication rate, morphology, genetic insult) and well as functional (inability to work harmoniously with remaining microbiome, inability to provide nutrients etc. to human host) and this in turn can have detrimental affects on human health n space. **APPLICATION:** Clinical insults to the human microbiome from radiation, microgravity and environmental microbiome changes potentially will impact on human health, including the immune system, lung function, skin health and cognition. Longer journeys and settlements will require human participants to live in these stressful environments in their best health and functioning.

Learning Objectives

1. The audience will appreciate space environmental insults to the human microbiome.
2. The audience will gain an understanding of anticipated functional changes to microbiome from ionizing radiation, Galactic Cosmic Radiation, microgravity and environmental (habitat) macrobiome structure.
3. Participants will begin to appreciate the clinical manifestations of microbiome dysfunction and the potential impact on space exploration.

Wednesday, 06/04/2025 ***8:30 AM***
Regency V

[S-36] PANEL: PILOT SPATIAL DISORIENTATION RESEARCH, MODELING, AND TRAINING

Chair: Eric Groen

Panel Overview: **BACKGROUND:** *Pilot spatial disorientation (SD) remains a leading contributory factor in flight mishaps. Emerging knowledge, technology, and research tools yield better understanding of SD phenomena and their effects on pilot behavior, which should ultimately lead to effective mitigations.* ***PANEL:*** *This panel will expand upon research featured in our 2023 and 2024 AsMA panels by discussing new insights in research and modeling of SD, such as the effect of hypoxia on vestibular perception, the simulation of visual perceptual illusions, and modeling of sensory integration. The panel will start with two presentations on the capabilities of two world-leading SD devices: the Desdemona facility (at TNO) and the Kraken (at NAMRU-D). Both devices offer unique possibilities for research into the effects of SD on pilot performance, and can also be used for advanced SD awareness and avoidance training.* ***RELEVANCE:*** *The panelists will discuss research gaps to inform future SD research, development, and modeling initiatives, in addition to how such efforts may ultimately lead to safety mitigations. Altogether, the panel will give insight in the state-of-the-art of our understanding of SD.*

[192] THE DESDEMONA FACILITY: ADVANCED SPATIAL DISORIENTATION RESEARCH AND TRAINING IN THE NETHERLANDS

Eric Groen[1], Erik Frijters[2]
[1]*TNO, Soesterberg, Netherlands;* [2]*Royal Netherlands Air Force, Soesterberg, Netherlands*

(Education - Program / Process Review)

BACKGROUND: The cutting-edge motion simulator DESDEMONA (acronym for 'DESorientation DEMONstrAtor') in the Netherlands has been specifically designed to reproduce vestibular spatial disorientation (SD) effects known from flight. This presentation will highlight its unique capabilities for research and training in the area of SD, and other related human factor topics. **OVERVIEW:** The DESDEMONA device combines a reconfigurable, single-seat cabin with a unique motion platform comprising a three-dimensional gimbaled system for unlimited rotations around any axis; two linear drives for 8-m horizontal and 2-m vertical motion; and a planetary drive that allows for sustained centrifugation at 3g. This kinematic design makes it possible to control all motion axes in parallel, which results in a superagile motion simulator that is ideal for the simulation of motion-critical maneuvers. Various cabin configurations are available, including a turbo-prop trainer aircraft (PC-7), fighter aircraft (F-16, F-35), military helicopters (Apache, Chinook, Cougar), and a left-hand seat of transport aircraft (Boeing 737). Together with realistic flight models and high-fidelity virtual environments, pilots can actively practice challenging flight maneuvers in their own aircraft type, while experiencing SD. DESDEMONA has been operational since 2008 and is used for SD awareness training by the Royal Netherlands Air Force (RNLAF), ranging from basic demonstrations of SD illusions for student pilots to advanced 'SD-prone' scenarios flown by experienced pilots. Examples of the latter are a full-motion recovery from an inverted deep stall by F-16 pilots, and a mountain flying course for military helicopter pilots with various SD effects such as sloping terrain and White-out conditions. DESDEMONA is also used for research purposes. Motivated by loss-of-control in-flight (LOC-I) accidents, such as Air France flight 447, funding was granted to enhance DESDEMONA's aerodynamic model and motion envelope to become the first ground-based simulator where airline pilots can realistically practice recoveries from an aerodynamic stall. **DISCUSSION:** DESDEMONA offers unique research possibilities, not only for aviation applications, but also for ship or ground-vehicle simulation. Its motion software and vehicle models can be adapted, and all simulator data, such as control inputs, can be logged for post-hoc analysis. Physiological monitoring and gaze tracking is available to investigate physiological and mental workload.

Learning Objectives

1. The audience will learn about the historical background of the world's most advanced disorientation device.
2. The audience will learn about the possibilities to provide disorientation training with ground-based devices.

[193] THE NAVY DISORIENTATION RESEARCH DEVICE: REVOLUTIONIZING HUMAN ORIENTATION RESEARCH

Kaila Vento, Bradley Fairfax, Richard Folga
Naval Medical Research Unit Dayton, Wright-Patterson AFB, OH, United States

(Education - Program / Process Review)

BACKGROUND: The Navy's Disorientation Research Device, or Kraken, at Naval Medical Research Unit Dayton (NAMRU-D) was created to provide unprecedented human orientation research capability. Since delivery in 2016, the Kraken has hosted 10 unique research and technical development efforts. These projects have fostered global collaborations, pushed technical boundaries, and driven innovative solutions, expanding the possible applications of a large multi-axis acceleration research platform. **OVERVIEW:** The Kraken is an advanced simulation platform that integrates a six-degree-of-freedom acceleration environment with high-fidelity visual displays to accurately replicate acceleration forces encountered in flight and various vehicle platforms. Key advancements include state-of-the-art virtual and mixed reality technologies, advanced eye-tracking systems and normobaric mask-on breathing systems, both developed and patented by NAMRU-D. Other mission-ready, fully integrated systems include flight helmet and mask suite, communication earplugs, spatial audio, noise-canceling, inertial measurement units, electromyography, electroencephalography, and optical tracking systems. A unique custom-engineered motorized head-on-neck rotator, subjective haptic and visual attitude indicators are specifically crafted to support foundational perceptual modeling. Each simulation study is meticulously tailored using the Kraken visualizer application, ensuring that motion dynamics are optimized for specific research objectives and motion is clearly communicated to collaborators. The Kraken operates with a comprehensive suite of aircraft flight controls, enabling human-in-the-loop flight simulation driven by motion, including the NASA Government Reference Model lunar lander. The Kraken Build Lab serves as an advanced offline development, testing, and evaluation ability for research configurations, fostering continuous innovation and refinement. Collaborative initiatives with OH State University and the University of Colorado Boulder focus aim to advance human perceptual modeling by integrating the Observer Model into the Kraken's motion control framework. **DISCUSSION:** The Kraken is instrumental in both foundational and applied human orientation research, with a focus on aeromedical challenges plaguing aviation safety for decades. Planned applications include integration of high-fidelity flight simulation and state-of-the-art physiologic sensors for advanced multi-platform applications in spatial disorientation modeling and countermeasure development.

Learning Objectives

1. Understand the design features and operational capabilities of the Kraken and its applications in aerospace environments.
2. Identify the collaborative partnerships involved with the Kraken and the potential for the Kraken to adapt to multi-mission roles.

[194] ADVANCEMENTS IN SPATIAL ORIENTATION PERCEPTION MODELING FOR ACTIVE MOTION AND VISUAL REFERENCES

Aaron Allred, Nicole Rote, Lanna Klausing, Aadhit Gopinath, Torin Clark
University of Colorado Boulder, Boulder, CO, United States

(Education - Tutorial / Review)

INTRODUCTION: Spatial disorientation (SD) represents a failure to correctly perceive one's self-orientation and self-motion, and when applied to operating aircraft, extends perceiving the orientation and motion of the piloted vehicle. The potential for catastrophic outcomes from SD in aviation has motivated computational modeling efforts to better understand the onset of SD during flight and ultimately develop countermeasures. However, most modeling efforts to date have been constrained to understanding spatial (dis)orientation during passively applied motions in the dark. In contrast, pilots who experience SD during flight are often actively flying aircraft and have various visual references at their disposal. Here, we advance models of spatial (dis)orientation perception to capture both the consequences of active flight as well as visual references on perceived heading changes. **TOPIC:** We present an augmented observer model of spatial (dis)orientation perception, which captures how head motion results in perceptions of self-motion and self-orientation through internal models of sensory dynamics and kinematic relationships. To incorporate the consequences of active motion and known vehicle dynamics, learned central nervous system representations of the kinematic consequences of control inputs and vehicle dynamics are modeled. Further, visual pathways are tuned to explain perceptions of heading given visual references (N = 10). The study was approved by the University of Colorado Institutional Review Board, and individuals provided informed consent. **APPLICATION:** Simulations demonstrating differences in self-orientation and self-motion perceptions during active and passive motions are produced. Our augmented observer model produces unique predictions of spatial (dis) orientation during active motion with known vehicle dynamics compared to passive motions. Moreover, heading perceptions depend on the

availability of visual cues of angular velocity and angular position. The development of this augmented observer model represents two crucial spatial (dis)orientation modeling advancements to understand perceptions of self-motion and self-orientation during flight. We anticipate this work will be used in the future to better understand spatial (dis)orientation for mishap investigations and countermeasure development.

Learning Objectives

1. This effort produces augmentations to the observer model of spatial (dis)orientation perception to model pilot perceptions.
2. Perceptions during different combinations of active/passive flight and visual references differ, demonstrating the importance of these modeling advancements during mishap investigations and future countermeasure development.

[195] THE IMPACT OF HYPOXIA ON HUMAN VESTIBULAR FUNCTION AT LOWER ALTITUDES

Kyle Pettijohn[1], Max Teaford[2], Cora Cox[1], John Oas[1], Daniel Merfeld[1]

[1]*Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH, United States;* [2]*University of Tennessee at Chattanooga, Chattanooga, TN, United States*

(Education - Tutorial / Review)

INTRODUCTION: Pilots face many conditions that may interfere with their ability to maintain accurate spatial orientation and situational awareness. One such condition is hypoxia. Prior research has demonstrated that even relatively mild hypoxia degrades peoples' ability to sense earth-vertical translations; however, the relationship between the severity of hypoxia experienced and the impairment to vestibular thresholds is not known. The current study aims to characterize this relationship. **TOPIC:** In this study, participants underwent vestibular threshold testing under normoxic and three normobaric hypoxia conditions. Motions were provided by a Moog six degree of freedom motion platform, while participants performed a two-alternative forced choice motion discrimination task. An adaptive staircase was used to determine the smallest motion that could be reliably sensed. On separate days, participants completed testing while breathing gas mixtures with an oxygen content of 20.9%, 17.9%, 16.6%, and 15.4%. These concentrations were designed to simulate altitudes of sea-level, 4,000ft, 6,000ft, and 8,000ft, respectively. Preliminary results indicate that earth-vertical translation thresholds were impaired with increasing altitude. Compared to baseline, thresholds were higher at the equivalent of 8,000 ft, showed a tendency to increase at 6,000ft, and were nominally, though likely not statistically significantly, higher at 4,000ft for this small sample. **APPLICATION:** These results suggest that the hypoxia experienced, even at low simulated altitudes, can reduce how well people can reliably discriminate upward and downward motion. Even at altitudes lower than the cabin pressure required by the FAA for commercial flights (8,000 ft), larger motions are required for people to consistently sense that they have moved. Additional studies are needed to see whether the performance decrements described here extend to other motions that involve different vestibular organs (e.g., pitch or roll tilts) and how and when degraded vestibular thresholds begin to affect performance.

Learning Objectives

1. The audience will learn what vestibular thresholds are and how they relate to motion perception.
2. The audience will learn that hypoxia adversely affects peoples' vestibular thresholds.

[196] CHANGES IN EYE MOVEMENTS DURING SIMULATED BLACK HOLE FLIGHTS UNDER DIFFERENT LEVELS OF WORKLOAD

Frank Robinson[1], Nicklaus Fogt[2], Steven Linnville[3], Dain Horning[1]

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(Education - Tutorial / Review)

INTRODUCTION: The Black Hole Illusion (BHI) occurs when pilots overestimate their altitude when flying a visual approach at night, increasing the risk of a mishap. Flight instruments provide spatial information to help maintain a safe glideslope, but pilots do not always utilize instruments effectively due to distraction or other attentional demands. This study investigated changes in instrument scanning behavior during instances of BHI across different levels of workload. **TOPIC:** A total of 28 pilots participated in this study across two study sites. They flew repeated simulated BHI flights with no added workload, a secondary auditory monitoring/working memory task, or the secondary task plus an additional visual search task. We used an eye tracking system to compare instrument scanning behaviors across levels of workload and during periods in which pilots flew on glideslope to those when pilots began to deviate from glideslope. High workload was associated with a smaller dispersion of gaze and a lower gaze transition rate. We found that periods of glideslope deviation were associated with a higher probability of looking outside the cockpit and a lower probability of looking at the vertical speed indicator. We also conducted a more detailed analysis examining the probability of transitions between different paired areas of interest (AOIs; e.g., transitions between looking outside the aircraft and the altimeter). We found that periods of glideslope deviation were associated with reduced probability of transitions within several AOI pairs, particularly shifting gaze between outside the window and the attitude indicator and shifting gaze between outside the window and the vertical speed indicator. **APPLICATION:** The results of this study will help inform the design of future training and alerting systems to help mitigate the effects of spatial disorientation.

Learning Objectives

1. The audience will be able to identify characteristics of the black hole illusion.
2. The audience will be able to describe how workload and scan patterns affect flight performance under black hole conditions.

Wednesday, 06/04/2025 ***8:30 AM***
Regency VII

[S-74] PANEL: SIMULATOR SICKNESS, CYBERSICKNESS, AND THE VESTIBULAR SYSTEM

Chair: Anna Clebone Ruskin
Co-Chair: Keith Ruskin

Panel Overview: *Virtual reality (VR) and extended reality (XR) are being used for aerospace activities that include cockpit procedure training and aircraft and equipment maintenance, while aircraft simulators have been used for decades for pilot training. Although VR and XR are effective techniques for teaching and practicing these skills, symptoms of cybersickness may impair training or prevent learners from completing programs that rely on these technologies. Cybersickness is defined as a motion sickness-like experience that is induced by visual stimulation in a virtual reality environment and may be caused by discrepancies between visual and vestibular sensations. Symptoms can include nausea, vomiting, autonomic discomfort, disorientation, and drowsiness. This panel will review the pathophysiology of cybersickness, then discuss pharmacologic and nonpharmacologic countermeasures. Proposed mitigation strategies will include ginger and other nonsedating, "over the counter" remedies, mindfulness techniques or behavioral modifications (with or without using a Barany chair), and transcranial galvanic vestibular stimulation. We will also propose a 'cybersickness mitigation bundle' that includes treatments that are tailored to the individual's predisposition, their symptoms, and the intensity of the planned virtual stimulus.*

[407] PATHOPHYSIOLOGY OF CYBERSICKNESS AND SIMULATOR SICKNESS

Keith Ruskin
University of Chicago, Chicago, IL, United States

(Education - Tutorial / Review)

INTRODUCTION: Aerospace applications of virtual reality and extended reality include training, assistance with maintenance tasks, and control of unmanned aerial vehicles. The prevalence of cybersickness is 60-90%, with 6-13% of participants opting out before the end of a virtual reality session due to cybersickness. The timing of cybersickness is often 10 minutes after the beginning of the virtual stimulus. **TOPIC:** Cybersickness occurs when there is a sensation of motion that is not in accordance with that expected by the motor cortex, and is hypothesized to be caused by a mismatch between the visual and vestibular systems. Cybersickness and motion sickness share common traits, including physiologic manifestations and symptoms. Both are caused by differences between the inputs the visual, proprioceptive, and vestibular systems expect and the inputs these systems receive. Cybersickness caused by a head-mounted display can affect cutaneous vascular tone, heart rate, and reaction time. The physiologic responses to motion sickness have also been hypothesized to coordinate a decrease in body temperature through cutaneous vasodilation, sweating, and reduced thermogenesis. **APPLICATION:** Motion sickness and cybersickness can cause headaches, drowsiness, irritability, and acting out of character ("Sophite Syndrome"), which can persist for days. These symptoms may impair training on the day that cybersickness occurs and may interfere with training or subsequent work responsibilities for several days after that. **RESOURCES:** Gavgani A, Nesbitt K, Blackmore K, Nalivaiko E. Profiling subjective symptoms and autonomic changes associated with cybersickness. Autonomic Neuroscience. 2017 Mar;203:P41-50. Mazloumi Gavgani A, Walker FR, Hodgson DM, Nalivaiko E. A comparative study of cybersickness during exposure to virtual reality and "classic" motion sickness: are they different? J Appl Physiol (1985). 2018 Dec 1;125(6):1670-1680. Nalivaiko E, Rudd JA, So RH. Motion sickness, nausea and thermoregulation: The "toxic" hypothesis. Temperature (Austin). 2014 Dec 31;1(3):164-71. Nalivaiko E, Davis SL, Blackmore KL, Vakulin A, Nesbitt KV. Cybersickness provoked by head-mounted display affects cutaneous vascular tone, heart rate and reaction time. Physiol Behav. 2015 Nov 1;151:583-90. doi: 10.1016/j.physbeh.2015.08.043.

Learning Objectives

1. Participants will be able to explain the pathophysiology of cybersickness and simulator sickness.
2. Participants will be able to identify specific features of virtual reality and extended reality that elicit symptoms of cybersickness.

[408] HOMEOSTASIS OF THE VESTIBULAR SYSTEM

Robert Fong
University of Chicago, Chicago, IL, United States

(Education - Tutorial / Review)

INTRODUCTION: An intact vestibular system, including semicircular canals and otoliths, provides information related to the position of a person's head in space is responsible for coordinating eye movements and posture. It is an essential component of proprioception, equilibrium, and balance. The sensory conflict theory states that a mismatch between the visual and vestibular systems causes motion sickness. Cybersickness occurs when there is a sensation of motion that is not in accordance with that expected by the motor cortex. **TOPIC:** The vestibular system includes the utricle, the saccule, and the superior, posterior, and lateral semicircular ducts, and their associated neural pathways. The system contains specialized mechanoreceptor cells called "hair cells," which contain cross-linked actin filaments called stereocilia that are connected at the tips by "tip links." Efferent signals from the vestibular system include vestibulo-ocular reflex, which allows a person's eyes to remain fixed on an object while the head is moving and the vestibulospinal reflex, which coordinates spinal musculature with head movement and allows a person to maintain balance and posture. The function of the peripheral vestibular system involves the acceleration of endolymph within the vestibular apparatus. Head movement in a given direction produces acceleration that stimulates the stereocilia of hair cells. When the head stops accelerating, hair cells return to their baseline position which allows them to respond to further changes in endolymph acceleration. **APPLICATION:** A better understanding of the vestibular system physiology will help clinicians to understand why simulator sickness or cybersickness can occur. Symptoms of vestibular system dysfunction include vertigo, nausea, vomiting, and visual disturbance. The relationship of the vestibular system to cognition is not well understood, but vestibular dysfunction has been associated with difficulty in spatial orientation, memory, learning, and object recognition. "Sophite syndrome" is associated with motion sickness and symptoms include drowsiness and irritability. **RESOURCES:** Curthoys IS, Grant JW, Pastras CJ, Fröhlich L, Brown DJ. Similarities and differences between vestibular and cochlear systems–a review of clinical and physiological evidence. Frontiers in Neuroscience. 2021 Aug 12;15:695179. doi: 10.3389/fnins.2021.695179

Learning Objectives

1. Audience will understand how the vestibular system enables people to maintain eye and postural coordination.
2. Audience will understand how the vestibular system detects acceleration and rotation.

[409] DUAL, OPPOSING-PHASE GALVANIC VESTIBULAR STIMULATION FOR CYBERSICKNESS MITIGATION IN THE FUTURE

Anna Clebone Ruskin
University of Chicago, Chicago, IL, United States

(Education - Tutorial / Review)

INTRODUCTION: Innovative approaches to the management of cybersickness and space sickness can help people to tolerate unusual environments while minimizing unacceptable side effects such as sedation or cardiovascular risk. Galvanic vestibular stimulation is a promising modality, but a better understanding the effect on the vestibular system, characteristics of the electrical current used for stimulation, and potential hazards can ensure safety during the application of electricity to the brain. **TOPIC:** The vestibular system is thought to be a key mediator of cybersickness due to discrepancies in sensory inputs. An ideal intervention for cybersickness would have no side effects and be easy to administer. Galvanic vestibular stimulation (GVS) uses a low-power electrical current applied to the mastoid process to activate canal and otolith afferent pathways via the eighth cranial nerve. GVS has shown promise as a treatment for motion sickness. Applying GVS in opposite phases to each mastoid process reduces vestibular sensitivity by decreasing the perception of movement. Proposed mechanisms include inducing otherwise-nonexistent vestibular cues, or vibration of the vestibular organs to add noise to the sensory modality. Although the precise mechanism of action for galvanic vestibular stimulation remains unclear, functional MRI imaging revealed activation in the region of the temporoparietal junction, the central sulcus, and the intraparietal sulcus in volunteers. Several studies have demonstrated the effectiveness of vestibular stimulation for cybersickness, seasickness and to mitigate driving simulator sickness. In one study, stimulation

was provided either during curves or intermittently throughout the course; both techniques were effective. The limits of Galvanic Vestibular Stimulation for degrees of cybersickness and space sickness, and its contraindications and risks are a promising area for future discovery. **APPLICATION:** This presentation will review the basics of electricity as applied to Galvanic Vestibular Stimulation. The current chosen for GVS will mitigate symptoms of cybersickness or simulator sickness while minimizing the risk of side effects, which can include dizziness and disorientation. **RESOURCES:** Nature Communications volume 10, Article number: 1904 (2019); Exp Brain Res. 2020 Feb;238(2):427-437; J Neurophysiol. 1998 Nov;80(5):2699-709

Learning Objectives

1. Learners will be able to use galvanic vestibular stimulation to mitigate cybersickness.
2. Participants will understand how galvanic vestibular stimulation is thought to exert its effects.

[410] ACUTE AIRSICKNESS EVOKED BY COMBAT MANUVERS IN AN EXPERIENCED US MILITARY HELICOPTER PILOT: A CASE REPORT

Jaime Rivas Harvey, Jordan Alvey
U.S. Air Force, Colorado Springs, CO, United States

(Education - Case Study)

INTRODUCTION: This case report describes an experienced US military helicopter pilot who suffered multi-episodic airsickness after a specific combat maneuver despite never having faced airsickness during his flying career. **BACKGROUND:** Passive and active airsickness is common for military pilots starting their aviation career. Airsickness rates in military helicopter pilots can range from 20%-40% and can have varying effects on the individuals. In military aviation, pilots must overcome their airsickness to be qualified to fly solo for safety of flight. Instances of airsickness in combat-qualified military helicopter pilots are extremely rare. **CASE PRESENTATION:** The subject pilot is a 27-yr old US Army HH-60 Blackhawk pilot with 460 total flying hours to include deployment time. The subject stated that he had never experienced airsickness in his flying career including pilot training or recreational type activities. Each airsickness episode, four passive and two active, all followed "combat maneuvers" which consists of performing cyclic climb to pushover break and max/bank break turns resulting in transfering controls to his co-pilot. Environmental factors such as heat, dehydration, and poor meal planning played a role in each of these events. The subject's command requested aircrew rotation training (ART) from USAF Aerospace Physiology in lieu of medications. The subject completed the 3-day ART utilizing the Barany Chair during which he was given education on "box/diaphragmatic breathing" and the "drop-off" technique. After completing the ART program, the pilot was able to practice a mindfulness exercise to identify his physiological symptoms and successfully address them before the stimulus became too overwhelming. Furthermore, he completed the simulated combat maneuvers during the graduation spin with little to no symptoms. **DISCUSSION:** This case highlights that ART is at its core a practice in mindfulness that can be translated into treatment of sensory mismatches which result in malaise, nausea, or emesis. This translational science does not necessarily need to utilize a Barany Chair when applied to cybersickness as long as the instructors are trained in identifying high potential sensory mismatch event precursors to incorporate treatment techniques. This integration would likely reduce the prevalence of cybersickness to include participants opting out of training completion.

Learning Objectives

1. Audience will understand how to identify sensory-mismatch stimuli.
2. Audience will learn to incorporate a mindfulness practice along with physiological relaxation techniques to control airsickness and cybersickness.

Wednesday, 06/04/2025 ***8:30 AM***
Hanover F/G

[S-38] PANEL: RESIDENT IN AEROSPACE MEDICINE (RAM) GRAND ROUNDS I

Chair: Jonathan Elliot
Co-Chairs: Thomas Jarnot, Amy Kreykes

Panel Overview: *Resident in Aerospace Medicine (RAM) Grand Rounds consists of 5 clinical case presentations. Each case is presented by current RAMs who will review the clinical case, diagnosis, treatment pathway and current policies from different agencies. The aviator's aeromedical disposition and waiver or special issuance outcome (if applicable) will be discussed. These unique case presentations describe clinical aviation medicine as well as policy updates for common medical and/or mental health conditions encountered in the practice of Aerospace Medicine.*

[203] THE SIN OF ZYN

Stephanie Tamayo, Gordon Salgado
Naval Aerospace Medical Institute, Pensacola, FL, United States

(Education - Case Study)

INTRODUCTION: This case report describes the diagnosis and management of a Naval Aviator who suffered acute nicotine poisoning due to nicotine pouch use. **BACKGROUND:** Nicotine pouches are a new product sold as a 'healthy tobacco alternative.' They are nearly ubiquitous in the active-duty community, commonly relied upon for improved energy and endurance in the setting of inadequate rest, prolonged shiftwork and/or increased operational tempo. While they may aid in tobacco liberation, they also threaten nicotine poisoning and increasing nicotine dependence for the active-duty service member. **CASE PRESENTATION:** A previously healthy nonsmoker USN fixed wing pilot deployed on a carrier amidst operations 'sniveled' a mission critical flight due to acute illness diagnosed as nicotine poisoning attributed to oral nicotine pouches. Nicotine pouches are a new and poorly regulated product, which subsequently evade direct mention in the current CNAF M-3710.7 and/or the USN Aeromedical Waiver Guide. Investigation into and instruction on these new products is recommended. Pending further elucidation, the prohibition of nicotine pouches is advised. **DISCUSSION:** This case highlights the import of strict compliance with current guidelines (by servicemember and physician alike), reiterates the pathophysiology and management of Nicotine poisoning, draws attention to nicotine dependence in the service, and advises the investigation and regulation of Nicotine - independent of delivery vehicle.

Learning Objectives

1. Inform on the ubiquity of nicotine pouch use in the active-duty aviation community.
2. Reiterate the pathophysiology and management of acute Nicotine poisoning, and chronic nicotine dependence.
3. Inform on the relative doses of nicotine found across various common nicotine delivery vehicles (Cigarettes, cigars, dip, vape, nicotine pouches).

[204] CRYPTOGENIC STROKE: A CHALLENGING PATH FOR A NAVAL AVIATOR

Eliezer Rodriguez, Larissa Brandenburg
Naval Aerospace Medical Institute, Pensacola, FL, United States

(Education - Case Study)

INTRODUCTION: A 36 year old T-6 instructor pilot begins to slur speech and have left upper extremity weakness walking out to the aircraft with his student pilot. Although symptoms resolved after several minutes, he presented to the flight surgeon for evaluation and further

work up. This case study reviews the presentation, diagnostic path, final diagnosis and challenges that this naval Aviator faced for a waiver to continue to fly. **BACKGROUND:** A cryptogenic stroke account for 10 to 20 percent of ischemic strokes and requires an extensive work up to rule out other major cause. While more common in younger individuals with fewer traditional risk factors, there are still concerns of recurrence and sequelae, such as seizures. While these risks are well established for older individuals with large artery atherosclerosis, small vessel disease, cardioembolic, and hypercoagulable there is considerably less data on young healthy individuals. In aviation, a balance must be struck between safety of flight and continued career in aviation. **CASE PRESENTATION:** An unexplained, seemingly transient event, in a young healthy aviator was found to be something more with nearly imperceptible neurologic weakness, imaging consistent with ischemic stroke etiology and uncertainty of continuing a career as a Naval Aviator. **DISCUSSION:** This case will discuss the guidelines for diagnosis and workup of an ischemic stroke, define a cryptogenic stroke and discuss the current aeromedical waiver considerations from civil and military governing authorities. This presentation is intended for Aerospace Medicine residents, military flight surgeons regarding the challenges these cases pose in Naval Aviation.

Learning Objectives

1. The participants will be able to identify the diagnostic steps and evaluation criteria for ischemic stroke in young, healthy individuals.
2. The audience will learn about the aeromedical waiver process across the Department of Defense and Civil authorities.
3. The audience will learn about the challenges posed by balancing flight safety and career continuity for an aviator.

[205] MEDICAL RISK ASSESSMENT AND OPERATIONAL IMPACTS OF BONE LOSS IN A HYPOTHETICAL FEMALE SPACEFLIGHT CREWMEMBER

Brian Rodriguez, Ethan Stephens, Jeffrey McBride
UTMB, Galveston, TX, United States

(Education - Case Study)

INTRODUCTION: This presentation discusses occupational surveillance, medical considerations, and operational consequences of spaceflight associated bone loss through a hypothetical case study **BACKGROUND:** Microgravity results in decreased resistive forces on bone that terrestrially help to maintain bone density and strength. Without countermeasures, individuals lose 1-2% of their bone mineral density per month of spaceflight. These changes are most prominent in the femoral trochanter, femoral neck, pelvis, and lumbar spine. Concern for protracted or irreversible trabecular bone loss exists based on pre/post-flight studies performed with quantitative computed tomography. Moreover, bone turnover increases urinary calcium and may pre-dispose to increased risk of nephrolithiasis. **CASE PRESENTATION:** A hypothetical 60-year-old female mission specialist is chosen to participate as a prime crewmember for a long duration mission. She is a veteran astronaut, having completed prior long-duration missions. Preflight, she was found to have mild osteopenia as evaluated by DEXA. **DISCUSSION:** Success of current and future spaceflight missions relies on astronauts' operational capability. Though the inflight impact to crew health and performance is not well characterized, bone loss may result in skeletal fragility, increasing fracture risk. With the transition to longer duration missions outside of low-Earth Orbit, and surface operations on the Moon and Mars, skeletal fragility will become an increasingly important risk factor. Individualized consideration of risk stratification for crewmembers and tailoring of appropriate countermeasures will be prudent.

Learning Objectives

1. The audience will gain an appreciation for potential aeromedical considerations of bone loss.
2. The audience will gain an appreciation for the impact of spaceflight associated bone loss to crew health and performance.

[206] SARCOIDOSIS IN A MILITARY AVIATOR: A CASE REPORT

David Smith, Ryan Bogart, Casey Naumoff
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Case Study)

INTRODUCTION: This case describes a military aviator diagnosed with pulmonary sarcoidosis following evaluation for intermediate uveitis. **BACKGROUND:** Sarcoidosis a multisystem granulomatous disorder of variable incidence and prevalence worldwide. In the United States, sarcoidosis prevalence is estimated at 60 per 100,000 persons, with females twice as likely as males to develop disease, and lifetime risk in black individuals is nearly three times that of white individuals. Nearly half of all cases are identified through incidental finding on imaging. There is no definitive diagnostic test for sarcoidosis; rather, the diagnosis is made based on the appropriate clinical scenario and exclusion of other similarly presenting diseases. Histopathologic confirmation can be established with biopsy of non-necrotizing granuloma. The course of disease ranges from spontaneous remission, including radiographic resolution, which occurs in an estimated 60-80% of patients with radiographic stage I disease, to fibrocystic scarring, progressive fibrosis, pulmonary hypertension, and respiratory failure in stage IV disease. Older age, Black race, female sex, and higher radiographic stage are associated with lower chance of remission and higher chance of symptoms. **CASE PRESENTATION:** This aviator presented in his late 30s with 10 months of persistent right eye visual field disturbances. Retinal specialist evaluation diagnosed pars planitis, a form of intermediate uveitis. Investigation for possible non-infective etiology revealed mediastinal and hilar lymphadenopathy and pleural based nodules. Suspicion of sarcoidosis was confirmed with biopsy revealing non-caseating granulomas. The patient underwent ocular corticosteroid injections, with noted improvement of inflammation on fundoscopic and slit lamp exams. He has remained symptom free of sarcoidosis from other systems and was returned to flying status with waiver after a positive retention evaluation. **DISCUSSION:** Sarcoidosis is an aeromedically significant disorder requiring careful consideration. Sarcoidosis is disqualifying for military service and for aviation duties within the U.S. Air Force, U.S. Army, and U.S. Navy. All military branches have a pathway for exception to this disqualification. The Federal Aviation Administration requires deferral for more than minimal or symptomatic sarcoid. Aeromedical decisions should be made after careful evaluation of the precipitating factors and success of treatment.

Learning Objectives

1. Ensure aerospace medicine clinicians consider sarcoidosis and other pathologic disorders in their differential diagnosis when evaluating aviators with uveitis.
2. Review the common considerations for sarcoidosis as it pertains to the aeromedical environment.

[207] POTENTIAL PREVENTIVE MEASURES FOR BONE LOSS IN LONG-DURATION SPACEFLIGHT

Ethan Stephens, Brian Rodriguez, Jeffrey McBride
UTMB, Galveston, TX, United States

(Education - Case Study)

INTRODUCTION: This case presentation describes a hypothetical veteran space flier who is at risk for bone loss and discusses available evidence regarding countermeasures to preserve bone health. **BACKGROUND:** Bone loss has been documented during long-duration spaceflight in missions from Gemini to the International Space Station. Cortical and trabecular bone have been observed to decrease at rates of 0.9% and 1.2-1.5% per month for vertebra and hip respectively, using volumetric bone mineral density quantitative computer tomography. Compounded on the spaceflight risk of bone loss is bone loss secondary to normal aging. Premature bone loss from spaceflight may predispose individuals to increased skeletal fragility, and increased

risk of fracture. Thus, it is imperative to address spaceflight associated bone loss in preparation for a maturing spaceflight population. **CASE PRESENTATION:** The subject is a 60-year-old veteran female space flier who presents preflight and would like to discuss preventive measures for bone loss for her upcoming long-duration spaceflight. Past medical history includes diet and exercise-controlled hypertension, and mild osteopenia noted on dual-energy x-ray absorptiometry. **DISCUSSION:** Resistive exercise is the only inflight countermeasure used to mitigate bone loss during long-duration spaceflight. Exploration-class missions to the Moon and Mars will have further limited mass and volume constraints that will dictate the exercise device and load factor available for resistive exercise on these flights. In-flight skeletal fragility could increase fracture risk. This case report will highlight currently available data regarding resistive exercise and pharmaceutical countermeasures for bone loss during long duration spaceflight.

Learning Objectives

1. The audience will gain an appreciation for potential pharmacotherapeutic options in managing bone loss during spaceflight
2. The audience will gain an appreciation for the effect of resistive exercise on bone loss in long-duration spaceflight.

[208] NAVIGATING THE DEPTHS: A CASE STUDY OF DECOMPRESSION SICKNESS AND OXYGEN TOXICITY IN A PILOT SUBJECTED TO HYPOBARIC AND HYPERBARIC CHAMBER EXPOSURES

Jesse Laverdiere, Emily Hawker
U.S. Army Department of Aviation Medicine, Fort Novosel, AL, United States

(Education - Case Study)

INTRODUCTION: This case report details the presentation and management of a pilot who developed symptoms consistent with decompression sickness following a hypobaric chamber exposure and subsequently experienced oxygen toxicity during hyperbaric oxygen (HBO2) treatment. The case explores the complications arising from hypobaric and hyperbaric environments and highlights the associated risks in aviation training and hyperbaric chambers. **BACKGROUND:** Decompression sickness (DCS) and oxygen toxicity are distinct conditions that can affect aviators undergoing altitude chamber training or HBO2 therapy. While DCS results from decompression and excess nitrogen in tissues, oxygen toxicity, a less common but serious complication of HBO2 therapy, can cause seizures, pulmonary and other neurologic symptoms. **CASE PRESENTATION:** A military pilot underwent a 25,000-foot altitude hypobaric chamber profile. More than 24 hours post exposure, the pilot reported joint pain, tingling in the upper extremities, lightheadedness, and a sensation of skin crawling after physical exercise. Interim oxygen therapy at a local hospital initially alleviated symptoms, but subsequent HBO2 treatment led to a tonic-clonic seizure at 60 feet sea water (fsw) equivalent, with loss of consciousness, rigidity and tongue biting. Following seizure resolution and decompression to 30 fsw, HBO2 resumed but again induced symptoms of central nervous system oxygen toxicity, prompting early termination of therapy. Both MRI and EEG during hospitalization showed no abnormalities, and the patient has since resumed normal duties without recurrence of symptoms. **DISCUSSION:** This case emphasizes the complexities involved in treating DCS with HBO2, underscoring the risks of oxygen toxicity in hyperbaric environments. For flight surgeons, understanding these risks is vital for managing aviators' health and evaluating waiver eligibility post-treatment. The decision-making process reflects the balance between therapeutic benefit and potential risks in the treatment of decompression injuries.

Learning Objectives

1. The audience will learn about altitude DCS following a hypobaric chamber exposure.
2. The audience will learn about a rare but serious complication of HBO2.
3. The audience will learn about the aeromedical implications of an oxygen toxicity seizure.

Wednesday, 06/04/2025 ***8:30 AM***
Grand Hall East Corridor - Posters Only

[S-39] POSTER : TO AUTOMATE OR NOT TO AUTOMATE: THAT IS THE QUESTION

Chair: Daniel Roberts
Co-Chair: Andrew Bellenkes

[209] AUTOMATING ROBOTIC SURGERY FOR SPACEFLIGHT: LLM INTEGRATION TO FOSTER ASTRONAUT-ROBOT COLLABORATION

Divy Kumar[1], Dillan Prasad[1], Benjamin Weiss[1], Aditya Khandeshi[1], Rishi Jain[1], Michael Oblich[1], William Metcalf-Doetsch[2]
[1]*Northwestern University Feinberg School of Medicine, Chicago, IL, United States;* [2]*Northwestern Medicine, Chicago, IL, United States*

(Education - Program / Process Review)

BACKGROUND: The NASA Human Research Roadmap identifies several risks that may require surgical interventions, including bone fractures, renal stone formation, SANS, and injuries sustained due to dynamic loads and EVAs. Current remote robotic surgical approaches are rendered impractical for future spaceflights due to significant communication latencies. The round-trip communication delay is approximately 2.6 seconds in lunar orbit and can range from 8 to 40 minutes for missions to Mars. This review aims to evaluate the latest advancements in Large Language model (LLM)-integrated robotic surgery automation and identify areas where further research is required. **OVERVIEW:** LLM integration in automated robotics has significantly advanced robotic surgery, particularly in aerospace medicine where access to specialized surgeons is limited. LLM frameworks such as SuFIA enable comprehension and execution of surgical instructions in natural language, allowing more intuitive human-robot interaction. Recent research in multimodal LLM architectures allows for surgical reasoning and motion planning for robot-assisted blood suction. LLM error detection and correction can facilitate real-time surgeon-robot collaboration, as immediate expert consultation is not possible in space. Also, LLM use in simulation is important for the varied environments and gravitational forces encountered during space missions. Significant research gaps remain in improving real-time surgical prediction and adaptability to make it more reliable and effective for space applications. Developing predictive models, adaptive control algorithms, and advanced segmentation and tokenization techniques would allow for anticipation of surgical complications, behavior modification, and surgical instrument guidance. **DISCUSSION:** The integration of Large Language Models (LLMs) in robotic surgery is crucial for space missions where specialized medical expertise is limited. LLMs enable robotic systems to assist in decision-making and execution of surgical instructions, thus reducing the cognitive load on astronauts and enhancing surgical precision and safety. LLM-integrated robotic surgery can also benefit both military and civilian terrestrial healthcare, particularly in remote areas where access to specialized surgeons is difficult. By enabling physicians to perform complex surgeries with robotic assistance, these technologies can broaden the scope of treatable conditions and enhance global health.

Learning Objectives

1. The audience will be able to describe the role of LLMs in enhancing human-robot interaction in surgical settings.
2. The audience will learn about the application of multimodal LLM architectures in robotic surgery.
3. The audience will be able to identify the research gaps in LLM-integrated robotic surgery for aerospace medicine.

[210] VALIDATION OF A SMARTPHONE-BASED AI-POWERED PUPILLOMETER IN PARABOLIC FLIGHT

Kellie Gerardi[1], Shawna Pandya[2], Hugo Chrost[3], Michal Wlodarski[3], Marek Dziubinki[3], Radoslaw Chrapkiewicz[3], Sanjay Manohar[3], Norah Patten[4], Aaron Persad[5]
[1]*International Institute for Astronautical Sciences; Nova Southeastern University, Jupiter, FL, United States;* [2]*International Institute for Astronautical Sciences; University of Alberta Faculty of Medicine & Dentistry, Sherwood Park, AB, Canada;* [3]*Solvemed.AI, Lewes, DE, United States;* [4]*International Institute for Astronautical Sciences, Dublin, Ireland;* [5]*International Institute for Astronautical Sciences; University of Maryland Eastern Shore, Lewes, DE, United States*

(Original Research)

INTRODUCTION: The Spaceflight Associated Neuro-ocular Syndrome (SANS) is a constellation of findings affecting intraocular pressure, intracranial pressure (ICP), optic disc edema, globe shape, and more, and is considered a potential show-stopper for long-duration spaceflight and exploration-class missions. Quantitative pupillometry (QP) provides a novel method for examining pupillary light reflex, and is non-invasive, rapid and easy-to-use. Pivotally, QP can act as an inference of intracranial pressure changes, allowing for rapid evaluation of intracranial pathology, such as seen in SANS. A pupillometric measurement can be completed in seconds. In the present study, we aimed to validate the use of a novel smartphone-based, AI-powered pupillometer (AI Pupillometry System, Solvemed Inc.) in the microgravity environment, while also determining if exposure to the hyper- and reduced gravity phases of parabolic flight are sufficient to induced changes in pupillary dynamics as compared to 1-g conditions. **METHODS:** In the present study, we aimed to validate the use of a novel smartphone-based, AI-powered pupillometer (AI Pupillometry System, Solvemed Inc.) in the microgravity environment, while also determining if exposure to the hyper- and reduced gravity phases of parabolic flight are sufficient to induced changes in pupillary dynamics as compared to 1-g conditions. The smartphone device was deployed to collect data in participants (n=2) pre-, post-, and in-flight, including both the straight and level and microgravity portions of flight to account for cabin-induced lighting changes in pupillometric measurements. The research participants additionally completed qualitative surveys offering inputs as to devifuntionalityity and protocol optimization. **RESULTS:** The device functioned as expected in the microgravity environment of parabolic flight, and data was successfully collected pre, during and post flight. The survey feedback are being incorporated into future microgravity monitoring protocols. **DISCUSSION:** The smartphone-based AI Pupillometry System offers a more compact, lightweight form factor, addressing the mass and volume considerations in the spaceflight environment. The AI component allows for reliable measurement in different lighting conditions. This study marks the first time the AI Pupillometry System was deployed in a microgravity environment. This successful deployment advances the System's technology readiness level towards use in spaceflight.

Learning Objectives

1. To educate the audience about the value of automated pupillometry as a potential tool for intracranial pressure (ICP) monitoring during exposure to altered gravity environments.
2. To educate the audience as to the results of the first deployment and validation of an automated pupillometer in an altered gravity environment.
3. To highlight the value of an AI-based pupillometer as a potential monitoring tool for neuro-ophthalmological health in astronauts.

[211] AI-POWERED HEALTH MONITORING SYSTEM FOR DEEP SPACE MISSIONS: A PROCESS REVIEW AND FUTURE RESEARCH FRAMEWORK

Kyla Zhang[1], Zhicheng Jiao[2], Xuyu Wang[3], Peter Lee[2]
[1]*Brown University & Warren Alpert Medical School, Lake Oswego, OR, United States;* [2]*Brown University/Warren Alpert Medical School, Providence, RI, United States;* [3]*Florida International University, Miami, FL, United States*

(Education - Program / Process Review)

BACKGROUND: As humanity prepares for extended deep space missions, AI-powered health monitoring presents a critical research frontier. Current space medical systems lack sophisticated AI integration, limiting their capability to process complex biomedical data and provide real-time health insights, particularly given the technological gap of communication delays and resource constraints. **DESCRIPTION:** This review examines AI integration to resolve the technology gap in space health monitoring systems, focusing on data processing, pattern recognition, and predictive capabilities. Building on the 2021 NASA workshop on AI/modeling for space biology, we analyze three priorities: (1) machine learning algorithms for continuous health assessment, (2) AI-enhanced biomarker detection and analysis, and (3) intelligent systems for early warning and risk prediction. **FUTURE FRAMEWORK:** Research initiatives target six core objectives: (1) Real-Time Physiological Data Analysis with Deep Learning Models for rapid health insights and anomaly detection. (2) AI-Driven Sensor Fusion Technologies integrating bio- and environmental sensors for holistic health monitoring. (3) Generative Models for Healthcare Data Synthesis to produce synthetic health data replicating rare space medical events to overcome real-world data scarcity. (4) AI-Driven Digital Twins for health simulation and prediction. (5) Validation through Terrestrial Analog Studies ensures accuracy in predictive models for space-like conditions. (6) Integration of AI-Powered Adaptive Diagnostic Tools with existing systems for dynamic healthcare delivery. **DISCUSSION:** AI-enhanced health monitoring systems will significantly improve real-time medical decision-making and reduce dependency on Earth-based support. These advances translate to enhanced monitoring and predictive healthcare for military aviation, high-altitude operations, and remote medical care. The framework establishes standardized protocols for AI-driven health assessment across platforms, particularly benefiting high-performance aircraft operations and long-duration space missions. The system architecture enables broad collaboration between space agencies, military services, and civilian healthcare providers, creating a unified approach to remote health monitoring. While challenges remain in hardware reliability and validation, the potential to revolutionize both space medicine and terrestrial healthcare justifies continued international development.

Learning Objectives

1. [Participants will be able to...] Evaluate critical technological gaps in current space health monitoring systems and identify where AI solutions can provide the greatest impact.
2. [The audience will understand...] Key development priorities for AI-powered health monitoring systems in deep space missions, including biomarker analysis and predictive risk detection.
3. [Attendees will learn about...] Research frameworks for validating AI health monitoring systems through Earth-based analogs and hybrid architecture approaches.

[212] GUAARD: GUIDELINES FOR THE USE OF AI ON ASTRONAUT REPOSITORY DATA

Kiana Pillay, Ruth Reitzel, Jacqueline Charvat, Mary Van Baalen
NASA, Houston, TX, United States

(Education - Program / Process Review)

BACKGROUND: Artificial intelligence (AI) is rapidly emerging in the medical field. While AI has promising attributes for improving healthcare

efficiency, it is often applied to health data with large populations (N= >100,000). NASA's Lifetime Surveillance of Astronaut Health (LSAH) houses the repository for all NASA astronaut medical monitoring data that can be requested to be re-used for secondary data analysis. Recently, LSAH has received research requests to use this data for developing predictive AI models. While there are scientific and ethical considerations using AI and PHI, there are increasing concerns for use of AI in small niche populations, such as the NASA astronaut corps (n=360), including protecting astronaut privacy, scientific efficacy of building predictive models using small populations, and potential bias introduced by small populations. **OVERVIEW:** LSAH is establishing guidelines and assessing the implications of applying AI to astronaut medical data. A comprehensive literature search using PubMed and Google Scholar was conducted to identify and synthesize relevant research to develop AI-related definitions and guidelines for using AI on astronaut data. Search strategies include keyword searchers for artificial intelligence, AI, privacy, bias, and small populations. Literature was selected based on its relevance to AI and concerns specific to the astronaut population. Each article was summarized, and data related to context of the article within the target population, key findings, and, where applicable, the type of AI used was abstracted for further assessment. This research addresses the knowledge gap in implementing AI with astronaut medical data. **DISCUSSION:** A total of 8 articles were included in this review, categorized into three topics including bias (n=4), privacy (n=3), and small populations (n=1). Based on the literature, LSAH should focus guidelines around 1) using high-quality data to reduce bias in AI outputs, 2) re-evaluating anonymization methods to protect astronaut identities, and 3) using synthetic data to train AI models to address small population issues. This research applies to those concerned with integrating AI with astronaut or patient data. As AI advances, being informed about its developments and implications for human safety is crucial. Implications for this research include establishing standards for researchers requesting to use astronaut medical data with AI to ensure safe and ethical practices.

Learning Objectives

1. The participant will be able to understand the potential bias and implications of using artificial intelligence (AI) on small population data.
2. The audience will learn about the potential ethical concerns for AI use on astronaut medical data.

[213] WITHDRAWN

[214] OPTIMIZING ADAPTIVE AUTOMATION IN AVIATION: A LITERATURE REVIEW ON DYNAMIC AUTOMATION SYSTEM INTERACTION

Joseph Atchley[1], Jon Vogl[2], Matthew D'Alessandro[2], Jordayne Wilkins[3], Bethany Ranes[1], Isaiah Persson[1], Charles McCurry[3], Sharon Bommer[3]

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(Original Research)

BACKGROUND: Automation has been pivotal in reducing pilot workload and enhancing safety; however, it also introduces challenges such as over-reliance, disengagement, and diminished situational awareness. With the growing complexity of modern military aircraft systems and increasingly dynamic operational environments, adaptive automation offers a promising solution by dynamically adjusting to the pilot's workload and environmental conditions. **METHODS:** A literature review was conducted on the evolution of adaptive automation in aviation, comparing foundational research with modern advancements (2013-2023) to identify best practices for future automated systems. Key areas explored include automation activation processes—static, adaptable, and adaptive—and their respective impacts on safety and operator performance. **RESULTS:** Articles (N = 2555) were reviewed for relevance in this study, and 13 papers were included that included a use case of adaptive automation. Ten general adaptive automation recommendations were synthesized based on these papers. **DISCUSSION:** Literature review findings emphasize the importance of maintaining situational awareness, particularly during automation handoffs. Transparency in automation interfaces is crucial, ensuring pilots remain informed about system decisions and actions both in real-time and in near-future projections. This is especially important in high-stakes environments, where failure to properly manage automation transitions can lead to catastrophic outcomes. The review concludes with recommendations for future adaptive automation systems in aviation, focusing on dynamic task allocation, human-centered interface design, and enhanced transparency to optimize safety and performance. By addressing the risks of automation misuse and disuse, adaptive systems can support human operators while leveraging the strengths of automation to manage increasingly complex aviation scenarios. These guidelines offer a foundation for future research and system development in adaptive automation.

Learning Objectives

1. Learn about ten recommendations to keep in mind when developing adaptive automation systems. These recommendations have been shown to enhance performance, reduce cognitive workload, and improve safety outcomes when applied effectively.
2. Understand the challenges and opportunities for performance when implementing adaptive automation systems within the domain of aviation.
3. Recognize the similarity between foundational recommendations for adaptive automation systems and the common recommendations included in modern works.

[215] ACCEPTANCE OF PHYSIOLOGICAL MEASUREMENTS OF PILOTS – RESULTS FROM SEMI-STRUCTURED INTERVIEWS

Raphael Kneffel[1], Maike Fischer[2], Stefan Sammito[1]

[1]*German Air Force Centre of Aerospace Medicine, Cologne, Germany;* [2]*German Aerospace Center (DLR), Braunschweig, Germany*

(Original Research)

INTRODUCTION: As aviation becomes increasingly complex, the demands on Human-Machine Interaction (HMI) are growing. Adaptive automation systems, based on physiological measurements of pilots, could improve flight safety. However, it remains unclear to what extent pilots will accept these technologies in operational use. **OBJECTIVES:** The aim of the study was to investigate pilots' acceptance of the measurement of physiological data in operational settings and its use for adaptive automation systems. Both civilian and military pilots were included in order to analyze how they respond to these technologies, and what requirements they have for such systems. **METHOD:** In a qualitative study, semi-structured interviews were conducted with 18 civilian A320 pilots and 5 military Eurofighter pilots. The interviews were analyzed to gain insights into user acceptance. **FINDINGS:** The findings showed that civilian pilots see the greatest benefit in measuring physiological data for fatigue and crew management, while military pilots focus on G-LOC and hypoxia. Both groups expressed concerns regarding comfort and data protection. Adaptive automation systems were viewed skeptically, particularly due to concerns that they might interfere with control at critical moments. **CONCLUSIONS:** The study indicates that adaptive automation and the collection of physiological data are generally accepted by pilots, provided that the systems do not add extra workload and data protection is ensured. A hybrid approach that integrates the advantages of adaptable automation could be a promising solution for future human-machine interactions in aviation.

Learning Objectives

1. Participants will learn how civilian and military pilots evaluated the use of adaptive automation systems and physiological measurements in the cockpit, and what differences exist between these groups.
2. Participants will learn that adaptive automation systems were viewed skeptically, while a hybrid approach to automation is proposed as a possible solution.

[216] REAL-TIME PHYSIOLOGICAL MONITORING FOR WARFIGHTER TRAINING

Brian King, Alessio Medda
Georgia Tech Research Institute (GTRI), Atlanta, GA, United States

(Education - Tutorial / Review)

INTRODUCTION: The Georgia Tech Research Institute (GTRI) has developed an ecosystem that achieves real-time monitoring of service members during training exercises, allowing for the transport and visualization of real-time data over cellular and/or local long-distance networks. The ultimate goal is to prevent heat related injuries by informing leadership of individuals that are approaching and sustaining dangerous levels of exertion during training events. The cloud component allows for data ingestion, visualization (real-time and post hoc), storage, and security. **TOPIC:** Separate on-body communication devices are used to transmit/store both physiological data (heart rate, skin temperature, heat stress index score) from the sensor(s), and add geolocation data for real-time movement tracking and post hoc analysis. Setup with a cellular network allows for monitoring anywhere, not just on site. The cloud server fuses data sources and run algorithms that are not possible at the edge due to processing power and/or access to all necessary data. With sensors and devices deployed in the field, leadership can monitor physiological conditions and unit location via any internet-enabled web browser (phone, tablet, laptop, etc). **APPLICATION:** The system capabilites have been tested and iterated for multiple use cases (physical training run, ruck-sack march, land navigation), with live demonstrations ranging from 50 to 500 participants. Leadership in training events have utilized the real-time information to identify "participants of interest" and sent personnel to assess their risk of heat injury. **DISCUSSION:** The poster/slides will discuss the background of the system architecture and components, use cases performed during live training events, and integration of sensors and algorithms to inform the health, readiness, and performance of the user. The goal is to identify data, processing, and usability needs and add those capabilities to the system to adapt to the needs of the aerospace community. **RESOURCES:** See the following for more information: https://www.gtri.gatech.edu/newsroom/gtri-helps-develop-wearable-sensor-system-prevent-heat-injuries-among-soldiers

Learning Objectives

1. The audience will learn about the system used to monitor real-time physiological data during training to assess performance and help prevent injury.
2. The audience will consider other metrics (physiological or otherwise) that could be incorporated to meet their needs to assess human performance.

[217] EVALUATION OF NEUROPHYSIOLOGICAL RESPONSES OF IMPENDING HELICOPTER CRASH IN SIMULATION

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(Original Research)

INTRODUCTION: Monitoring aviator performance through physiological measures is an ongoing effort across the defense services. A prominent area of monitoring has focused on excessive workload that could lead to a mishap or accident. If a physiological measure can predict an imminent mishap, an intervention such as adaptive automation may be introduced to mitigate the mishap. However, much of the research in this area has not utilized realistic tasks that result in performance failure. Performance failure, such as a crash, could provide useful information regarding how neurophysiological responses change under such stress. **METHODS:** Participants visited the laboratory twice. During the first visit, the participants completed several flights that were used to create scenarios with individualized workload manipulations for the second visit. During the second visit, participants completed a baseline flight with comfortable levels of workload and a high workload flight. Of the 12 participants, four crashed during the high workload flight. Electroencephalography (EEG) data were collected continuously throughout the flight. **RESULTS:** The EEG data were segmented into the following increments prior to the crashes and successful landings taking place: 30 seconds (s), 20 s, 10 s, and 5 s. An engagement index of beta/(alpha + theta) was calculated. The data were plotted to evaluate trends. In examining the plots, those who crashed showed a decreasing pattern in the engagement index leading up to the crash, whereas those who landed safely demonstrated an increasing pattern. Increases in this ratio typically demonstrate more cognitive engagement. **DISCUSSION:** We observed different neurophysiological patterns in pilots who were about to crash versus those who landed successfully. Caution needs to be taken when interpreting this data, which was collected within a simulated flight environment. Here, it appeared the aviators "gave up," likely upon realizing a crash was about to occur. Alternatively, in a real flight, an aviator would demonstrate full engagement while attempting to avoid a crash. This dataset supplies a unique opportunity to further understand changes in neurophysiological response when a task becomes too challenging to maintain. This can provide additional insight into understanding the physiological changes that must be monitored to predict aviator performance.

Learning Objectives

1. The audience will understand the utility of physiological measures in monitoring aviator performance.
2. The audience will learn about current efforts in operator state monitoring within the US Army.
3. The audience will understand the limitations of creating realistic flight scenarios within the simulator.

[218] EXPLORING THE CORRELATION BETWEEN INTEROCEPTION AND PHYSIOLOGICAL ADAPTABILITY AMONG ENVIRONMENTAL CONDITIONS

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Naval Medical Research Unit - Dayton (NAMRU-D), Dayton, OH, United States

(Original Research)

INTRODUCTION: Hypoxic stress typically induces certain physiological responses (changes to cardiovascular and respiratory function). Interoception is a concept surrounding internal sensation of the body. Detection of one's own discrete internal signals is interoception accuracy (IA), a component of interoception. The correlation between interoception and physiology is inadequately understood. Drawing off earlier work establishing respiratory sinus arrhythmia (RSA) predictability from IA, testing this relationship and other biosignals in a Hypoxic (Hx) environment was necessitated. Understanding the relationship between IA and physiological signals such as RSA and Galvanic Skin Response (GSR) may help to elucidate individual differences contributing to aviator's Hx susceptibility. This study investigates this knowledge gap to better understand individual factors' roles in Hx and stressed environments aviators face. **METHODS:** Eight participants took part in a fixed-based flight simulator study, where IA groups were determined through a heartbeat counting task score with a median split. Participants had two flight sessions, one normoxic (Nx) and one Hx, on separate days. Condition order was counterbalanced . GSR and RSA were recorded prior to- and during-flight to assess stress responses and physiological function. **RESULTS:** Results indicated that high IA participants exhibited significantly greater respiratory sinus arrhythmia (RSA) modulation in the stressed, Hx condition compared to low IA participants ($p = 0.001$, $\eta p2 = 0.424$ [large effect]), alongside lower GSR levels under Hx ($p = 1.39E-11$, $\eta p2 = 0.099$ [medium effect]). Additionally, high IA individuals maintained higher oxygen saturation (SpO2) levels in the Hx condition ($p = .01$, $\eta p2 = .037$ [small effect]), demonstrating enhanced physiological function and stress mitigation. **DISCUSSION:** Despite the limited sample size, findings suggest that greater IA relates with relatively better

physiological responses under stress. Specifically, greater RSA modulation was observed in the Hx condition when there was low modulation in the Nx condition. Moreover, GSR levels were substantially lower in the high IA group in the Hx condition. This highlights the importance of autonomic adaptability in low oxygen environments. Future research may also continue to investigate how IA and biosignals are correlated and explore the underlying mechanisms that connect them.

Learning Objectives

1. The audience will learn about various bio signals important to physiological stress monitoring.
2. Audience members will gain insight into potentially novel topics of interoception and its components.
3. Finally, members will learn how interoception and physiological signals may correlate and interact under stressful environments.

[219] INTEROCEPTIVE ACCURACY AS AN INDICATOR OF FLIGHT PERFORMANCE

Allison Ludwig[1], Mariateresa Sestito[2], Dain Horning[1], Tayton Hess[1], Mary Nimmer[1], Kevin Novak[1]
[1]*Naval Medical Research Unit-Dayton, Dayton, OH, United States;* [2]*Embry-Riddle University, Daytona Beach, FL, United States*

(Original Research)

INTRODUCTION: Spatial disorientation (SD) is a persistent problem in military aviation causing heavy equipment damages and loss of life. SD has a variety of causes, including degraded visual environments and hypoxia. Interoception, the ability to detect subtle physiological and orientation-related changes in one's body, has not yet been investigated as an influencing factor of SD. Having a higher interoceptive ability may make individuals more prone to SD due to an individual's reliance on bodily cues rather than flight instruments. **METHODS:** Participants (n = 8) were military or civilian aviators. Participants performed a heartbeat counting task to assess interoceptive accuracy (IA), a sub-component of interoception. Participants were divided into high/low interoception groups. Participants performed a series of flights and asked to fly to a series of target headings/altitudes in a fixed base simulator. Altitudes alternated above and below a cloud deck, simulating visual meteorological conditions (VMC) and instrument meteorological conditions (IMC), respectively. Participants were blinded to breathing oxygen concentration conditions (21.0% or 10.2% O2), separated by at least 48 hours between sessions. **RESULTS:** Error from the instructed altitude and heading were primary metrics of flight performance, indicative of SD. Heading error was significantly lower under VMC compared to IMC, ($F(1, 418.86) = 12.77$, $p = .0004$, $\eta p2 = .030$). Altitude error was higher for all participants in the hypoxic concentration condition ($F(1, 444.76) = 3.89$, $p = .049$, $\eta p2 = .009$). While there was no main effect of interoception, there was an interaction effect with oxygen concentration condition. Low IA individuals, compared to high IA individuals, had higher altitude error under hypoxia, ($F(1, 444.57) = 12.29$, $p = .0005$, $\eta p2 = .027$). **DISCUSSION:** The study showed high IA individuals performing better under hypoxia than low IA individuals. This may indicate that high IA capabilities make them more resilient in operational stress conditions. More in-depth studies are needed to better characterize high IA psychophysiological profile correlated with better performance under SD/hypoxia stressors. Additionally, re-creating the real forces of flight during the study (full motion vs. fixed based platform) will help to better sort out those effects.

Learning Objectives

1. To show that high interoceptive accuracy correlated with better performance during simulated in-flight stressors.
2. To demonstrate how some individuals may be more resilient to spatial disorientation due to internal traits.

[220] WITHDRAWN

Wednesday, 06/04/2025 ***10:30 AM***
Centennial Ballroom I

[S-40] PANEL: SHORTER TIME ON DNIF STATUS THROUGH NEW INNOVATIONS IN USAFSAM ACS NEUROPSYCHIATRY WAIVER PROCESS

Chair: Henrik Close
Co-Chair: Justin Bunn

Panel Overview: *The United States Air Force School of Aerospace Medicine (USAFSAM) Aeromedical Consultation Service (ACS) plays a critical role in ensuring the medical qualifications of airmen, and its Neuropsychiatry Waiver process is a key component of this mission. The panel will explore the ACS Neuropsychiatry Waiver process and compare it to the Federal Aviation Administration's (FAA) Special Issuance process, highlighting the similarities and differences between the two processes. The presentations will also cover new innovations in the ACS Neuropsychiatry Waiver process that aim to shorten the time airmen spend on DNIF status, including the use of comprehensive psychological testing and a revised policy for waiver consideration for airmen with PTSD, adjustment disorder, and other stressor-related disorders. Attendees will gain a better understanding of the medical evaluation processes for airmen and the importance of maintaining high medical standards for flight safety.*

[221] USAFSAM ACS NEUROPSYCHIATRY WAIVER PROCESS: IMPLICATIONS FOR AIRMEN AND AVIATION SAFETY

Kevin Heacock
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Tutorial / Review)

INTRODUCTION: This presentation will explore the ACS Neuropsychiatry Waiver process and its comparison to the FAA's Special Issuance process. **TOPIC:** The ACS Neuropsychiatry Waiver process is a systematic and evidence-based approach to evaluating airmen with a history of psychiatric conditions, with the goal of determining their medical qualifications for flight duties. The process involves a thorough review of medical records, neuropsychological testing, and consultation with specialists. **APPLICATION:** This presentation will provide a detailed comparison of the two processes, highlighting the similarities and differences, and discussing the implications for airmen and the aviation industry. Attendees will gain a better understanding of the medical evaluation processes for airmen and the importance of maintaining high medical standards for flight safety.

Learning Objectives

1. Describe the key components of the ACS Neuropsychiatry Waiver process, including the medical record review, neuropsychological testing, and specialist consultation.
2. Differentiate the ACS Neuropsychiatry Waiver process from the FAA Special Issuance process in terms of the types of conditions evaluated, the evidence required, and the decision-making criteria.
3. Identify the implications of the ACS Neuropsychiatry Waiver process and the FAA Special Issuance process for airmen and the aviation industry, and articulate the importance of maintaining high medical standards for flight safety.

[222] USAFSAM ACS COMPREHENSIVE REVIEW AND EVALUATION PROCESS FOR PILOTS WITH MENTAL HEALTH CONDITIONS

Ryan Peirson
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Tutorial / Review)

INTRODUCTION: This section summarizes the critical role of the United States Air Force Aeromedical Consultation Service's Neuropsychiatry review and evaluation procedures in the waiver or

disqualification process for pilots with a history of mental health diagnoses. It will provide an overview of the process, including in-person evaluations, medical record reviews, and the final risk assessment. **TOPIC:** The topic focuses on the United States Air Force Aeromedical Consultation Service's Neuropsychiatry review and evaluation procedures for pilots with a history of mental health diagnoses. The process involves a week-long evaluation, with multiple interview sessions with a psychiatrist and psychologist team. In cases where in-person evaluation is not possible, medical records are thoroughly reviewed. The final risk assessment involves discussions with over 20 physicians. **APPLICATION:** The United States Air Force Aeromedical Consultation Service's Neuropsychiatry review and evaluation procedures are rigorous and meticulous in nature, ensuring the highest standards of flight safety while supporting the mental health and well-being of airmen. The process is critical in ensuring the safe and effective return to flight duty for airmen with mental health conditions. The application of this material is broad, as it applies to aerospace medicine and human performance.

Learning Objectives

1. Describe the comprehensive procedures involved in the US Air Force Aeromedical Consultation Service's Neuropsychiatry review and evaluation process for pilots with a history of mental health diagnoses, including the week-long evaluation, multiple interview sessions with a psychiatrist and psychologist team, and thorough record review.
2. Explain the importance of the final risk assessment for pilots seen in-person, including discussions with over 20 physicians, and its role in making informed recommendations for waiver or disqualification.

[223] THE ROLE OF COMPREHENSIVE PSYCHOLOGICAL TESTING IN EVALUATING PILOTS WITH MENTAL HEALTH CONDITIONS IN THE UNITED STATES AIR FORCE

Monica Malcein
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Tutorial / Review)

INTRODUCTION: This abstract summarizes the presentation on the use of comprehensive psychological testing in evaluating pilots with a history of mental health diagnoses in the United States Air Force. **TOPIC:** The United States Air Force Aeromedical Consultation Service's Neuropsychiatry branch utilizes comprehensive psychological testing as a critical component of the evaluation process for pilots with a history of mental health diagnoses. Thorough and evidence-based psychological testing is performed by the psychologists and neuropsychologist team. The testing includes a range of measures, such as cognitive, personality, and symptom assessments, and is tailored to the individual needs and history of each pilot. The results of the psychological testing can be compared to baseline testing performed prior to the pilot's initial training, providing valuable information about any changes or impairments in cognitive or psychological functioning. **APPLICATION:** The presentation will highlight the importance of psychological testing in making informed recommendations for waiver or disqualification and ensuring the safe and effective return to flight duty for airmen with mental health conditions. Attendees will gain a better understanding of the psychological testing procedures, and how they support the mental health and well-being of airmen while maintaining the highest standards of flight safety. The presentation will also discuss the role of the psychologist in the evaluation and interpretation of the psychological testing results. The information presented will be useful for aerospace medicine and human performance professionals who work with pilots and airmen with mental health conditions.

Learning Objectives

1. Describe the comprehensive psychological testing procedures performed by the US Air Force Aeromedical Consultation Service's Neuropsychiatry when evaluating pilots with a history of mental health diagnoses, including cognitive, personality, and symptom assessments.
2. Explain the importance of comparing the results of the psychological testing to baseline testing performed prior to the pilot's initial training, and how it supports the safe and effective return to flight duty.

[224] INNOVATIONS AND ENHANCEMENTS TO THE USAF PROCESS FOR WAIVERS FOR FLYERS WITH MENTAL ILLNESS

Terry Correll
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Tutorial / Review)

INTRODUCTION: It is widely known that mental health conditions in US Air Force flyers are one of the most common causes of significant disruption in operational readiness and one of the most common reasons aviators lose their ability to fly. It is critical to our national security to fully support United States Air Force (USAF) operational missions. **TOPIC:** We will highlight the innovations and enhancements to USAF policy which enable returning flyers to operations as rapidly as possible, but also with necessary accountability and close follow up to insure maximal safety. We will examine the criteria for optimal cases, resolution of impairing symptoms, management of causative stressors, appropriate/shortened waiting periods, maximizing the clinician's judgment, and clearly define comprehensive/optimal mental health care that should be provided. Attendees will gain a better understanding of the innovative policies and their implications for airmen and the aviation industry. The focus will primarily be on new and innovation strategies in the US Air Force to hasten the process of obtaining a waiver while providing better oversight and accountability. **APPLICATION:** Although specific for Air Force pilots and aircrew evaluated at the USAF Aeromedical Consultation Service, the underlying issues are common to aviators and waiver processes in all the military services and civilian organizations.

Learning Objectives

1. Examine and discuss new and innovation strategies in the US Air Force to hasten the process of obtaining a waiver for any psychiatric diagnosis while providing better oversight and accountability during and after treatment.
2. Evaluate and analyze the criteria for optimal mental health care in the USAF to ensure operator safety, well-being, and operational readiness.

Wednesday, 06/04/2025 ***10:30 AM***
Centennial Ballroom II

[S-41] PANEL: WHAT GOES ON IN THE MIND? - MENTAL STATE MONITORING USING PHYSIOLOGICAL MEASURES IN AEROSPACE

Chair: Anne-Marie Brouwer
Co-Chairs: Charelle Bottenheft, Erik Frijters, Simone Löhlein, Karl Tschurtschenthaler, Evy van Weelden

Panel Overview: *With aerospace tasks becoming increasingly more cognitive in nature, continuous, non-obtrusive and objective information about cognitive processes and states (workload, attention, situation awareness) are desired in real time operation as well as in training and selection. Physiological measures such as EEG brain signals and heart rate, as well as implicit behavior recorded through e.g. eye trackers and camera's contain information about mental state. They can be obtained using increasingly comfortable sensors. Faster data processing currently allows analyses (including AI and machine learning) that were not possible before. Latest trends and developments are presented by researchers in academic and applied aviation research. Firstly, the Netherlands-US TeamMetrics project group (Airforce Research Lab AFRL, Netherlands Aerospace Center NLR, the Netherlands Organization for applied scientific research TNO) shows how EEG may help us monitor information intake in a semi-realistic multi-UAV task. The panel features three research groups that focused on measuring*

workload in pilots, mostly in the context of training. The programme Next Gen Aircrew Performance (TNO) tested a setup to measure workload with 14 fighter pilots in a high fidelity simulator. Tilburg University (the Netherlands) examined the potential of pilots' workload as estimated through EEG to adapt flight simulation training to the individual student. The HuMiCS Lab (Humans, Military missions and Cognitive Systems) at the University of the Bundeswehr Munich (Germany) tested the relation between workload, physical discomfort and performance in a motion simulator with a flight-training-like scenario. We end with another example of applying automated assessment of pilots' activity and mental workload, namely in an adaptively aiding cockpit agent (by the HuMiCS Lab). The five presentations are followed by a discussion including the audience on required future steps. Discussion also entails ethical aspects around the envisioned applications. Amidst the promises and the hypes of brain or mind reading and AI, the attendees will get a realistic picture of what currently is and is not possible in terms of monitoring mental state in the aerospace domain and its applications. In the discussion the audience will be actively engaged in reflecting on how this technology can be used in the most effective and responsible way.

[225] OBJECTIVELY MEASURING FIGHTER PILOTS' MENTAL WORKLOAD IN A HIGH-FIDELITY F-16 SIMULATOR

Charelle Bottenheft, Juliette Bruin, Anna Reuten, Erik-Jan Cornelisse, Mark Houben, Wietse Ledegang, Ivo Stuldreher, Eric Groen
TNO, Soesterberg, Netherlands

(Original Research)

INTRODUCTION: The next-generation Air Force is moving towards information-heavy and networked operations with advanced sensors, display technologies, datalinks and increased automation. These new technologies and fusion of information enhance aircrew situational awareness. However, managing all these systems might also increase pilots' mental workload, or on the other hand, reduce their vigilance due to automated processes. Both effects might threaten flight safety and mission effectivity. The main aim of this study is to investigate whether physiological measures can differentiate between levels of mental workload during flight simulation. **METHODS:** A study was conducted with fourteen fighter pilots using a high-fidelity F-16 simulator. As measures for mental workload we used electrocardiography, electrodermal activity, electroencephalography, eye tracking, and subjective self-ratings. The within-subjects design involved a mission where the pilot had to eliminate a target in hostile territory, with flight segments ranging from low to high mental workload. Participants were given a secondary mathematical task, which alternated between easy and difficult math calculations. We investigated whether physiological measures could differentiate between difficulty levels across different flight segments, as well as within the same flight segment. **RESULTS:** Subjective mental effort ratings significantly differentiated between flight segments with varying levels of mental workload ($p < .001$). Higher ratings were given for the hard 'engagement' segment compared to both the easy 'holding' segment ($p = .002$) and medium 'intercept' segment ($p = .013$). Also higher mental effort ratings were given for the medium 'intercept' segment compared to the easy 'holding' segment ($p = .026$). **DISCUSSION:** Our findings confirm the effectiveness of our manipulation in establishing distinct mental workload conditions. Physiological data should indicate whether they can differentiate between these varying levels of mental workload. Objectively measuring and predicting mental workload of aircrew could have several advantages. First, the impact of new technologies and concepts of operations on the pilot's workload can be assessed. Second, continuous monitoring mental workload could be useful in guiding pilots to allocate their attention reasonably, thereby contributing to flight safety and mission effectivity. Finally, it allows for the adjustment of (simulator) training difficulty to optimize learning for pilot students.

Learning Objectives

1. The audience will learn about subjective and physiological measures used to assess mental workload in the cockpit.
2. The audience will learn whether physiological measures could differentiate between difficulty levels within flight segments, independent of task specific confounds such as varying levels of required muscle activity.
3. The audience will learn about the potential benefits of objectively measuring and predicting mental workload for aircrew.

[226] REAL-TIME PILOT ACTIVITY AND WORKLOAD ASSESSMENT TO ENABLE ADAPTIVE ASSISTANCE IN MILITARY MANNED-UNMANNED-TEAMING MISSIONS

Karl Tschurtschenthaler, Axel Schulte
University of the Bundeswehr Munich, Neubiberg, Bavaria, Germany

(Original Research)

INTRODUCTION: The key component in Manned-Unmanned Teaming (MUM-T) is the management of unmanned aerial vehicles, which requires pilots to cope with multiple supervisory control tasks concurrently. Mental states such as workload are therefore ubiquitous in MUM-T research. Our approach aims to solve this issue through cockpit agents that assist the pilot by adapting to the mental states involved in human multitasking. **METHODS:** The presented cockpit agent continuously encodes physiological measures (e.g. manual and gaze interactions) to a series of features. A probabilistic graphical model then uses these features to classify pilot activity. Mental workload assessment is based on the Multiple-Resource Theory and realized by computing interference of mental resources during concurrent tasks. We integrated this mental state assessment into two types of assistance agents that aim to minimize interruptions: The first agent delays less critical feedback during execution of high-priority tasks to maintain the flow of the pilot. The second system chooses the least intrusive feedback modality based on the allocated mental resources. To evaluate both intervention methods, we conducted a human-in-the-loop experiment in a MUM-T research simulator with eight pilot recruits. Throughout the experiment, performance in tasks with different priority were continously evaluated. In case of low pilot performance, the system adaptively notified the pilot. To determine change in performance, we used a non-adaptive system as baseline. **RESULTS:** Both intervention types led to a performance increase of ~37% for the high-priority tasks. In addition, participants reported a lower workload (around 12.5%) and higher flow state (around 33%). Overall, the adaptive interventions were well-received, with participants expressing broad acceptance of the system's approach during debriefings. **DISCUSSION:** The proposed method presents a novel approach to recognize pilot activity based on the real-time assessment of physiological measures, providing a strong basis for closed-loop assistance. Our evaluation demonstrates that this method significantly improves the performance of pilots, particularly during high-priority tasks.

Learning Objectives

1. The audience will learn that adaptive automation agents can increase crew performance in Manned-Unmanned Teaming missions.
2. The audience will learn how physiological measures that are acquired in real-time can be utilized for real-time inference of pilot activity and mental workload in a multitasking environment.
3. The audience will learn how interventions by cockpit automation can be generated that are adaptive to the multitasking of pilots.

[227] ANALYSING PILOTS' PHYSICAL STATE IN SITUATIONS OF HIGH WORKLOAD DURING MILITARY INITIAL FLIGHT TRAINING

Simone Löhlein
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(Original Research)

INTRODUCTION: Situations of excessive demands and high workloads not only lead to personal discomfort and reduced performance but can also lead to errors and accidents in safety-critical environments such as aviation. Identifying the causes and predicting the vulnerability of pilots is therefore an important concern, particularly in military aviation. The identification of individual stress situations can help to design

targeted training and coping strategies. Therefore, we investigate the relationship between the workload in typical flight training task situations and the individual physical response. The latter is reflected both in subjectively perceived discomfort and workload, but also in objective physiological parameters. **METHODS:** We conducted a human-in-the-loop experiment in a motion simulator with a flight-training-like scenario that was made up of training-typical task blocks with increasing mental demand. Every two minutes subjective perceived workload as well as dizziness and nausea, common measures for physical discomfort were queried. In addition, eye-tracking parameters (attention distribution, saccade rates, gaze patterns and duration of head down phases) and objective flight and side task performances were continuously recorded. The set-up is complemented by the measurement of heart rate, EGG, EDA and body temperature. **RESULTS:** Our results show a positive correlation between the subjective parameters of discomfort and workload (meta-analysis over subjects, $p<0.01$). Further, the objectively measurable value of reaction time increased in correlation with workload. Comparing the objectively estimated workload by experimental design with the subjectively reported workload, we verified the intended increasing mental demands of the training scenario. **DISCUSSION:** The subjective and objective measurements confirm that the modular experimental scenario is well suited to testing different workload situations. In current analyses, we aim to further explore the correlation of workload, performance, and pilots' physical state. To this end, we additionally consider physiological measures as well as eye-tracking data to complete the mental state model.

Learning Objectives

1. Get an idea of the subjective and objective measures that can be used to analyse a pilot's mental state.
2. Understand how physical and mental conditions affect a pilot's condition, well-being and performance.

[228] UTILIZING EEG BRAIN SIGNALS TO EVALUATE PILOT WORKLOAD IN VIRTUAL REALITY FLIGHT SIMULATION TRAINING IN REAL TIME

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(Original Research)

INTRODUCTION: Conventional ab initio flight training methods require extensive resources and, often post-hoc, subjective evaluations of performance. This research explored integrating Virtual Reality (VR) and other training mediums with (neuro)physiological sensors to assess pilot workload and social coordination (e.g., physiological synchrony) during training and provide real-time feedback. The aims of this work were to better understand the extent to which 1) VR technology and passive brain-computer interfaces are effective tools for flight training, as well as 2) the degree to which mental states can be monitored. **METHODS:** We conducted a literature review and four experiments. First, we performed a systematic review to identify gaps in the literature and explore prospects for EEG-based pilot workload monitoring. Next, we examined how simulator fidelity impacts both subjective (e.g., workload, engagement) and objective (e.g., performance, EEG) measures with novices. Further studies involved modeling EEG data from novice military pilots to predict workload and testing a neuro-adaptive VR training system. Lastly, we assessed interpersonal coordination between student and instructor in simulated and real flights by using cardiac measures to examine dyadic workload. **RESULTS:** Our studies have shown that VR serves as an engaging training medium, supported by subjective and neurophysiological measures of engagement. We found that pilots' EEG signals can successfully be used to monitor pilot workload during VR training, consequently allowing the simulation to adapt and manage pilots' workload in real time. However, pilot performance in the neuro-adaptive simulation did not differ from randomized training. Monitoring interpersonal coordination of learner-instructor dyads using cardiac signals also showed promise for assessing pilot workload during training, but larger samples are needed as we have encountered challenges in navigating the trade-off between exploratory tests and sample size constraints. **DISCUSSION:** Our findings explain and highlight that (neuro)physiological signals of pilots can be used in combination with newly emerging technologies, such as VR, in order to enhance flight training. However, the demonstration of the neuro-adaptive VR flight training system yielded different results between subjects. In fact, multiple studies were affected by inter-subject variability and small sample sizes, highlighting the need for further investigation of inter-subject variability in larger pilot samples.

Learning Objectives

1. The audience learns how wearable sensors such as EEG electrodes can have benefits in flight training, specifically in monitoring trainee's mental state in real-time for evaluation.
2. The audience learns about the added value of Virtual Realty in providing high-fidelity training opportunities and becoming a highly ecologically valid and safe testbed for new training methods or scenarios.

[229] MONITORING ATTENTION IN A SEMI-REALISTIC MUTI-UAV TASK

Anne-Marie Brouwer[1], Ivo Stuldreher[2], Juliette Bruin[2], Patrick Martin[3], Michael Tolston[4], Maykel van Miltenburg[5], Erik Frijters[6]
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(Original Research)

INTRODUCTION: Modern aerospace systems involve large amounts of information to be processed by human operators. This can be a critical bottleneck, differentiating between success and failure. Continuous measures of human information intake would be useful to evaluate systems or trainees. In real time, they could be used to decide to present information again, or decide that certain tasks can better be postponed or automated. We here focus on late brain EEG responses (event related potentials or ERPs), that are known to reflect top-down attention, as a potential way to monitor information intake in real life environments. **METHODS:** The experiment was conducted at and approved by Radboud University Nijmegen, the Netherlands. A 'pilot' and a 'navigator' were asked to together perform eight 5-min UAV (Unmanned Aerial Vehicle) task blocks in a naturalistic UAV-control setting, including speech. The task entailed flying multiple UAVs safely to target areas and then locating the target. Every other task block, the pilot was asked to change priorities from the general task to attending to certain spoken call signs that were present throughout. EEG was related to the call signs, as well as to other meaningful sounds (e.g. sounds associated with locating a target or with a search time-out). **RESULTS:** Call signs elicited late ERPs, only when they were target call signs, only in the pilots, and only during the blocks in which these sounds were relevant. Consistent with this, call sign performance data also indicated that pilots correctly processed this information. We did not find the hypothesized difference between task block type (yes/no call sign task) in pilots' responses to other task relevant sounds. The results rather show that pilots hardly respond to these sounds at all, while navigators do, which is consistent with the fact that the sounds related more strongly to the navigator's than to the pilot's task. **DISCUSSION:** We showed that even in a noisy, life-like environment, ERPs to sounds occurring in the task (including spoken words as in the call signs) reflect focused attention, as manipulated by (self-perceived) task requirements. Next steps include relating them to performance, apart from task requirements perse.

Learning Objectives

1. The audience will learn about EEG brain markers of attention, specifically the p300.
2. Through the example of monitoring attention in operators performing a UAV control task, the audience will learn about the challenges in the field of passive brain-computer interfaces/neuroergonomics, and the opportunities to enhance well-being and performance in the aerospace domain.

Wednesday, 06/04/2025 ***10:30 AM***
Centennial Ballroom III

[S-42] SLIDE : AVIATION ACCIDENT INJURY SEVERITY AND PREVENTION

Chair: Douglas Boyd
Co-Chair: Kristin Michelet

[230] DEFICIENCIES IN THE AUTOMATIC DEPENDENT SURVEILLANCE-BROADCAST SYSTEM FOR GENERAL AVIATION TRAFFIC DE-CONFLICTION-HUMAN FACTOR CONSIDERATIONS

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(Original Research)

INTRODUCTION: Under general aviation regulations, aircraft may operate by visual flight rules (VFR) with the pilot responsible for traffic separation via the "see-and-avoid" principle. Unfortunately, this method is known for its poor efficacy due to (ii) age-dependent deterioration of the human's field of vision (ii) fatigue (iii) stress (iv) image location over the blind spot with view from the other eye occluded by a physical obstruction. Recently, the Automatic Dependent Surveillance-Broadcast (ADS-B) system, comprised of a transmitter (ADS-B-Out) and an optional receiver (Traffic-In) has provided an additional means for traffic de-confliction. Although ADS-B-Out became mandatory in 2020 in designated US airspace no study, since then, has determined its efficacy in traffic-de-confliction. **METHODS:** Accidents were per the NTSB database. Responses to an aviator survey on ADS-B usage were collected September-October, 2023. Statistical tests included Poisson distribution and Chi-Square. **RESULTS:** The fraction of midair accidents with a fatal outcome (0.52) was significantly ($p<0.001$) higher (0.16) than accidents unrelated to midair collisions. Although the midair collision rate for ADS-B-Out equipped aircraft (2018-2022) trended downwards ($p=0.355$), such events persisted despite such equipage. Of 3,233 survey respondents, 97% indicated Traffic-In capability -thus, the unremarkable diminution in midair collision rate is unlikely due to low Traffic-In equipage. From a human factors perspective, displayed traffic viewing angle, annunciation type and knowledge of the time delay associated with displaying non-ADS-B-Out aircraft all failed to explain continued midair collisions. However, 86% of respondents were unable to visually acquire ADS-B-In-annunciated merging aircraft explaining, in part, a continued midair mishaps for such equipped aircraft. **DISCUSSION:** Half of mid-air collisions have a fatal outcome and herein we illustrate an imperfect ADS-B system for traffic de-confliction. Regarding practical implications, pilots operating in accordance with VFR should (i) prioritize on maneuvering away from such traffic at the expense of gaining visual contact (ii) avail themselves of air traffic control de-confliction services.

Learning Objectives

1. The limitations of the see-and-avoid method for general aviation traffic de-confliction.
2. The deficiencies of he automatic dependent surveillance broadcast system for traffic de-confliction.

[230A] A NEW SCORING SYSTEM TO PREDICT FATAL ACCIDENTS IN GENERAL AVIATION AND TO FACILITATE EMERGENCY CONTROL CENTER DISPOSITION

Jochen Hinkelbein[1], Manuel Michno[2], Catherina Hippler[3], Felix Liebold[4], Jan Smitz[3], Markus Rothschild[3], Volker Schick[3]
[1]Ruhr-University Bochum, Minden, Germany; [2]Anatomical Institute, Zürich, Switzerland; [3]University Hospital Cologne, Cologne, Germany; [4]University Hospital and Faculty of Medicine Leipzig, Leipzig, Germany

BACKGROUND: Numerous accidents occur with General Aviation aircraft every year. To date, pre-emptive prediction of survival or death is impossible. The current study aims to identify significant factors elementary to predict survival after General Aviation (GA) aircraft accidents. The Implementation of a scoring system, including these factors, may facilitate emergency control centres. **MATERIAL AND METHODS:** Data of flight accidents over a 20-year period (extracted from the German Federal Bureau of Aircraft Accident Investigation [BFU]) was analysed for fixed-wing motorized small aircrafts below 5,700 kg MTOW. Factors of interest were analysed using Chi2- and Mann-Whitney-U-Tests. Logistic regression was used to establish a score to calculate the probability of a fatal outcome after an aircraft accident. **RESULTS:** The BFU lists 1,595 GA aircraft accidents between 2000 and 2019. The factors "third quarter of the year" ($p=0.04$), "last quarter of the year" ($p=0.002$), "fire" ($p<0.0001$), "distance from airport >10 km" ($p<0.0001$), "landing" ($p<0.0001$) and "cruise" ($p<0.0001$), significantly correlated positively or negatively with a fatal outcome. "Take-off", "approach", "month", "day of the week", "persons on board above three", "night-time" and "icing conditions" showed no significant correlation. Using logistic regression "third quarter of the year" and "cruise" were excluded when using the B-STEP method. Including the four significant parameters, the score showed a strong effect with $f2=0.709$. **CONCLUSIONS:** The analysis of GA aircraft accidents in Germany enabled the identification of relevant factors and establishment of a new scoring system for survival prediction after small aircrafts accidents below 5,700 kg MTOW. The implementation of the scoring system in emergency control centres in the context of digital development and artificial intelligence can improve emergency response planning and distribution.

Learning Objectives

1. The audience will learn about General aviation crashes and how to estimate fatality risk.
2. The audience will learn the most important factor for GA accidents.
3. The audience will learn about a new scoring system for prediction.

[231] FATAL SPATIAL DISORIENTATION ACCIDENTS IN GENERAL AVIATION (2003 – 2021)

Hannah Baumgartner, Jason Sigmon
FAA, Oklahoma City, OK, United States

(Original Research)

INTRODUCTION: Spatial disorientation (SD) mishaps are a well-documented threat in general aviation (GA). Previous research by the Civil Aerospace Medical institute (CAMI) and others has examined the prevalence of SD fatal accidents in GA in past decades. However, no current baseline exists nor an evaluation of how current trends, such as a rise in single pilot turboprop and jet aircraft, may influence current rates of SD accidents in GA. **METHODS:** The National Transportation Safety Board's Carol database was queried for final reports that related to GA fixed-wing operations between 2003 and 2021. Reports were filtered to only include those referencing airplanes and included the term "spatial disorientation" in the factual narrative or probable cause. Findings, factual information, and analyses were evaluated for general information (e.g., fatalities, pilot experience, visual conditions) and overall trends across reports. **RESULTS:** A total of 370 final reports that involved fatal GA accidents with some reference to spatial disorientation were analyzed. These included 384 total pilot fatalities, 346 passenger fatalities, and an additional 11 ground fatalities. Accidents were fairly consistent across years, with a peak of 29 fatal SD accidents in 2019. Pilot experience levels varied across these accidents, with an average of 1799 flight hrs (SEM: ±164), and over half of pilots (n=200 of 384), were instrument-rated. Accidents more commonly occurred during day conditions and during the enroute stage of flight. Visual Flight Rules to Instrument Meteorological Conditions (VFR-IMC) occurred in 44% of accidents (n=161). A small but notable increase in SD fatal accidents involving turboprop and small jet aircraft was observed beginning in 2012. **DISCUSSION:** Understanding the current incidence and the

associated characteristics of SD accidents in GA is integral to addressing training and educational mitigations for SD. An increase in availability of light single-pilot turboprop and jet planes may explain the uptick in fatal SD accidents with these aircraft types. The current data will be contrasted with historical evaluations of SD fatal accidents from CAMI in 1978 and 1996 to better understand the changes in the occurrence of SD in GA.

Learning Objectives

1. Understand the incidence of fatal general aviation accidents related to spatial disorientation.
2. Understand the flight context and pilot demographics associated with fatal spatial disorientation accidents in general aviation.
3. Compare how fatal spatial disorientation accidents in general aviation has changed over time.

[232] INJURY METRICS FOR FUTURE AIRCRAFT ESCAPE AND CRASHWORTHY SYSTEMS

Matthew Lewis
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(Education - Program / Process Review)

BACKGROUND: Future escape and crashworthy systems need to be designed to minimise the potential for occupant injury during their safe operation. Each phase of the crew escape system can be associated with specific injuries. Even if these injuries occur their occurrence does not necessarily mean the system has malfunctioned as the dynamic nature of the event itself can result in injury. Consequently, during the design process a full understanding of such injuries must be assessed. **OVERVIEW:** There are many international standards which specify the injury metrics with applicable pass/fail criteria. Ideally, each of these criteria should predict the probability of specific injuries utilising injury probability graphs and hazard risk matrices, however, many do not. In their absence the significance of their exceedances is open to user interpretation, potentially resulting in huge costs to military programmes to achieve compliance for theoretical unvalidated injury mechanisms. Critically, the risk of spinal, head, limb flail and parachute landing injuries can be used to assess the safe ride characteristics of the escape system. The escape system standards for, DRI, MDRC, Nij, BRIC, LTA, HIC, etc were reviewed and the pass/fail criterion were assessed to determine if their limits could be validated against real time accident data. **DISCUSSION:** The analysis demonstrated that DRI shows good correlation to real time mishap data but MDRC has little real-world validation. Data from road traffic accidents show that BRIC is a better metric than HIC or LTA for predicting the risk of head injury and should be adopted in the air domain. Validated neck injury criteria have been introduced successfully into recent escape system procurement programmes and must be included in all future programmes particularly where HMD feature. Although windblast limb flail injury is a well understood risk this injury mechanism has no appropriate assessable criterion, other than the surrogate of limb displacement. Likewise parachute landing velocity is used as a surrogate for parachuting injuries where perhaps the tibia or femur injury index, for example, may be a better fit. This work is important for those involved with crew escape safety assessment and procurement, and is critical to minimising injuries to aircrew.

Learning Objectives

1. This presentation demonstrates the importance of using validated injury risk criteria to assess crew safety systems.
2. This presentation demonstrates that new injury metrics for limb flail injuries need to be developed.

[233] ALL GUTS, NO GLORY: THE MEDICAL IMPLICATIONS FOR GLIDER OPERATIONS IN WORLD WAR II

Jim Lucas
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(Education - Tutorial / Review)

INTRODUCTION: The effective use of military gliders by Allied forces during World War 2 is a well-documented but poorly-known aspect of the last great global conflict. And while much of the popular attention for the history of combat aviation and airborne assault in World War 2 is understandably devoted to the pilots of powered aircraft and parachute-borne infantry troops, the glider pilots of that era faced a significantly higher level of risk to life and limb with very little recognition of their bravery or sacrifice.**TOPIC:** The combat glider pilots of World War 2 faced staggering levels of risk on one-way flights into hostile territory - flying powerless aircraft made of metal pipes, wood, and canvas though a hail of flak and machine gun fire to silently reach targets behind enemy lines. With casualty rates as high as 30%, these heroic men were often referred to as "Suicide Jockeys" and the "Brotherhood of the Flying Coffin". Facing alarming levels of risk that would not be remotely tolerated by modern aeromedical standards, these heroes volunteered for missions involving a >90% chance to sustain some level of traumatic brain injury (TBI); flight-control and impact forces that often resulted in dislocations, open fractures, and traumatic amputations blunt and penetrating traumatic injuries; and, not uncommonly, death. And despite these risks, glider pilots were generally marginalized and looked upon as second-class aviators and soldiers for most of the war. The minimization of their impact and significance continues to this day, as most often the topics of gliders and their crews are rarely much more than an afterthought in most historical media. **APPLICATION:** A brief historical overview of the combat glider programs of the Allied forces, some of the major combat operations involving glider-borne troops and equipment, and the mechanisms of morbidity and mortality faced by those involved can provide a fuller understanding of the sacrifices and risks incurred in this early era of combat aviation. This historical perspective can further inform our evolving aerospace medical standards and practices as we look to the future of both combat aviation and deep space exploration. **RESOURCES:** Multiple sources which will be provided with the presentation.

Learning Objectives

1. Participants will learn about the tremendous medical risks and injury patterns faced by combat glider pilots during World War 2.
2. Participants will come away with a much greater understanding of the combat glider programs utilized by both Allied and German forces during World War 2.
3. Participants will gain a much fuller appreciating of the heroism and bravery of this long-overlooked and over-shadowed segment of the early combat aviation community.

[234] CIVILIAN VERSUS MILITARY ROTORCRAFT CRASHWORTHY SEAT STANDARDS FOR CRASH PROTECTION

Danielle Rhodes, B. Joseph McEntire, Joseph Willett, Valeta Carol Chancey
U.S. Army Aeromedical Research Lab, Fort Novosel, AL, United States

(Original Research)

INTRODUCTION: The Army UH-60 and AH-64 helicopter designs incorporated many crashworthy principles described in the Army Aircraft Crash Survival Design Guide. These aircraft are designed to absorb vertical impact energy to mitigate spinal injuries through energy attenuating landing gear, floor structure, and occupant seats. The desired seat performance and occupant restraint requirements were codified in MIL-S-58095 and MIL-S-85510. Both seat specifications were rendered inactive and unavailable for new seat development efforts and only available for reference. In this void, seats certified to civilian standards are being considered for use in military aircraft. A technical review of the military and civilian rotary-wing seat standards was needed to identify their differences and ensure Soldier crash protection would be not compromised. **METHODS:** Static and dynamic test requirements for military and civilian energy attenuating rotary-wing seating systems were reviewed. Documents reviewed included MIL-S-58095A, MIL-S-85510, JSSG-2010-7, SAE AS8049D, and SAE AS8049/1 Rev. B. Elements compared included dynamic test conditions (peak acceleration, velocity change, etc.), static

strength requirements, and the corresponding pass/fail criteria to include anthropomorphic test device (ATD) response measures. **RESULTS:** While the civilian rotary-wing seat standard more clearly articulates the requirements and incorporates the test surrogate response metrics, its static strength and dynamic test conditions are substantially inferior to military seat specifications and guidance. Some civilian static strength tests are 50% weaker than the military requirement. In dynamic tests, some civilian requirements only apply 37% of the energy of the corresponding military test. **DISCUSSION:** Civilian standards provide an appealing alternative due to less rigorous testing conditions and off-the-shelf, mass-produced materiel for seating systems. However, if civilian certified seats are employed in military rotary-wing aircraft, then occupant crash protection may be severely compromised. The seat may either separate from the fuselage or transmit injurious vertical loads as the seats are not designed to withstand the rigors of military crash environments. It is recommended that obsolete military crashworthy seat specifications be reinstated and updated with dynamic ATD response metrics and current Soldier anthropometry.

Learning Objectives

1. Civilian rotorcraft crew seat performance requirements are less stringent than military rotorcraft crew seat performance requirements.
2. MIL-S-58095A (AV) has been canceled and MIL-S-85510 (AS) rendered inactive leaving program managers without crashworthy performance requirements for testing.

Wednesday, 06/04/2025 ***10:30 AM***
Centennial Ballroom IV

[S-43] SLIDE : UNDER PRESSURE: DCS

Chair: Joseph Dervay
Co-Chair: Andrea Hanson

[235] DEVELOPMENT OF A DIGITAL DECOMPRESSION SICKNESS REMOTE EXAM FOR THE INTERNATIONAL SPACE STATION

Robert Sanders[1], Maybritt Kuypers[2], Sara Mason[3], Jean-Sebastien Zouehi[4], Maurice Marnat[4]
[1]*NASA, Houston, TX, United States;* [2]*MEDES/ESA, Cologne, Germany;* [3]*Aegis Aerospace, Inc, Houston, TX, United States;* [4]*MEDES, Toulouse, France*

(Education - Tutorial / Review)

INTRODUCTION: Decompression sickness is an evolving process, as such, it requires documentation overtime, not just a single moment. As NASA transitions from paper based questionnaires to digital formats, developing software to guide a persons to complete a thorough neurologic exam, allow for historical review and recent reference data, while communicating down to ground base medical resources was a unique challenge as NASA focuses more on exploration, preparing to retire the international space station. **TOPIC:** During spaceflight, there is a risk of crewmembers developing decompression sickness (DCS). This can happen when there is a loss of pressure in the space vehicle or when translating to a lower pressure environment like when performing Extra Vehicular Activities (EVA). NASA Space Medicine developed a contingent paper based DCS exam procedure for crew use in Low Earth Orbit. The EveryWear (EVW) iPad application developed by MEDES/CNES and the European Space Agency (ESA) allows for private medical messaging and data-collection for medial operations and science. It was first deployed on the ISS in support of ESA astronaut Thomas Pesquet's spaceflight in 2016. EVW use expanded to all ESA crewmembers, and in 2022 to all USOS crewmembers. In collaboration with NASA and ESA Medical Operations and MEDES/CNES, a custom DCS module was developed and deployed to the ISS within the EVW application to allow digital capture of the DCS exam conducted by an examining crewmember. The EVW application allows for dynamic questions and seamless photo-documentation. This critical clinical data will be communicated back to mission control in near real-time. The DCS module was augmented to allow crew review of serial DCS exams results which is a critical autonomous capability due to the potential for loss of signal to ground clinical team. **APPLICATION:** This tool is currently available for ISS crew, and will be available on upcoming Artemis missions, where communications will be more limited. The features in this tool have substantial potential for future use in other clinical and research tools for space exploration missions.

Learning Objectives

1. The audience will learn about the digital clinical tool currently available on to the International Space Station for the management of Decompression Sickness.
2. The participant will understand the features developed with this Decompression Sickness Module that would valuable for other clinical and research tools for future spaceflight.

[236] DECOMPRESSION SICKNESS PREVALENCE IN NASA'S EXPLORATION ATMOSPHERE RESEARCH

Kristi Ray[1], Alejandro Garbino[2], Robert Sanders[2]
[1]*UTMB/ NASA JSC, Galveston, TX, United States;* [2]*NASA JSC, Houston, TX, United States*

(Original Research)

INTRODUCTION: The National Aeronautics and Space Administration's (NASA) Exploration Atmospheres studies (EA) are done to assess pre-breathe protocols for denitrogenation and the evaluation of alternate cabin atmospheres and suit pressures for future spacecraft designs for planetary surface exploration (EVA). **METHODS:** EA includes both 3-day and 11-day trials. These trials include a depressurization and saturation to 8.2psia at 34% O2 or a depressurization and saturation to 9.6% at 28.5% O2 with additional repress to 4.3psia or 5.2 psia (simulating spacesuit pressure during EVA). All EVAs were conducted with 85% or 95% O2 with varying prebreathe times of 20 to 150 minutes. The accepted DCS risk is </= 15% risk of type 1 DCS, no type 2 DCS, and </= 20% high grade VGE. There were 6 proposed cases of type 1 DCS cases that were brought to NASA's DSSMB board for evaluation, resulting in a total of 3 cases that were confirmed. There were 2 cases of type 2 DCS that invalidated two prebreathe protocols. In addition, there was three cases of left sided cardiac bubbling that resulted in two of the type 2 DCS cases. **RESULTS:** An in-depth treatment algorithm was used during this study including the use of site level oxygen (SLO) (14.7 psia) and hyperbaric treatments using a chamber-side dual-lock deck decompression chamber with multiplace chamber back up available from NASA's Neutral Buoyancy Lab and local hospitals. The acute type 1 cases were treated with a minimum of 4 hours of SLO and the delayed type 1 case was treated in a hyperbaric treatment with a USN TT5. The acute type 2 cases were treated with a hyperbaric treatment with a USN TT6. All cases had complete resolution of symptoms. **DISCUSSION:** The effect of habitation and suit pressure is an essential part NASA's preparation for the upcoming Lunar Artemis missions to ensure protocols are created that optimize crew safety and health. These studies showed a higher prevalence of type 2 DCS than expected by models.

Learning Objectives

1. The audience will learn about type 1 and type 2 aerospace decompression sickness.
2. The audience will learn about NASA's accepted decompression sickness risk for exploration.

[237] NASA EXPLORATION ATMOSPHERE TESTS 3 & 4: DEVELOPMENT AND VALIDATION OF PLANETARY EVA PREBREATHE PROTOCOLS FOR ALTERNATE ATMOSPHERES AND SUIT PRESSURES

Alejandro Garbino[1], Monica Hew[2], Patrick Estep[2], Brett Siders[2], Karina Marshall-Goebel[3]
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(Original Research)

INTRODUCTION: Space suits operate at low pressures to optimize astronauts' performance. The drop in pressure from the habitat environment to the suit carries a risk of decompression sickness (DCS), which is mitigated by a 95% O2 prebreathe protocol. Prebreathe protocols for the lunar surface have a significantly higher risk compared to International Space Station microgravity Extravehicular Activities (EVA). In previous studies, we validated a prebreathe protocol from a 56.5 kPa 34% O2 cabin to a 29.6 kPa EVA pressure; however, the enriched oxygen cabin environment poses a flammability risk that requires significant changes to material design and selections. Here, we report outcomes for prebreathe protocols from a sub-30% O2 cabin and associated changes necessary to control DCS risk critical to upcoming lunar missions. **METHODS:** Fourteen volunteers completed 11-day hypobaric chamber studies with an "alternate exploration atmosphere" of 66.2kPa, 28.5% O2. Subjects acclimated for 48 hrs and then participated in five 6-hour simulated EVAs at 29.6 or 35.6kPa, 95% O2. Prior to EVA, subjects underwent a 20, 90, or 150-minute prebreathe. The EVA simulation was designed to be representative of future planetary EVAs, proportionate to the subject's VO2max. Decompression stress was monitored by real-time doppler and echocardiograph alternating every 15 min, as well as clinical monitoring for DCS signs/symptoms. Venous gas emboli (VGE) and DCS outcomes were verified against NASA-STD-3001 acceptance criteria. **RESULTS AND DISCUSSION:** Venous gas emboli (VGE) were identified during all EVAs. A neurological DCS case was identified in the 90-min/29.6kPa prebreathe, terminating further testing of this protocol. No DCS cases were identified in the 150 min/29.6kPa protocol. The 20 min/36.5kPa protocol was rejected due to a Type II DCS case. All DCS symptoms resolved with treatment, with no sequelae post initial treatment of DCS. These various test points highlighted to the significant benefit of elevated suit pressure to shorten prebreathe protocols, but also the difficulty in assessing and managing DCS during sustained EVA operations in remote planetary surfaces.

Learning Objectives

1. Attendees will be able to describe to relationship and tradeoffs between cabin oxygen & pressure, suit pressure and prebreathe duration.
2. Attendees will learn the testing and verification protocols NASA uses to mitigate DCS risk.
3. Attendees will learn how the limitations of suit pressure and materials flammability affect lunar EVA operations.

[238] NON-INFERIORITY PILOT TEST OF AN OXYGEN CLOSED CIRCUIT REBREATHER AT 35,000 FEET.

Maria-Vittoria Carminati[1], Nicolo Favero[1], Lorenzo Garbino-Carminati[2], Alejandro Garbino[1], Jonathan Clark[1]
[1]*C2Space Tech LLC, Houston, TX, United States;* [2]*C2Space Tech LLC, Aurora, CO, United States*

(Original Research)

INTRODUCTION: Human exploration of high-consequence environments comes with challenges, including physiological stresses such as decompression sickness (DCS). DCS occurs when gas bubbles form in nitrogen-supersaturated tissues due to a drop in atmospheric pressure, particularly relevant for space exploration involving extravehicular activities (EVA) and other space missions. Pre-breathe (or pre-oxygenation), involving inhalation of 100% oxygen before decompression, is essential for reducing DCS by decreasing tissue nitrogen levels. However, current prebreathe systems are open-loop, causing substantial oxygen waste and increase in cabin flammability when pre-breathe is conducted in closed environments such as cabins and space stations. In contrast, closed-loop oxygen rebreathers, which scrub CO2, replenish O2, and recirculate gas, significantly reduce gas requirements and flammability risks. **METHODS:** Our study at the Midland Altitude Chamber Complex (MACC) conducted two exposures consisting of a 60-minute pre-breathe and a 30-minute ascent to 35,000 ft. This pre-pilot study involved two participants, with Participant A using an open circuit system on Day 1 and a closed-circuit re-breather on Day 2, and vice versa for Participant B. **RESULTS:** Heart rate remained within normal limits for both systems. SpO2 stayed above 90% for both participants and equipment types over both days. Venous Gas Emboli (VGE) scores similarly did not show marked inferiority of the CCR. **DISCUSSION:** The findings demonstrate that closed-loop oxygen rebreathers provide significant oxygen savings and operational efficiencies compared to open-loop systems, supporting their use in reducing DCS risk while conserving resources in space operations.

Learning Objectives

1. Understand the physiological challenges and limitations of current pre-breathe and high-altitude oxygen delivery mechanisms.
2. Understand the safety and logistical challenges and limitations of current pre-breathe and high-altitude oxygen delivery mechanisms.
3. Understand the opportunities, advantages, and technical requirements of developing closed circuit rebreather oxygen delivery mechanisms for high-altitude pre-breathe technology.

[239] CEREBRAL PERFUSION AND INFLAMMATORY CYTOKINE EXPRESSION FOLLOWING A SINGLE HYPOBARIC HYPOXIC EXPOSURE IN AIRCREW TRAINEES

Meghan Robinson[1], Monroe Turner[1], Bianca Cerqueira[1], Goldie Boone[3], Holly Chapapas[1], Kelly McKay[1], Pedro Ramos[1], John Sladky[3], Paul Sherman[2]
[1]*KBR, Inc., San Antonio, TX, United States;* [2]*USAF 59th Medical Wing, San Antonio, TX, United States;* [3]*Brooke Army Medical Center, San Antonio, TX, United States*

(Original Research)

INTRODUCTION: The effects of hypobaria and hypoxia on the brain, as encountered in high-altitude flight, are not completely characterized. However, studies of chronic exposures, such as those in U-2 pilots, suggest deleterious effects on the structure and function of the brain. **METHODS:** Air Force pilot trainees were exposed to a single hypoxic hypobaric exposure as part of their training. Prior to, 1 day after, and 3 days after their exposure, participants underwent neuroimaging to measure cerebral perfusion via pseudo-continuous arterial spin labeling (pCASL). Data were processed using AFNI and FSL. 162 subjects contributed scans of sufficient quality for analysis. An additional cohort (n=41) participated in a similar experiment, with additional imaging on days 5 and 7, as well as blood samples on the day before, immediately before and after exposure, and 1, 3, 5, and 7 days after exposure. **RESULTS:** Cerebral perfusion increased on both the 1-day and 3-day imaging sessions. The smaller cohort showed increased perfusion in the same regions, on days 1, 3, 5 and 7 ($p<=0.02$). Changes in S100β from before to after exposure were correlated with cerebral perfusion at all time points ($p = 0.014$ to average). Other markers (NFL, UHL) demonstrated correlations with perfusion at both baseline to post-exposure timepoints, and thus are not clearly associated to hypobaric exposure. **CONCLUSIONS:** Our data suggest that a component of the brain's response to a hypobaric hypoxic exposure is to increase cerebral perfusion. This effect, even in response to a short exposure of a few minutes, was detectible even a week later. Further, increase in S100β, a marker of brain injury, was related to baseline perfusion, suggesting that there may be individualized resistance and vulnerability to hypoxic exposures of high-altitude flight. DISCLAIMERS: The views expressed are those of the authors and do not reflect the official views or policy of the Department of Defense or its Components. The voluntary, full informed consent of the subjects used in this research was obtained as required by 32 CFR 219 and DPDO 3216.06.

Learning Objectives

1. Describe changes in cerebral perfusion related to hypobaric hypoxic exposure.
2. Describe correlations of cerebral perfusion following hypobaric exposure to blood biomarkers associated with neural injury.

[240] AEROMEDICAL CONSIDERATIONS FOLLOWING DIVING-INDUCED OTIC VERTIGO

Gary Toups, Wiaam Elkhatib
Mayo Clinic Hospital, Rochester, MN, United States

(Education - Case Study)

INTRODUCTION: This case report describes a commercial airline pilot and scuba diver who experienced vertigo with nausea during a series of scuba dives. **BACKGROUND:** Scuba diving carries medical risks such as inner ear barotrauma and inner ear decompression sickness, both diving injuries with different manifestations. Resultant vertigo can cause disorientation and incapacitation for pilots. It is imperative to understand the association between diving, vestibular dysfunction, and aeromedical risk. **CASE PRESENTATION:** The subject was a 51-year-old commercial airline pilot and experienced PADI-certified recreational scuba diver. He had an acute episode of vertigo with nausea following a series of scuba dives over a one-week period. On day one, he dove twice to a maximum depth of 80 ft and total time of 40 minutes. On day two, his initial maximum depth was 112 ft, with another dive after a one-hour surface interval to a maximum depth of 100 ft, both with a 40-minute total dive time. All dives included safety stops and were spent mostly in shallow waters per a wrist-mounted dive computer while breathing air. A single right ear clearing issue was resolved via Valsalva. Given his symptoms and suspicion for decompression sickness, the pilot initially underwent recompression chamber therapy (U.S. Navy treatment table 6) without improvement. He subsequently was hospitalized for further workup. Otolaryngology consultants suspected diving-induced right inner ear barotrauma and provided three doses of IV dexamethasone. Symptoms improved. Brain MRI showed nominal internal auditory canals. Outpatient follow up one month later revealed 65% caloric weakness. Three months later, a 42% reduced right vestibular response, slight balance issues, plus mild high-frequency sensorineural hearing loss further suggested vestibular hypofunction following inner ear barotrauma. Comprehensive aeromedical evaluation was required before pursuing pilot medical recertification. **DISCUSSION:** This case highlights the differential diagnosis and aeromedical considerations for vestibular symptoms following scuba diving before resuming flight duties. Specifically, inner ear barotrauma versus inner ear decompression sickness must be distinguished given their vastly different implications towards prognosis and aeromedical recertification. This case highlights the relative dangers of these conditions and their application towards civilian operations.

Learning Objectives

1. Inner ear barotrauma versus inner ear decompression sickness can be distinguished based on clinical presentation and diagnostic evaluation.
2. Scuba diving can be associated with vertigo, a potentially dangerous aeromedical condition.

Wednesday, 06/04/2025 ***10:30 AM***
Regency V

[S-44] PANEL: ASSESSMENT OF PILOTS' SITUATION AWARENESS USING NON-OBTRUSIVE AND REAL-TIME MEASURES

Chair: Torin Clark
Co-Chair: Annemarie Landman

Panel Overview: *Situation awareness (SA) refers to the pilot's understanding of "what is going on", and depends on his or her ability to obtain and integrate relevant information. With the transition to a next-generation air force, SA gains interest, because modern weapon systems are being equipped with advanced sensor technologies and datalink capabilities that are meant to improve the pilots' SA. The assessment of pilot SA can be an important part of the evaluation of new flight deck equipment and procedures. If SA can be measured in real-time, this can even be used for automatic mitigation methods of poor SA. Recent advances in simulator technology offer novel ways of assessing pilots' SA non-obtrusively or in real-time. Using flight data, eye-tracking, and other physiological measures, in combination with known requirements within certain tasks, a pilot's SA can be measured without interrupting the task and without the requirement of secondary tasks or questionnaires. The current panel offers insights into the development of non-obtrusive SA measures, scenarios and tasks. The presenters will share their research protocols, results, considerations on the approach, and lessons learned. These insights will help the community in moving towards the development of validated and effective non-obtrusive and real-time measures of SA. These measures offer opportunities for evaluating SA accurately and in real-time.*

[241] ASSESSING SITUATIONAL AWARENESS IN FIGHTER PILOTS USING BEHAVIORAL MEASURES IN A SIMULATED INGRESS SCENARIO

Annemarie Landman, Lucia Hendrikse, Matthijs Koedijk, Eric Groen
TNO, Soesterberg, Netherlands

(Original Research)

INTRODUCTION: The assessment of pilots' situational awareness (SA) can be an important part of the evaluation of new flight deck equipment or procedures. With the transition to a next-generation air force, SA assessment gains interest, because modern sensor technology and interfaces are meant to improve the pilots' SA. This study was performed to obtain insight into the quantification of fighter pilots' SA using non-obtrusive behavioral measures and conditions that should induce higher and lower SA. **METHODS:** Fourteen F-16 pilots (all male) performed two ingress scenarios in a fixed-base F-16 simulator with a high-fidelity cockpit and visuals projected on a dome. In a "datalink condition" the Link 16 datalink was active, allowing pilots to detect information on air- and ground threats outside of their immediate vicinity. In a "no-datalink condition", the datalink was inactive, and coordinates of air threats were communicated over the radio. A list of events with according pilot responses reflecting adequate SA was developed with the help of two subject-matter experts (SMEs). One SME observed performance and interviewed pilots after each scenario to complete a checklist on pilot responses to each event. From this checklist, SA-detection and SA-comprehension/projection scores were obtained. Pilot responses were also measured using simulator logging and eye-tracking, and pilots judged their own SA using the MARS and SART questionnaires. **RESULTS:** Preliminary results revealed that the observed SA-comprehension/projection responses were significantly higher in the datalink condition, $p = 0.041$, but SA-detection responses were not, $p = 0.510$. Self-reported SA was also significantly higher in the datalink condition on the MARS, $p < 0.001$, but not on the SART, $p = 0.397$. Reliability checks confirmed that test-retest correlations were acceptable for both observed SA-detection, $r = 0.770$, $p = 0.001$ and SA-comprehension/projection, $r = 0.696$, $p = 0.006$. The observed pilot responses and interviews will be used to validate behavioral measures that are based on simulator logging and eye-tracking. **DISCUSSION:** Our datalink and no-datalink conditions appeared to be effective in inducing measurable high and low SA in the pilots, and this affected their comprehension/projection of events more than their detection. Our set of scenario events and observed responses appeared to be a promising basis for the development of automated digital measures that can be obtained through simulator logging and eye-tracking.

Learning Objectives

1. The participant learns about the impact of Link 16 or similar technology on pilot SA and mental workload.
2. The participant learns about validation methods with regards to behavioral measures of SA.
3. The participant learns about suitable tasks and sample groups for applying behavioral measures of SA.

[242] SITUATION AWARENESS AND WORKLOAD DISSOCIATION IN A SIMULATED SPACEFLIGHT SUPERVISORY CONTROL TASK

Jordan Dixon[1], Mica Endsley[2], Tristan Endsley[3], David Jamrog[3], Laura Smith-Velazquez[4], Avi Pfeffer[4]
[1]*The Charles Stark Draper Laboratory, Inc., Houston, TX, United States;* [2]*SA Technologies, Gold Canyon, AZ, United States;* [3]*The Charles Stark Draper Laboratory, Inc., Cambridge, MA, United States;* [4]*Charles River Analytics, Cambridge, MA, United States*

(Original Research)

INTRODUCTION: Situation awareness (SA) and workload have both received considerable attention over the past several decades. Little research has investigated the relationship between these two constructs however. The present study examines the relationship between workload and SA in a task involving operation of unmanned vehicles performing solar array inspection task on the International Space Station. **METHODS:** Ten participants were required to navigate between 2 and 6 unmanned vehicles to a series of waypoints, scanning ISS solar panels with two different sensors. They were also required to manually orient each vehicle so that it could collect data. Situation Awareness was measured via the Situation Awareness Global Assessment Technique (SAGAT) six times per scenario; 2 freezes during each 10-min block during which either 2, 4 or 6 vehicles were being controlled. Workload was measured using NASA Task Load Index (NASA-TLX) at the end of each SAGAT stop, and by time to respond to alarms. **DISCUSSION:** Considerable differences in the relationship between SA and workload across individuals were found, with 50% of participants showing an inverse correlation between SA and only one workload measure (subjective or secondary task) and 30% showing no correlation between SA and workload on either measure. Reasons for dissociation across different measures of workload and SA are discussed. The implication of these findings for the use of physiological measures of SA will be discussed, including challenges in determining whether common physiological measures, such as EEG, are assessing SA or workload.

Learning Objectives

1. Participants will learn about methodologies to assess situation awareness.
2. Participants will learn about relationships and dissociations between situation awareness and workload.

[243] BEHAVIORAL MEASURES OF SA AND APPLICATION OF AUTOMATIC MITIGATION OF LOSS OF SA IN A SIMULATED SPACEFLIGHT TASK

Torin Clark, Santiago Huertas, Nicole Rote, Erin Richardson, Jacob Kintz, Allison Hayman
University of Colorado-Boulder, Boulder, CO, United States

(Original Research)

INTRODUCTION: Situation awareness (SA) has traditionally been assessed with questionnaires or freeze probe assessments in laboratory environments. However, in some operational environments such as human spaceflight, it would be beneficial to have less disruptive measures of SA. "Embedded" measures derived from operator behaviors, such as actions, inactions, eye movements, or delays in decision making, may be an accurate way to infer SA. Further, if these measures could be used in real-time to continuously monitor operator SA, it may be possible to automatically trigger changes (such as an autonomous system changing its mode of operation) to mitigate the loss of SA. **METHODS:** Across related experiments, we collected written informed consent in a total of 34 subjects (12F/22M), aged 18-43 (mean: 24) under a protocol approved by the University of Colorado-Boulder IRB. Subjects performed a spaceflight-relevant task in which they monitored and maintained an environmental control and life support system, working with a simulated autonomous system. Intermittently, the simulation would "freeze" and subjects would complete the commonly used but disruptive SA Rating Technique (SART) questionnaire. We developed linear regression models to predict SART reports based upon recent operator behavior measures. **RESULTS:** Behavioral measures were able to predict SART reports (of unseen subjects in model building) accurately with mean absolute errors within about 6 points on the SART scale (~10% of the scale). We found model predictive accuracy was best without incorporating operator background information or eye tracking measures, suggesting these measures led to overfitting. Accuracy was similar whether the autonomous mode varied within trials, across trials or remained constant and across different feature-selection approaches used in model building. As a demonstration, we implemented and evaluated a system in which real-time predictions of SA triggered changes in autonomous modes aimed at mitigating losses in SA (while also maintaining ideal levels of other cognitive states, such as mental workload and trust in the autonomous system). **DISCUSSION:** These findings provide guidance to best practices for utilizing behavioral measures to estimate SA non-disruptively, continuously, and in real-time. Future work should aim to validate predictions against objective measures of SA, rather than subjective reports.

Learning Objectives

1. Participants will learn how behavioral measures may be used to estimate SA in non-disruptively.
2. Participants will learn about methodologies for validating predictions of SA against standard SA measurement approaches.

[244] APPLICATION AND VALIDATION OF PHYSIOLOGICAL MEASURES OF SITUATION AWARENESS IN A GENERALIZED PILOTING TASK

Kieran Smith[1], Jasper Shen[2], Tristan Endsley[3], Torin Clark[2]
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(Original Research)

INTRODUCTION: Situation awareness (SA) comprises a pilot's ability to 1) perceive, 2) comprehend, and 3) project into the future critical information in their environment. Questionnaire and freeze probe assessments of SA have informed advancements in display design and training protocol; however, these methods are difficult to implement in real tasks due to their disruptive nature. Advancements in sensors have enabled insights into a pilot's cognitive state without adding task load. As part of a broader panel on embedded measures of SA, this work evaluates how nondisruptive physiological and behavioral predictions can complement traditional SA assessments. **METHODS:** We collected written informed consent from 30 participants (16F/14M), aged 20-38 (mean: 25.67), recruited from flyers and emails under a protocol approved by the University of Colorado-Boulder IRB. Participants donned physiological sensors and completed a 24-minute simulation of the Multi-Attribute Task Battery II. The task was intermittently paused for twelve 18-question freeze-probe SA assessments, with six binary questions targeting each SA level (perception, comprehension, projection). SA scores (the sum of correct responses out of six) at each level were adjusted for query difficulty. Total scores were also computed. Physiological signals were synchronized, cleaned, and processed into literature- supported features. Relaxed LASSO regression models selected features and predicted SA scores for each level along a continuum. **RESULTS:** Results show mixed performance. Models predicting level 3 and total SA showed improved predictive accuracy (lower mean absolute errors or MAEs) over models trained with shuffled labels (MAEs of 0.81 and 0.87 compared to MAEs of 1.00 and 0.88 for level 3 and total SA, respectively). Models predicting levels 1 and 2 SA showed no such improvement. **DISCUSSION:** These findings underline the challenges of predicting complex cognitive states like SA from physiological and behavioral signals. Additional work may be needed for these signals to be useful in real-time SA evaluations. Future work will incorporate additional embedded measures and investigate non-linear models for predicting SA scores.

Learning Objectives
1. Participants will learn about challenges in the joint measurement of SA, physiological, and behavioral signals.
2. Participants will learn about successful and unsuccessful approaches in the predictive modeling of SA.

Wednesday, 06/04/2025 ***10:30 AM***
Regency VII

[S-45] SLIDE : MEASURING PHYSIOLOGICAL STRESS IN THE AVIATION ENVIRONMENT

Chair: Joanna Nelms
Co-Chair: Saha Devankush

[245] CARDIOVASCULAR EFFECTS OF HYPERCAPNIA DURING LOWER BODY NEGATIVE PRESSURE AND HEAD-UP TILT

Karolina Twardowska, Mara Bortnowschi, Rocco Skert, Yi-Hsin Lee, Gerrard Rafferty, Ross Pollock
King's College London, London, United Kingdom

(Original Research)

INTRODUCTION: Exposure to head-to-toe acceleration (Gz) may lead to G-induced loss of consciousness (G-LOC) due to reduced head-level blood pressure and flow. Despite various countermeasures, G-LOC remains a safety concern, causing accidents and fatalities. Inhalation of high concentrations of CO2 (5% and above) can improve G-tolerance but leads to breathlessness, headaches, lethargy, and confusion. This study explores the impact of lower concentrations of CO2 (5% and below) on the cardiovascular system and sex effects. **METHODS:** Twenty healthy volunteers (9 women and 11 men) participated in the study. Subjects were exposed to 2 mins of 80-degree head-up tilt and -60 mmHg of lower body negative pressure. This was repeated while breathing five gas mixtures: 0.04% CO2 (room air), 2%, 3%, 4% and 5% CO2 (each containing 21% O2 and balance nitrogen). Continuous recordings of heart rate and beat-to-beat blood pressure were made from which systolic (SBP), diastolic (DBP), and mean arterial blood pressure (MAP) were calculated, and estimates of cardiac output (CO) and stroke volume (SV) were made. After each session, subjects reported symptoms. **RESULTS:** SBP increased with 5% CO2 (+14.8 mmHg; $p<0.001$) compared to room air in all subjects. 4% CO2 increased SBP, but it was significant only in female participants (+11.8 mmHg; $p=0.043$). There was no effect of 2% and 3% CO2 on SBP. DBP and MAP increased with 5% CO2, while pulse pressure increased with both 4% and 5% CO2 with no significant sex differences. There was no CO2 effect on HR, CO or SV. The severity of breathlessness and difficulty breathing significantly increased while inhaling 5% CO2, while lower concentrations had no effect on symptoms. **DISCUSSION:** Inhalation of 5% CO2 significantly increased blood pressure during combined LBNP and head-up tilt, but the response was reduced with lower concentrations of CO2. The blood pressure response was different between female and male participants, suggesting that women may be more sensitive to CO2 or have a stronger cardiovascular response to hypercapnia. While symptom reporting improved with lower concentrations of CO2, the reduced cardiovascular response indicates they are less likely to improve G-tolerance.

Learning Objectives
1. The results suggest a greater impact of hypercapnia during lower body negative pressure and head-up tilt on women compared to men.
2. Inhalation of 4% carbon dioxide or lower results in minimal side effects, however, the cardiovascular response is also blunted.

[246] WITHDRAWN

[247] CHARACTERIZING THE RISK OF ORTHOSTATIC INTOLERANCE AND COUNTERMEASURE PRESCRIPTION FOR EXPLORATION MISSIONS

Jason Lytle[1], Stuart Lee[1], Annelise Miller[2], Stephanie Melvin[3], Sarah Pickering[2], Cambria O'Grady[2], Matthew Poczatek[3], Sondra Perez[1], Steven Laurie[1], Millennia Young[4], James Pattarini[4], Brandon Macias[4]
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(Original Research)

INTRODUCTION: Artemis astronauts returning to the Moon will experience head-to-foot (+Gz) accelerations during the descent to and ascent from the lunar surface. Weightlessness induced cardiovascular deconditioning increases the risk of orthostatic intolerance (OI) during +Gz exposures. Given that females are more susceptible to OI when re-exposed to 1-G, the effect of sex on OI and OI countermeasures (CM) must be considered for these missions. The goals of this study were to assess the effect of sex on OI and the efficacy of the Orion orthostatic intolerance garment (OIG) to protect against OI during exposure to +Gz forces anticipated during Artemis missions. **METHODS:** Thirty-seven healthy participants (19 females, 36.4±8.7 years, 172.8±10.8 cm, 72.7±13.4 kg) participated in this IRB-approved study. Hypovolemia induced with 20mg furosemide was used to simulate plasma volume loss typical of spaceflight. Participants were exposed to three 20-minute head-up tilt tests (HUTTs) simulating 0.50-, 0.75- and 1.00-Gz (randomized order), and on a separate day while wearing a custom-built OIG. Plasma volume, tilt tolerance time, blood pressure, and heart rate were measured throughout. **RESULTS:** Furosemide reduced plasma volume by 10.9 ± 3.5 and 11.4 ± 2.8 % in males and females, respectively. While hypovolemic without the OIG, five males and eleven females became presyncopal during 1.00-Gz HUTT, and three males and nine females became presyncopal during 0.75-Gz HUTT. One male and two females became presyncopal during 0.50-Gz HUTT. Females became presyncopal earlier than males during 0.5, 0.75 and 1-Gz tilts. While hypovolemic and wearing the OIG, all males completed all HUTTs without presyncope, while 2 females became presyncopal at 1.00-Gz, 1 female became presyncopal at 0.75-Gz, and all were able to complete the 0.50-Gz. **CONCLUSION:** Based on these data, some hypovolemic males and females exposed to 0.50-, 0.75- or 1.00-Gz during simulated lunar descent or ascent without the OIG can be expected to develop symptoms of presyncope, without activation of a standing and postural muscles during Artemis missions, with females appearing to be at greater risk. The OIG appears effective in mitigating OI across the range of G-levels expected during descent to and ascent from the lunar surface.

Learning Objectives
1. The audience will be able to describe the orthostatic intolerance risks associated with lunar ascent and descent.
2. The audience will be able to understand sex differences in orthostatic intolerance with and without countermeasures.

[248] ADAPTIVE AUTOMATION AND TASK DEMAND TRANSITIONS: ANALYZING THE IMPACT OF TRANSITION DIRECTION ON PHYSIOLOGICAL AND COGNITIVE WORKLOAD RECOVERY

Jonathan Vogl
U.S. Army Aeromedical Research Lab, Fort Novosel, AL, United States

(Original Research)

INTRODUCTION: Advancements in technology have changed the dynamic of work as it is performed in safety-critical tasks. Today, many systems offer operators the option to ease the burden of complex tasks by offloading subtasks to automation technology. The goal of adaptive automation is to eliminate the need for operators to engage/disengage automation, and instead have automated control of subtasks adapt to the

needs of the operator in real time. However, each change in automation also creates a task demand transition, which have been shown to elicit unexpected effects on cognitive workload metrics. **METHODS:** A subset of results from a larger study examining task demand transitions is examined to identify task demand change effects on continuous physiological data streams. This study aimed to simulate a task demand transition by means of an automated handoff of task controls, yielding a low-high-low task demand sequence using a single-dual-single task presentation method. This design yields two transition directions, i.e., transitioning from a low demand to high demand, or from a high demand to low demand. Two levels of the variable demand schedule were designed to mimic high and low levels of cognitive demand conditions. Cardiac activity (heart rate and heart rate variability metrics) and pupil diameter (left and right pupil) recovery times (i.e., return to baseline after a transition event) were recorded across these dynamic transitions. **RESULTS:** Results indicate a significant transition direction effect within the physiological data ($p = 0.008$), while overall task demand level did not yield significant differences ($p = 0.583$). Thus, the direction which the demand was being driven was more relevant to the recovery time in the physiological metrics relative to the general cognitive workload level itself. **DISCUSSION:** These results may inform future adaptive automation systems to consider the direction of task demand changes to account for influences in physiological data that may occur as a function of cognitive workload history.

Learning Objectives

1. Dynamic task demand transitions are representative of real-world scenarios and should be tested in laboratory settings as unexpected changes may occur as a function of the direction demand is being driven.
2. Physiological metrics may show unexpected changes during task demand transitions that recover to expected levels over time.

[249] WITHDRAWN

[250] COMPARISON OF OPERATIONAL JET FUEL AND NOISE EXPOSURES: AUDIOLOGICAL TEST RESULTS

David Mattie, Tom Jaworek
U.S. Air Force Aeromedical Research Lab, 711th Human Performance Wing, Kettering, OH, United States

(Original Research)

INTRODUCTION: Flight line personnel are constantly exposed to noise and jet fuel while working on flight lines. Studies suggest jet fuel in combination with noise are more associated with hearing loss than with noise exposure alone. However, no previous research used this study design to examine the combined effects of jet fuel and noise exposures on the hearing of flight line personnel. **METHODS:** Samples were collected from 97 flightline exposed and 71 control volunteers stationed at Japan Air Self-Defense Force Air Bases (Hamamatsu, Matsushima, Hyakuri, Yokota and Iruma) and US Air Force Air Bases (Kadena and Misawa) in Japan. Individual noise levels were measured by wearing a personal sound level monitor and volatile organic chemicals (VOCs) by also wearing a chemical sampling pump during a single shift. Blood samples were collected post shift. Urine samples (entire void) were collected prior to shift (morning first void) and post shift. VOCs were measured in air, blood, and urine. An audiologic test battery, consisting of immittance measurements, audiograms, distortion product otoacoustic emissions (DPOAE) and auditory brain response (ABR) was conducted after shift. **RESULTS:** Total VOCs in personal air samples were in the ppb range for each group compared to permissible limits. Tinnitus and temporary hearing loss were reported in audiological histories but were also present in some controls. Average noise levels on the flight line ranged from 90 to 103 dB which exceeded the 85 dB action level for requiring hearing protection and the 90 dB exposure limit, but all exposed subjects reported wearing hearing protection. Although immittance, DPOAE and ABR tests identified 56 out of 336 significant differences at $p<0.05$ between flight line personnel and control subjects, the results were not consistent across tests and aircraft type. **DISCUSSION:** The limited significant results for the battery of hearing tests still indicated the potential for hearing loss and the continued need for hearing protection. (Disclaimer: No DoD endorsement implied.)

Learning Objectives

1. Participants will learn about exposure levels of noise on the flight line.
2. Participants will learn about an audiological test battery for flight line personnel.
3. Participants will learn about the potential for hearing loss from combined exposure to jet fuel and noise.

Wednesday, 06/04/2025 ***10:30 AM***
Hanover F/G

[S-46] PANEL: RAM GRAND ROUNDS - PANEL II

Chair: Serena Auñón-Chancellor
Co-Chairs: Caleb James, Michael Harrison

Panel Overview: *Residency in Aerospace Medicine - Grand Rounds Panel II*

[251] A CASE OF ASTRONAUT RETURN TO DUTY FOLLOWING EMBOLIC CEREBROVASCULAR ACCIDENT MANAGED WITH PATENT FORAMEN OVALE CLOSURE

Matthew Makowski, Vasilis Mavratsas
UTMB, Galveston, TX, United States

(Education - Case Study)

INTRODUCTION: Presented here is a case of an embolic cerebrovascular accident (CVA) in an astronaut and the subsequent management with patent foramen ovale (PFO) closure prior to aeromedical clearance for spaceflight. **BACKGROUND:** Crewmembers with a history of CVA pose a risk to aircraft and spacecraft operations due to the impacts caused by lingering disability, medication side effects, threat of recurrence, and secondary seizures. Treatable etiologies, such as a PFO amenable to closure, create the possibility for waiver and return to flight duties. **CASE PRESENTATION:** A crewmember with prior spaceflight experience and no pertinent past medical history developed a sudden onset peripheral visual field deficit shortly after returning from a high-elevation terrestrial spaceflight analog experience followed by extensive international air travel. Workup was significant for an occipital thrombotic CVA, seen on magnetic resonance imagining, and an echocardiogram revealing a PFO. The crewmember was initially managed with antiplatelet and anticoagulation therapy and subsequently treated with percutaneous PFO closure. The visual field deficit reached near complete resolution. The crewmember subsequently achieved medical clearance for full terrestrial and spaceflight duties. **DISCUSSION:** Civilian and military regulations outline the steps for aeromedical disposition of crewmembers who have suffered a CVA. This case discussion will review CVA waiver requirements from NASA, FAA, and the United States armed services with an emphasis on PFO closure. Learning Objective #1: The audience will learn the aeromedical risks of embolic cerebrovascular accident.

Learning Objectives

1. The audience will learn the aeromedical risks of embolic cerebrovascular accident.
2. The audience will learn the association between high altitude exposure and the development of venous thromboembolism.
3. The audience will learn the association between high altitude exposure and the development of venous thromboembolism.

[252] ACUTE URINARY RETENTION IN AN ASTRONAUT, ITS TREATMENT AND AEROMEDICAL DISPOSITION - A HYPOTHETICAL CASE

Andrew Lam[1], Michael Stephens[2], Jeffrey Jones[3]
[1]*UTMB, Galveston, TX, United States;* [2]*Mayo Clinic, Rochester, MN, United States;* [3]*Baylor, Houston, TX, United States*

(Education - Case Study)

INTRODUCTION: This case report describes a hypothetical occurrence of acute urinary retention in spaceflight with consideration of treatment, disposition, and prevention. **BACKGROUND:** Acute urinary retention is an operationally relevant condition documented in-flight in astronauts. Micturition may be impaired by biomechanical, pharmacologic, obstructive, psychosocial, and neurogenic factors, many of which are uniquely affected in spaceflight environments. While onset is most common early in a mission, symptoms can recur throughout flight and even upon return to Earth. Besides physical discomfort and pain, acute urinary retention may cause life- and mission-threatening complications such as urinary tract infection, acute kidney injury, and persistent voiding difficulty from damage to the detrusor muscle (i.e., myogenic bladder). **CASE PRESENTATION:** A 55-year-old male astronaut on his second flight to the International Space Station developed suprapubic pressure. During a private medical conference, he shared that he had not voided since orbital insertion. He denied flank pain and fevers. He had no known history of benign prostatic hyperplasia or urinary obstruction. While on station, he had been given an antiemetic to treat space motion sickness symptoms. The flight surgeon advised intermittent self-catheterization and initiated tamsulosin. A first attempt at catheterization failed due to urethral resistance. A second attempt successfully evacuated the bladder. Prophylactic antibiotics were deferred. Tamsulosin was discontinued 14 days later without further issue. **DISCUSSION:** Management of acute urinary retention in spaceflight entails intermittent or indwelling bladder catheterization, with possible concomitant administration of α-adrenergic antagonists and prophylactic antibiotics. Within the Department of Defense (DoD) and NASA, medical standards for urinary retention dictate that crewmembers with pertinent histories or risk factors must undergo evaluation and applicable intervention for a safe return to flight. Measures such as prophylactic medication or surgery, behavior modification, or preemptive catheter placement may prevent urinary retention or reduce its operational impact. Future research may help quantify risks, clarify pathophysiologic mechanisms, and enhance insight into mitigation strategies for acute urinary retention in space.

Learning Objectives

1. List at least 3 risk factors for urinary retention in spaceflight.
2. List 3 potential treatments for urinary retention in spacefarers.
3. Discuss how acute urinary retention may impact operations in human spaceflight.

[253] SPONTANEOUS PNEUMOTHORAX IN A NAVAL AVIATOR: FAILURE TO DISCLOSE SYMPTOMS

William Roy, Caroline McDowell
U.S. Navy NMOTC Naval Aerospace Medical Institute, Pensacola, FL, United States

(Education - Case Study)

INTRODUCTION: This case report describes a Naval Aviator who failed to report acute onset of right chest pain two days prior to flying a training mission at high altitude that resulted in a near total collapse of the right lung. **BACKGROUND:** A safety of flight issue can rapidly develop while operating a naval strike fighter at high altitudes if the low ambient pressure precipitates an acute exacerbation of a pre-existing medical condition, especially one involving the lung where sudden incapacitation of an aviator in control of an aircraft could result. This case report discusses the aeromedical implications associated with spontaneous pneumothorax and further emphasizes the necessity for all aviators and aircrews to disclose symptoms early and seek evaluation from a flight surgeon prior to flying. **CASE PRESENTATION:** A previously healthy, 33-year-old non-smoker U.S. Naval Aviator presented to the medical department complaining of a two-day history of right chest pain that acutely worsened while operating an F/A-18 Hornet at altitudes above 20,000 ft on a training sortie. The aviator dismissed the pain as musculoskeletal in nature, which he first noticed during heavy weight lifting exercise two days earlier. He did not report the chest pain to a flight surgeon and elected to make his assigned flight. The examination was pertinent for absent breath sounds over the right lung and a CXR confirmed near total collapse of the right lung, consistent with a spontaneous pneumothorax. He was admitted to a local hospital, a right thoracostomy tube was placed, and a wedge resection of the apical segment of his right upper lobe and pleurodesis was performed due to recurrence of the pneumothorax. The patient remained stable and was soon discharged. **DISCUSSION:** This case emphasizes the importance of early reporting of new or worsening symptoms by aviators and aircrews to a flight surgeon prior to flying, as safety of flight should be the first, last, and only concern, ensuring not only their health and safety, but also mission completion. Although pneumothorax is a disqualifying condition a waiver may be obtained if conditions are satisfied.

Learning Objectives

1. The audience will be able to discuss the signs and symptoms of pneumothorax.
2. The audience will be able to discuss pre-existing conditions that increase the risk of developing a spontaneous pneumothorax.
3. The audience will gain a better understanding for the importance of aviators and aircrews disclosing medical issues to a flight surgeon prior to flight and the conditions required for waiver approval for pneumothorax.

[254] PITUITARY APOPLEXY: A RARE COMPLICATION

Brian Jimenez Alicea, Erica Murray
U.S. Army, Fort Novosel, AL, United States

(Education - Case Study)

INTRODUCTION: This case report describes an Active-Duty female flight crew member presenting to the emergency room with worsening headache, ophthalmoplegia, and visual disturbances and found to have pituitary apoplexy. **BACKGROUND:** Pituitary apoplexy (PA) is caused by a sudden hemorrhage or infarction of the pituitary gland and is considered a medical emergency. PA is a rare disease with an incidence and prevalence are 0.17 episodes per 100,000 and 6.2 cases per 100,000 respectively. It is generally associated with non-functioning pituitary neuroendocrine tumors. Though PA can present in several ways, the most alarming is sudden onset of debilitating headache, diplopia, and hypopituitarism involving the hypothalamic axis leading to life-threatening hypotension, coma, and death. Diagnosis is confirmed via imaging study, and surgical decompression is preferred in the setting of severe or progressive impairment of vision and neurologic symptoms and clinical deterioration. **CASE PRESENTATION:** A 49-year-old AD female presented to the emergency room with acute onset of worsening right frontal headache, ophthalmoplegia and photophobia. The patient was previously diagnosed with a pituitary macroadenoma and current on her flight physical with an approved waiver. Neurologic examination revealed diplopia with right orbital superolateral deviation and bitemporal hemianopsia. MRI demonstrated expansion of the tumor, and the patient underwent transsphenoidal resection. Postoperatively her neurologic symptoms improved and on discharge resolved with patient eventually achieving full visual recovery. **DISCUSSION:** Pituitary tumors are waiverable and require routine monitoring and subspecialty consult. Although the risk of pituitary apoplexy in macroadenomas is rare, it is a complication that should remain high on the differential.

Learning Objectives

1. The audience will learn to identify the symptoms, signs, and exam findings of pituitary apoplexy.
2. The audience will review the aeromedical implications of pituitary tumors
3. The audience will understand the pathophysiology of pituitary apoplexy.

[255] NEUROLOGICAL DECOMPRESSION SICKNESS IN A MILITARY DIVER: A CASE REPORT

Coty Winn, Justin Noble
USAFSAM, Wright-Patterson AFB, OH, United States

(Education - Case Study)

INTRODUCTION: This case report describes an unprovoked episode of severe neurological decompression sickness (DCS) in a military diver. **BACKGROUND:** Neurological DCS is believed to result from the formation of nitrogen bubbles within cerebral arteries, causing a temporary space-occupying lesion, which blocks blood flow within the brain and may result in stroke-like effects or seizures. **CASE PRESENTATION:** This patient was a healthy special warfare airman in his mid-20s who presented after an episode of severe neurologic compromise, which occurred on ascent during a routine training dive. His symptoms fully resolved after dive chamber treatment with a standard United States Navy Treatment Table Six. He had no prior history of predisposing conditions. No new conditions were identified during an extensive multi-system evaluation. **DISCUSSION:** Neurological DCS is a potentially fatal condition and carries a risk of permanent sequalae. It may occur with significant decrease in atmospheric pressure, whether underwater or at altitude. Affected patients may have predisposing medical or physical conditions, but DCS may still occur in previously healthy individuals. The mainstay of treatment is decompression in a chamber as soon as possible to reduce the mass effect and subsequent ischemia related to bubble formation. Risk of recurrence is difficult to stratify.

Learning Objectives

1. Increase awareness of neurologic DCS in aeromedical and operational providers.
2. Discuss possible contributing factors to DCS.
3. Foster discussion of DCS and return to flight or special statuses.

[256] TYPE 2 DIABETES, ANXIETY, AND METASTATIC PROSTATE CANCER IN AN AIRMAN WITH A CLASS III MEDICAL CERTIFICATE

Michael Stephens, Clayton Cowl
Mayo Clinic, Rochester, MN, United States

(Education - Case Study)

INTRODUCTION: This report outlines a case of an airman with metastatic prostate cancer, type 2 diabetes mellitus, and a history of anxiety requiring the use of pharmacologic treatment who was granted a Special Issuance Authorization with FAA Class III medical certification. **BACKGROUND:** Managing multiple medical conditions poses unique aeromedical challenges for aviation medical examiners. Each condition may impact physical and cognitive function critical to aviation safety. Hypoglycemia risks, medication side effects and cancer-related fatigue or cognitive impairment may compromise in-flight performance. This case underscores the need for tailored assessment in the certification of pilots with complex medical conditions. **CASE PRESENTATION:** A 70-year-old male requested a Class III medical certificate with a history of anxiety disorder treated with pharmacologic therapy, diabetes requiring hypoglycemic medication, and metastatic, biopsy-proven adenocarcinoma of the prostate (Gleason 4 + 4). MRI and PET/CT imaging demonstrated metastases to the liver, rib, regional lymph nodes and right inferior pubic ramus. Radiation therapy and chemotherapy with docetaxil were initiated while luprolide injections, daily abireterone and prednisone were prescribed for maintenance therapy. Although denied a medical twice previously, his clinical status stabilized. PET/CT imaging and labs demonstrated no evidence of tumor recurrence or additional metastatic spread, there was decreased uptake in prior metastatic sites, and his PSA became undetectable. His diabetes was well-controlled utilizing only metformin (hemoglobin A1c 5.9%). A HIMS psychiatrist determined his past anxiety was likely situational and in remission or due to an adjustment disorder following the death of his daughter. He had not required medication for more than 9 years and demonstrated clinical stability. Incidentally, he was found to have a left-eye cataract that did not affect his tested visual acuity. Ultimately, a Special Issuance was granted by the agency. **DISCUSSION:** This case illustrates the challenging certification process for pilots with multiple medical comorbidities. Despite his medical history, aeromedical certification was ultimately successful due to detailed workup, clinical documentation and communication from the AME to the FAA reviewer. This case provides insight into the complexities of managing chronic illness within aviation safety standards emphasizing individual risk assessment.

Learning Objectives

1. Understand aeromedical certification requirements and evaluation process for airmen with complex medical conditions, including metastatic cancer and diabetes requiring hypoglycemic medications and mental health-related issues.
2. Examine the physiological and cognitive impacts of chronic illnesses and their treatments on flight performance, focusing on the risks of hypoglycemia and cancer-related fatigue in aviation safety and its interaction with mental health conditions.
3. Discuss the ethical and regulatory considerations involved in potentially transitioning from FAA Class III Special Issuance to BasicMed for airmen with progressive health conditions, balancing pilot autonomy with aviation safety standards.

Wednesday, 06/04/2025 ***2:00 PM***
Centennial Ballroom III

[S-47] SLIDE : ABOVE THE NECK

Chair: Tyson Brunstetter
Co-Chair: Karina Marshall-Goebel

[257] REVEALING SANS MECHANISMS: NOVEL MRI TECHNIQUES AND THE GLYHPATIC SYSTEM

Luisa Fernanda Jaimes[1], Adriana Zuluaga[2], Diego M Garcia[3]
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(Education - Program / Process Review)

BACKGROUND: Most spaceflight participants experience Spaceflight-Associated Neuro-ocular Syndrome (SANS) to varying extents. SANS, a priority for NASA's human research roadmap, lacks a terrestrial equivalent, complicating long-duration space mission planning. Suspected SANS mechanisms include cephalad fluid shifts, elevated intracranial pressure, and reduced cerebrospinal fluid (CSF) dynamics, exacerbated by factors like CO_2 levels and sleep disruption. Various neuroimaging techniques have attempted to capture SANS-related changes, yet limitations persist in resolving its underlying mechanisms. We propose novel Magnetic Resonance Imaging (MRI) techniques to advance the understanding and assessment of SANS pathophysiology. **OVERVIEW:** Previous efforts proposed mechanical pressure, edema, metabolic and venous stasis as causal factors for SANS. Emerging theories suggest additional roles for cerebral blood volume pulsatility, vascular remodeling, and glymphatic-lymphatic imbalances. Advanced MRI techniques can target these by visualizing changes in the CSF and perivascular space (PVS). Recent studies highlight PVS enlargement in astronauts, likely linked to fluid shifts and CSF flow alterations. MRI could therefore elucidate SANS-related cerebral and ocular changes during prolonged spaceflight in an non-invasive fashion.Innovative MRI approaches, including phase-contrast MR imaging, allow quantification of CSF flow dynamics, and cine sequencing enables real-time visualization of ventricular flow related to cardiac cycles. Structural sequences like T1-weighted and T2-weighted turbo spin-echo imaging can indirectly indicate CSF pressure fluctuations (e.g., via the Evans Index), while pontomesencephalic and callosal angles offer insight into pressure-induced changes. Furthermore, 3D segmentation enables precise volumetric analysis to track PVS dilation over time.

DISCUSSION: This approach holds significant clinical and operational promise by enhancing knowledge on diagnostics, risk factors and informing countermeasures to mitigate SANS risks. Advanced imaging supports cross-service collaboration, aligning space agencies in bolstering astronaut health for deep-space missions and advancing our understanding of human physiology in extreme environments.

Learning Objectives

1. Understand the proposed pathophysiological mechanisms of Spaceflight-Associated Neuro-ocular Syndrome (SANS), including fluid shifts, intracranial pressure variations, and CSF flow dynamics.
2. Identify advanced MRI techniques applicable for assessing changes in the cerebrospinal fluid (CSF) and perivascular space (PVS) as they relate to SANS.
3. Recognize the potential clinical and operational implications of advanced imaging techniques for diagnosing and mitigating SANS in long-duration space missions.

[258] SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME (SANS): 2025 CLINICAL OVERVIEW – EYES & VISION

Tyson Brunstetter[1], Sara Mason[2], Suzi Osborne[3], Millennia Young[1], C. Robert Gibson[3], Mary Van Baalen[1], Ann Tsung[3], William Tarver[1]
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(Original Research)

INTRODUCTION: Spaceflight Associated Neuro-ocular Syndrome (SANS) is unique to long duration spaceflight (LDSF), with unclear pathophysiology. Primary signs include optic disc edema (ODE), chorioretinal folds, globe flattening, and hyperopic refractive shifts. It is not yet known what severity and/or duration might lead to acute or permanent impacts to visual performance. This brief provides the latest SANS clinical analyses from an ocular/visual perspective. **METHODS:** Data were obtained from clinical records to compile a SANS clinical update. Areas of interest include: (1) SANS prevalence, (2) SANS across repeat LDSF missions, and (3) surveillance of retinal nerve fiber (RNFL) thickness. **RESULTS:** (1) SANS prevalence during LDSF: Earliest Indication: 71%; Clinically Concerning: 16%; Pathological with Acute Functional Impact: 5%; and Pathological affecting Long-Term Health: 0%. (2) 16 "Repeat Flyers" have flown LDSF followed by a subsequent long/extended-duration spaceflight (LD/EDSF). Of these, 6 were diagnosed with SANS in their first LDSF, while 10 were not diagnosed with SANS. In subsequent LD/EDSF, all 6 previous SANS cases (100%) were diagnosed with SANS, while 9-of-10 previous non-SANS cases (90%) were not diagnosed with SANS. A SANS/non-SANS diagnosis from prior LDSF was highly predictive of diagnosis in subsequent missions (Fischer's exact test, $p = 0.0009$), with 100% sensitivity, 85.7% specificity. SANS ODE metrics were similar across missions for individuals ($n = 5$; $r = 0.94$, $p = 0.0002$), regardless of SANS status. (3) A small group of SANS cases ($n = 6$) having >7 years of post-flight RNFL data revealed no clinically concerning decreases in RNFL thickness. **DISCUSSION:** (1) Overall SANS prevalence remains stable (~70%), with a subset (<20%) being diagnosed with clinically significant SANS. (2) Previous LDSF SANS cases are highly likely to be diagnosed with SANS in future LDSF at a similar ODE severity. Crewmembers not diagnosed with SANS during a previous LDSF are substantially less likely to be diagnosed with SANS in future LDSF missions. (3) A risk of SANS ODE is permanent loss of RNFL thickness (vs. pre-flight), leading to permanent visual defects. Preliminary results suggest no clinically concerning loss of RNFL tissue over time in a small population of early SANS cases.

Learning Objectives

1. Understand the pattern of Spaceflight Associated Neuro-ocular Syndrome (SANS) across subsequent long-duration spaceflight, in both SANS cases and non-SANS cases.
2. Understand the potential risk of SANS optic disc edema on the retinal nerve fiber layer and an astronaut's visual performance.

[259] CARDIOVASCULAR AND OCULAR GRAVITATIONAL DOSE-RESPONSES DURING GRADED TILT AFTER HYPOVOLEMIA: PRELIMINARY RESULTS

Adrien Robin[1], Syeda Yasmin Zaman[1], Cort Reinarz[1], Kami Lawson[1], Jason McKnight[1], Nastassia Navasiolava[2], Marc-Antoine Custaud[2], Lisa Haddad[1], David Zawieja[1], Ana Diaz-Artiles[1]
[1]*Texas A&M University, College Station, TX, United States;* [2]*University of Angers, MITOVASC, Angers, France*

(Original Research)

INTRODUCTION: Microgravity exposure leads to a chronic upward fluid shift and induces a state of relative hypovolemia. It is suggested that the factors that redistribute fluid play roles in the pathogenesis of spaceflight-associated neuro-ocular syndrome (SANS), stagnant or retrograde blood flow in the internal jugular vein (IJV), and increased risk of venous thrombosis. This research effort proposes to characterize cardiovascular and ocular responses to varying tilt angles in deconditioned participants (16M/16F), either by drug-induced acute hypovolemia or by 48h 6° head-down bed rest in a cross-over design. **METHODS:** In the present work, we discuss the results from 6 participants (5M/1F) from the drug-induced hypovolemia arm of the study (40mg oral furosemide diuretic to induce hypovolemia). Before and 3 hours after ingestion of furosemide, subjects are exposed to a graded tilt protocol (from 45° head-down tilt to 45° head-up tilt, in 15° increments) to generate gravitational dose-response curves. Measurements at each tilt angle include segmental bioimpedance, central hemodynamics, NIRS calf and regional cerebral blood flow, IJV cross-sectional area and pressure, and intraocular pressure (IOP). **RESULTS:** The diuretic protocol led to an acute hypovolemia 3h post treatment (–16±3% in plasma volume, $n=6$, $p = 0.001$). This induced decreases in stroke volume and cardiac output (both $p < 0.001$) and an increase in heart rate ($p < 0.001$). We also observed a non-linear gravitational dependence of the total blood flow in the forehead, IOP, and IJV cross-sectional area, with a global decrease in IOP during hypovolemia ($p = 0.003$). **DISCUSSION:** After 3h post diuretic ingestion, we observe a hypovolemia state, representing spaceflight conditions. Hypovolemia is considered one of the main factors contributing to cardiovascular deconditioning when returning to an Earth-like gravity. At the end of the study, we aim to provide an integrative framework for cardiovascular and ocular responses to acute fluid shift before and after deconditioning, constituting a ground model representing spaceflight induced changes. ACKNOWLEDGEMENTS: This work is supported by the Translational Research Institute for Space Health through Cooperative Agreement NNX16AO69A. This work is also partially supported by the NASA Human Research Program (Grant number 80NSSC20K1521), the College of Medicine at TX A&M University, and the College of Nursing at TX A&M University.

Learning Objectives

1. The audience will learn about the gravitational dose responses curves of cardiovascular and ocular variables related to gravity level.
2. Dehydration causes increases in heart rate, and decreases in stroke volume, cardiac output, and intraocular pressure.

[260] FROM SPACE TO EARTH HEAD-UP TILT SLEEPING LOWERS INTRAOCULAR PRESSURE IN PATIENTS WITH GLAUCOMA

Claudia Stern[1], Alexander Haendel[2], Doris Mittelstaedt[3], Steffen Stupp[3], Alexandra Noppe[3], Freia Paulke[3], Marie-Therese Scmitz[4], Scott Ritter[3], Claus Cursiefen[2], Jens Jordan[3], Philpp Enders[2]
[1]*German Aerospace Center DLR, Cologne, Germany;* [2]*Medical Faculty and University Hospital of Cologne, Cologne, Germany;* [3]*German Aerospace Center, Cologne, Germany;* [4]*Institute of Medical Biometry, Informatics and Epidemiology, University Hospital Bonn, Bonn, Germany*

(Original Research)

INTRODUCTION: Elevated intraocular pressure (IOP) is crucial for the pathogenesis of glaucoma, a leading cause of blindness worldwide.

IOP responds to gravity, and astronauts often experience an IOP increase during the initial phase of space missions. The microgravity analogue head-down tilt bedrest also increases IOP, particularly in the first days. We tested the hypothesis that head-up tilting of the whole bed by 10° during the night could reduce intraocular pressure in patients with glaucoma. **METHOD:** In a controlled, prospective study, we recruited 16 patients with difficult to control glaucoma from the patient pool at the Department of Ophthalmology of the University Hospital Cologne. Patients were selected based on their confirmed nocturnal IOP peaks while lying down compared to daytime values (an average increase of >5 mmHg in at least one eye). After obtaining informed consent, the study participants were hospitalized for three days and two nights at the DLR :envihab facility. In a "cross-over" fashion, we assigned patients to two groups: Group A remained in a flat, horizontal position throughout the first night, followed by 10° head-up tilt of the whole body throughout the second night; In group B, nocturnal positions were reversed. We measured IOP, the primary endpoint, at midnight, 3:00 a.m., and 6:00 a.m. using rebound tonometry (ICARE pro). **RESULTS:** The patients, aged between 39 to 77 years with an average of 57.7 years had an equal distribution of sexes. The effect of 10° head-up-tilt position on IOP at 6:00 a.m. was statistically significant and estimated as -0.91 mm Hg (95% confidence interval (CI) [-1.39; -0.42]) compared to the flat position. The between patient variation was 3.91 (95% CI [2.64;-5.79]), the between eye variation was 1.55 (95% CI [1.02; 2.35]) and the residual variation was 1.71 (95% CI [1.54; 1.91]). **CONCLUSION:** Our study demonstrates that sleeping in a 10° head-up tilt position attenuates nocturnal IOP in patients with glaucoma and nocturnal IOP peaks. The finding highlights the importance of gravity in IOP regulation and may have practical applications for ocular health maintenance in astronauts and in patients on Earth.

Learning Objectives

1. The audience will learn about the influcence of differen body positions on intraocular pressure.
2. The audience will learn that head-up tilt can reduce intraocular pressure.

[261] SONO-GRAVITY: SONOGRAPHIC NEEDLE GUIDANCE FOR INTRACRANIAL PRESSURE EVALUATION IN MICROGRAVITY

Francisco Santos, Edson Oliveira
Lisbon School of Medicine - University of Lisbon, Lisbon, Portugal

(Original Research)

INTRODUCTION: Spaceflight-Associated Neuro-Ocular Syndrome (SANS) is a significant health risk for astronauts on long-duration spaceflights, potentially caused by elevated intracranial pressure (ICP). Current invasive ICP measurement methods are impractical in space, where safety and ease of performance are paramount, while non-invasive methods still need to be validated and offer less reliability. **METHODS:** We developed and tested a novel invasive lumbar puncture (LP) technique using a Needle Guidance System (NGS) paired with ultrasound and a digital pressure transducer, which is gravity-independent. This study demonstrates that this NGS technique is feasible and easy to perform, even for someone with less medical experience, offering high accuracy rates, and making it a potentially viable method for assessing ICP in microgravity environments. METHODS: Thirty participants (15 males and 15 females), including medical doctors, medical students, and engineering students, were divided into three groups. Participants received minimal training (12 minutes) on both the NGS-assisted and standard LP techniques. Each participant performed five attempts with each technique in a dummy. Metrics such as success rate (successful CSF egress), time to puncture, and subjective evaluations of difficulty and confidence (using the NASA Task Load Index) were recorded. Statistical analysis was conducted using Wilcoxon signed-rank and Mann-Whitney U tests. **RESULTS:** The NGS-assisted technique resulted in significantly higher success rates (80%) compared to the standard LP technique (50%) across all groups ($P < 0.05$). Non-medical participants, including engineering students, performed similarly to medical professionals using the NGS technique (78% vs. 84%, $P = 0.63$), while the standard technique success rate showed a significant difference (28% for engineers vs. 78% for doctors, $P < 0.001$). **DISCUSSION:** The study demonstrates that the NGS technique enhances accuracy and success rates, especially for individuals with no previous LP experience. This suggests the potential for the NGS technique as an ICP measurement method in space environments if we consider that with more training the error rate will certainly decline. Further research is being conducted, applying AI with deep learning algorithms to the technique, and confirming these findings in human subjects and in microgravity conditions.

Learning Objectives

1. Understand how a Needle Guidance System improves the safety and success rate of a lumbar puncture, especially when performed by non-medical personnel.
2. Evaluate the feasibility of invasive intracranial pressure monitoring in space environments using novel medical technologies.
3. Understand the importance of invasive intracranial pressure determination in long-duration spaceflights to the better comprehension of the pathophysiology of Spaceflight-Associated Neuro-Ocular Syndrome.

[262] ASSESSING THE RELATIONSHIP BETWEEN CO2 CONCENTRATIONS AND CONGESTION SYMPTOMS IN MICROGRAVITY

Lorna A. Evans[1], Matthew Makowski[2], Suzi C. Osborne[3], David Alexander[3]
[1]*Mayo Clinic, Jacksonville, FL, United States;* [2]*UTMB, Galveston, TX, United States;* [3]*NASA, Houston, TX, United States*

(Original Research)

INTRODUCTION: The International Space Station (ISS) provides a vital setting for studying the impact of elevated CO2 levels on human health in microgravity. While space adaptation is commonly associated with congestion symptoms, these symptoms can persist in astronauts during long-duration missions, even after the initial redistribution of fluids. Therefore, we aim to investigate the specific relationship between CO2 levels and congestion symptoms. This study seeks to establish that increased CO2 levels aboard the ISS are significantly correlated with the frequency of congestion symptoms experienced by astronauts. **METHODS:** This retrospective analysis included data from various ISS expeditions between 2014 and 2024, involving both male and female crew members. Congestion symptoms and CO2 levels were recorded. CO2 levels from onboard sensors were analyzed as hourly averages and reported as means (SD) for maximum CO2 levels over 7-day periods. A Student's T-test was used to assess CO2 levels between weeks with and without symptoms. The first seven days of spaceflight were excluded to account for space adaptation. **RESULTS:** The analysis of maximum CO2 levels recorded weekly revealed varying effects on congestion symptoms among crew members. In Node 3, with 459 observations, CO2 partial pressure ranged from 1.020 to 5.628 mmHg with a mean of 2.953 mmHg (SD = 0.785). The Lab sensor, which included 349 observations, ranged from 1.196 to 7.174 mmHg with a mean of 2.672 mmHg (SD = 0.784). During weeks in which crew members were symptomatic, the average CO2 level was 2.841 mmHg (SD = 0.639), compared to 2.574 mmHg (SD = 0.842) in asymptomatic members, yielding a significant difference ($p = 0.002$). Columbus 12 showed a highly significant correlation between CO2 levels and congestion symptoms ($p < 0.001$). **DISCUSSION:** This study provides evidence of the relationship between elevated CO2 levels and congestion symptoms in microgravity. Notable variations in the Lab sensor and Columbus 12 data indicate that higher CO2 concentrations may exacerbate these symptoms among astronauts. The consistent findings from these sensors highlight the need for ongoing monitoring

and management of CO2 levels aboard the ISS. These results are vital for long-duration missions, as CO2 accumulation can cause physiological stress and impair performance. Addressing CO2 management is critical for ensuring astronaut health and mission success.

Learning Objectives

1. Understand the relationship between elevated CO2 levels and congestion symptoms experienced by astronauts in microgravity.
2. Recognize the importance of monitoring CO2 concentrations to improve health management strategies during long-duration space missions.

Wednesday, 06/04/2025 ***2:00 PM***
Centennial Ballroom IV

[S-48] SLIDE : DATA 2 DECISIONS

Chair: Kathleen Samoil
Co-Chair: Stephen VanderArk

[263] STANDARDIZED MULTIDISCIPLINARY RESEARCH OF CREW HEALTH AND PERFORMANCE GENERATES ROBUST EVIDENCE FOR MONITORING AND INFORMED DECISION MAKING

John Hardy, Corey Theriot
NASA HRP Human Health and Performance Contract, Houston, TX, United States

(Education - Program / Process Review)

BACKGROUND: Space medicine professionals face numerous challenges when making critical decisions on how to best manage a crewmember's health and performance often relying on both subject matter expertise and evidence from biomedical research to inform their decisions. However, biomedical research in the space environment is regularly met with several inherent limitations including small sample sizes, disciplinary siloing, and highly variable crew research compliments. To overcome these barriers and address the need for rigorous research data, many space programs have developed multidisciplinary studies with a wider scope of investigation that is reproducible across missions, NASA's Human Research Program's Standard Measures study is an example of such efforts. **OVERVIEW:** The Spaceflight Standard Measures study is an integrated research compliment that monitors spaceflight adaptions across multiple physiological and psychological domains. The study was developed by the Human Research Program in 2017 to monitor high priority human system risks and provide context for concurrent experiments. Each of the six scientific disciplines comprising the study contain a minimal set of previously validated measures that are repeatedly collected throughout all three mission phases. To date, 35 professional astronauts have completed the study, generating a rich dataset of over 100,000 data points. This dataset is accessible to space medicine and research professional for both scientific and clinical inquiries. Results from a linear mixed effect model provides an example of how a longitudinal dataset can be used by researchers and space medicine professionals to inform their decision making. The data of over 30 astronauts was pooled together and an analysis performed on variables of two scientific disciplines: nutritional biochemistry and cellular profile (immunology and virology). The results of the analysis identified differences in how individuals adapt to spaceflight and how crewmember demographics (i.e. age, sex) and mission design (i.e flight duration) affect these responses. **DISCUSSION:** Commentary on the practical application of results from the Spaceflight Standard Measures study for the monitoring of crew health and performance is discussed. Finally, resources on how and where clinicians and research professionals can access standard measures data is provided to further support the space medicine community.

Learning Objectives

1. The participant will be able to identify multiple benefits of a standardized multidisciplinary assessment used to monitor adaptations to spaceflight for space medicine and research professionals.
2. The participant will understand how biomedical research data may be used to improve decisions regarding crew health and performance.
3. The participant understand where and how they can access HRP Standard Measures data to answer their clinical and research questions.

[264] ENHANCING EXPLORATION PLATFORMS AND ANALOG DEFINITION (EXPAND) ESSENTIAL MEASURES PROGRAM FOR COMMERCIAL SPACEFLIGHT

Jimmy Wu[1], Emmanuel Urquieta[2], Eric Bershad[3], Mathias Basner[4], Mark Shelhamer[5], Richard Gibbs[6], Harshavardhan Doddapaneni[6], Aparna Krishnavajhala[6], Adrian Ecker[4], Rihana Bokhari[1], Dorit Donoviel[1]
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(Education - Program / Process Review)

BACKGROUND: With the era of commercial astronaut (CA) missions growing, it is important to collect a standardized suite of medical, research, and environmental data sets across all the various commercial spaceflight missions. This presentation will describe the Enhancing eXploration Platforms and Analog Definition (EXPAND) Essential Measures program and its approach to standardizing the collection of biomedical data and biosamples on these early CA pioneers of commercial spaceflight. **OVERVIEW:** The Translational Research Institute for Space Health (TRISH) has established the EXPAND Essential Measures program to collect a standardized core set of physiological, functional, and environmental data as well as biosamples during the pre-/in-/post-flight phases of a commercial spaceflight mission. TRISH has formed close relationships with the commercial spaceflight providers to enroll their customers in EXPAND Essential Measures. All data and biosamples are managed in a centralized database and repository with an accurate data dictionary and biosample catalog that will be made available to the scientific community for data and biosample requests. TRISH is establishing a Data Privacy and Release Board (DPRB) to review and approve data and biosample requests. **DISCUSSION:** Commercial spaceflight missions create the opportunity to increase the diversity and heterogeneity of humans going into space allowing for a broader understanding of how the human body adapts and adjusts to the hazards of spaceflight. Currently, EXPAND Essential Measures has collected data from three commercial spaceflight missions and nine subjects. Total number of data points collected include 1,450 survey records, 520,022 physiological data points, and 244,882 functional data points. A total of 794 biosamples of various types (e.g. blood, saliva, urine, stool, and body swab) have been collected. EXPAND Essential Measures will enable cross-discipline analysis as well as make the data available to commercial spaceflight stakeholders and scientific community to support the health and safety of human spaceflight.

Learning Objectives

1. The audience will learn about the EXPAND Essential Measures protocol and specific data sets and biosamples that are collected.
2. The audience will learn about the EXPAND Data Privacy and Release Board how the board will serve as the authority in releasing of EXPAND data and biosamples to the scientific community.

[265] THE DEVELOPMENT OF OPERATIONAL MEDICAL STANDARDS AT A COMMERCIAL SPACEFLIGHT COMPANY

Michael Harrison[1], Melinda Hailey[1], Jeffrey McBride[2], Ted Duchesne[1], Todd Huhn[1]
[1]*Axiom Space, Houston, TX, United States;* [2]*UTMB, Galveston, TX, United States*

(Education - Program / Process Review)

BACKGROUND: Medical standards for commercial spaceflight participants (SFPs) currently are not mandated by any regulatory body. Spaceflight providers may develop proprietary medical certification processes or apply those developed by other agencies such as NASA. We present one company's process to develop and validate a governance structure, medical standards and an associated data archive to inform medical risk assessment and mitigation for short-duration orbital missions. **OVERVIEW:** Medical certification for spaceflight is a multistep process that includes initial medical screening followed by a more comprehensive assessment and evaluation against a set of predefined and objective medical standards to quantify and mitigate risk associated with medical and psychiatric diagnoses. Additional evaluation over the course of mission training provides information related to softer behavioral health considerations such as interpersonal skills, followership and leadership capabilities, and general expeditionary behaviors. The information from the former tools may provide rationale for waivers, follow-up evaluation, or, in extreme cases, disqualification from flight status. Information gathered from the latter is assessed against training milestones and core competencies to influence the training track of the crew as individuals and as a group. One commercial space company has developed and cross-referenced a database of publicly available medical standards from civilian and military resources to create medical standards specifically to support their commercial spaceflight missions and customer base. The database is designed to store medical cases of prospective and flown astronauts while also tracking associated mitigation strategies, in-flight medical events and their associated treatments, and immediate post-flight reconditioning course. **DISCUSSION:** Objective approaches to risk mitigation and medical certification, specific to the population and mission, is required to optimize the safety and success of human spaceflight in the commercial industry. Learning will occur at an exponential rate as the numbers of missions and providers grows in the coming decade. The method adopted by this commercial company allows for frequent and timely modifications to medical standards, influenced by objective data and lessons learned, as customers are evaluated and missions are flown. This iterative approach focuses on safety and provides a method to expand access to spaceflight.

Learning Objectives

1. The audience will learn about the processes in developing and operationalizing a medical standards system specific for the orbital commercial space industry.
2. The participant will gain an understanding of the complexities in risk evaluation and mitigation required to support a population of commercial astronauts flying orbital missions.

[266] EFFECTS OF THE SPACE ENVIRONMENT ON CRITICAL MISSION TASKS: EVALUATING PROCEDURAL PERFORMANCE DURING DEEP SPACE MISSIONS

Dora Babocs[1], Divy Kumar[2], Hyun Yi Woo[3], Rowena Christiansen[4], Krishi Korrapati[5]

[1]*University of Texas Health Science Center at Houston, Houston, TX, United States;* [2]*Northwestern Feinberg School of Medicine, Chicago, IL, United States;* [3]*Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, United States;* [4]*University of Melbourne Medical School, Melbourne, Australia;* [5]*Rosalind Franklin University, Chicago, IL, United States*

(Education - Program / Process Review)

BACKGROUND: Although human factors significantly contribute to mission success, the effects of extended spaceflight on competent procedural performance across long-duration missions has not yet been deeply studied. Exposure to the space environment has a significant impact on all organ systems, especially with longer mission duration. As a result, diverse medical conditions may present, some potentially requiring surgical intervention. This scoping review study will investigate procedural performance in space, with the aim of enhancing surgical and anesthetic safety during long-duration spaceflight. **OVERVIEW:** The NASA Human Research Roadmap (HRR) identifies altered sensorimotor and vestibular functions that can impact critical mission tasks as one of the 23 key spaceflight-associated risks. Particularly for life-saving interventions, performing procedural medicine in space could represent a critical mission task. The study methodology includes using all relevant keywords identified by the team to conduct searches in several major biomedical databases and 'grey' literature, such as NASA databases and Google Scholar, with the results then uploaded to Covidence for processing. **DISCUSSION:** Numerous spaceflight effects on the central nervous system have been noted, including structural and functional alterations, and modifications to adaptive plasticity, particularly in the sensory systems. The sensorimotor, visual, somatosensory, and vestibular networks can all be affected, with altered functional responses to vestibular stimulation after spaceflight. This has implications for transitions between gravitational environments, as do spaceflight-associated cognitive deficits affecting memory, concentration, and task management. Decrements in cognition and reduced tactile feedback and sensation in space may impact on dexterity and fine-motor skills, as well as concentration, decision-making, and effective teamwork during stressful scenarios. Long-term microgravity exposure may affect a surgeon's vision, for instance through development of Spaceflight-Associated Neuro-ocular Syndrome (SANS), and possible radiation-related cataract formation. Alongside the physiological and pathophysiological changes, psychological factors must also be considered. The stress of isolation, a confined environment with limited social interactions, and altered circadian rhythm, with both the duration and quality of sleep being affected, will potentially impact cognitive performance.

Learning Objectives

1. Learners should be able to appreciate the impact of the space environment on various aspects of procedural performance, including physiological, cognitive, and psychological factors. They will gain insights into the challenges proceduralists face during long-duration spaceflight and how these challenges can affect their ability to perform life-saving interventions.
2. The audience will gain insights into how performing anesthetic and surgical procedures could represent a critical mission task, and how this meshes with the key spaceflight-associated risks identified by NASA's Human Research Roadmap.
3. Learners will be able to understand the importance of comprehensive planning to address the unique challenges and considerations for procedural interventions during long-duration spaceflight, including the impact of the space environment on anesthetic and surgical performance, and how teamwork and resource management are key factors in ensuring successful procedural outcomes.

[267] MEDICAL SYSTEM DESIGN FOR A COMMERCIAL SPACE STATION

Carlo Canepa[1], Kenny Chao[2], Molly McCormick[3], Dana Levin[3]

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(Original Research)

INTRODUCTION: Historically, NASA has used a combination of computational models, subject matter expertise, heuristics, and experience to design spacecraft medical systems. While the goals, population, capabilities, and limitations of commercial space stations differ from previous, government-owned spacecraft, medical care remains a critical part of crew operations. This project adapted NASA's historical approach to the commercial world by using Vast Space's Haven-1 mission as the design reference. **METHODS:** A 40-day reference mission with 2 male and 2 female crew to Vast Space's Haven-1 was used to inform the design. Haven-1 is a single-module station due to launch into low-Earth orbit in 2025. A physician panel with broad expertise and experience first developed a list of likely and/or consequential medical conditions to the mission. The panel then developed a probabilistic risk calculator based on these conditions

and used clinical and operational experience informed by the results of the risk calculation to identify resource needs and desired quantities, along with mass and volume estimations. The results were compared to custom runs of NASA's PRA tools and published lists of historical spacecraft medical equipment. The final Medical Design Resource List (MDRL) resulted from integrating each of these steps. **RESULTS:** The analysis includes 170 potential medical conditions. Onboard diagnostic and treatment resources were deemed necessary for most of them. 86 unique resources were identified, totaling less than 6 kg of mass and less than 30 L of volume. A comparison of this medical kit to NASA PRA output and published historical spacecraft medical resource data revealed significant overlap. **DISCUSSION:** This process estimated the risk to crew and generated a medical system resource list for a 160-person-day reference mission. The resulting resources were substantially aligned with prior spacecraft medical systems but included a few additional resources commensurate with the medical risks of flying a broader population than historically government-sponsored astronauts. While the effectiveness of this system will need to be validated with in-flight data, this illustrates that previously employed space medical system design methods can be successfully adapted to the commercial environment.

Learning Objectives

1. Historically successful techniques for medical system design can be applied to commercial spaceflight operations.
2. Medical system design must incorporate feedback from engineers, specialist physicians, acute care physicians, preventive medicine physicians, designers, pharmacists, and those with spaceflight experience.

[268] DEVELOPING A CORE COMPETENCY FRAMEWORK FOR INTERNATIONAL AEROSPACE MEDICINE EDUCATION AND TRAINING.

Rowena Christiansen[1], Lisa McNamee[2]
[1]*The University of Melbourne, Melbourne, Australia;* [2]*Trinity College Dublin, Dublin, Ireland*

(Education - Program / Process Review)

BACKGROUND: Current demand for aerospace medicine (AsM) expertise outstrips available trained health professionals internationally, particularly in the capacity to support human spaceflight endeavours. Increasing numbers of commercial spaceflight missions, and a potential paradigm change with future SpaceX 'Starship' high-capacity flights, will only compound this issue. A prior scoping review study by the authors identified thirty-six international AsM education and training (E&T) opportunities currently offered annually, including a small number of board certification-level physician residencies, and some Masters degree programs, as well as short courses. The newly established OSMED organization supports a growing international consensus that AsM E&T can be expanded through collaboration and agreement on core competencies to be attained. **OVERVIEW:** This project aims to identify the core competencies required by existing professional AsM E&T programs and recognised industry standards, such as those published recently by the Potomac Institute, and to leverage these to develop an internationally accessible AsM E&T program that can supplement the current limited 'gold-standard' residency opportunities. Achievement of final competency, and subsequent accreditation to a standard accepted by industry, would potentially create opportunities for international health professionals to participate in supporting human spaceflight missions globally. Such a program could not be successfully developed without international cooperation and collaboration, and the support of existing providers and industry. **DISCUSSION:** Common core competencies from existing programs and published standards include: clinical expertise and skills in emergency, preventative, and occupational medicine; knowledge of the aerospace environment and risks; professional communication and teamwork skills; and operational skills and knowledge. Collating a core competency framework based on existing AsM E&T would facilitate the development of a modular program that could be progressively rolled out and delivered as the underlying infrastructure and support was put in place. However, it is envisaged that a wider consultation of leaders from aerospace and space medicine, and aerospace engineering and design, would provide useful input towards developing an international AsM core competencies framework that will best equip health professionals to meet future needs in a manner that is recognized by industry.

Learning Objectives

1. Participants will learn about existing international aerospace medicine education and training opportunities.
2. Participants will appreciate that recognition of competency to participate in supporting human spaceflight missions is based on a tripartite structure of education, training, and accreditation.
3. The audience will recognise that, while a number of common core competencies can be identified, programs and published standards will differ in some aspects of the components of education and training.

Wednesday, 06/04/2025 ***2:00 PM***
Regency V

[S-49] PANEL: OCCURRENCES OF SPATIAL DISORIENTATION IN MILITARY PILOTS

Chair: Eric Groen
Co-Chair: Tracy Grimshaw

Panel Overview: *Spatial disorientation (SD) is a situation where a pilot's perception of the aircraft motion or orientation is incorrect. SD remains a significant safety risk in flight, hence it is important to understand the conditions that may lead to SD. Likewise, it is important to understand how different manifestations of SD depend on the aircraft type and the operational concept. This knowledge can be used, for example, to update SD training programs so that pilots can learn to cope with SD conditions that are representative of their current operations. In this panel, researchers from the UK will share results from SD surveys held among their military pilots. One presentation will review the latest survey results; another presentation will provide insight in trend analysis based on the SD database; and a third presentation will explain pilot experiences with dissociative types of SD, such as the Giant hand phenomenon.*
One typical result of the SD survey was that fighter pilots regularly experience a sensation of the Leans during air-to-air refueling in low-visibility conditions. Apparently, the contour of the tanker aircraft can be perceived as a false horizon. This observation inspired an exploratory study on the possibility to induce the Leans during air-to-air refueling in a fixed-base simulator. The results of this study will be addressed in the fourth presentation. A fifth and final presentation will discuss episodes of overwhelming SD where the pilot is unable to make a properly coordinated response.

[269] UNDERSTANDING THE FACTORS CONTRIBUTING TO SPATIAL DISORIENTATION IN UK MILITARY AVIATION: ANALYSIS OF INCIDENTS 2021- 2024

Tracy Grimshaw[1], Jonathan Boyd[1], Alaistair Bushby[2]
[1]*QinetiQ LTD, Farnborough, Hampshire, United Kingdom;* [2]*RAF CAM, Henlow, United Kingdom*

(Original Research)

INTRODUCTION: The UK Disorientation Incident Survey (DIS) has collected anonymous military aircrew reports of spatial disorientation since 2004, to understand the factors that are associated with disorientation. The aim of the latest survey was to collect incidents occurring from January 2021 to March 2024. **METHODS:** The DIS asks aircrew to describe occasions in flight when they either became confused about their aircraft position, motion or attitude or they suddenly realised that the position, motion or attitude of their aircraft

had changed. Aircrew also rated the risk to flight safety of each incident. Independently, spatial disorientation (SD) experts analysed the incident descriptions to establish the factors that contributed to the incident and to determine whether the SD was recognised (the aircraft had not significantly departed from its intended attitude or position) or unrecognised (the aircraft had significantly departed from its intended attitude or position). **RESULTS:** There were 656 responses to the survey, of which 81 involved SD incidents; 47 rotary-wing, 25 fast-jet, and 9 multi-engine. For fast-jet, the majority of SD incidents took place during the day (88%), with many featuring associated with clouds (60%), formation flying or air-to-air refuelling (72%). Fifty-six percent experienced the leans. For rotary-wing, incidents occurred during both day (49%) and night (47%) and mainly involved environmental factors e.g. featureless terrain, clouds. For fast-jet and multi-engine aircraft, unrecognised SD was mainly associated with daytime flying and in-cockpit distraction. Unrecognised rotary-wing SD mainly involved environmental factors (e.g. brown-out, low ambient light). Only 4 out of the 81 SD incidents reported through the survey had been reported through official reporting channels. **DISCUSSION:** Results highlight that SD continues to pose a risk to flight safety, yet reporting of SD through official mechanisms is low and therefore does not provide a full understanding of the risks of SD to military aircraft. The incidents collected in the latest survey will be used in training and education for aircrew.

Learning Objectives

1. To understand the number of SD incidents in UK military aircraft 2021-24.
2. To understand the factors contributing to SD between 2021-2024.

[270] TRENDS IN UK MILITARY ROTARY WING SPATIAL DISORIENTATION INCIDENTS SINCE 2004

Jonathon Boyd, Tracy Grimshaw
QinetiQ Ltd, Farnborough, Hampshire, United Kingdom

(Original Research)

INTRODUCTION: Spatial disorientation (SD) continues to present a risk to flight safety for military aircrew. The UK military has surveyed aircrew regarding experience of disorientation seven times between 2004 and 2024. These data have been used to establish common themes and trends associated with the development of disorientation. The database currently holds 709 UK military SD incidents across all UK military air platforms, including the latest survey data from early 2024. The current presentation describes the analysis of 399 RW incidents collected between 2004 and 2024. **METHODS:** The data were analysed to determine 1) factors contributing to SD (e.g. manoeuvring, environmental, pilot, aircraft factors), 2) how these related to the risk to flight safety (minor, significant or severe) as judged by aircrew and, 3) whether the SD was recognised (the aircraft had not significantly departed from its intended attitude or position) or unrecognised (the aircraft had significantly departed from its intended attitude or position), as judged by SD subject matter experts. Logistic regression analysis was conducted to infer which incident factors were associated with risk to flight safety and SD recognition. **RESULTS:** The number of RW incidents reported has remained constant since 2012, with some variations in platform types. The most prevalent factors involved with incidents were flying at night (57%) and use of night vision devices (NVD) (38%). Generally, unrecognised incidents involved brown-out/whiteout and pilot factors including in-cockpit distraction. Drifting, low ambient light wearing NVD, brownout/whiteout and landing were involved with a high proportion of significant/severe incidents. The majority of unrecognised SD incidents were associated with a significant risk to flight safety. **DISCUSSION:** The database represents a unique record of UK military SD incidents over a 20 year period, with results reflecting changes in operational focus and aircraft. Results have been used to inform SD education and training and these latest results will be used to understand key factors involved in SD risks to flight safety.

Learning Objectives

1. To understand trends in rotary wing spatial disorientation over a 20 year period.
2. To understand the factors featured in unrecognised disorientation in rotary wing aircraft.

[271] A SURVEY OF AVIATION DISSOCIATIVE PHENOMENA AMONGST UK MILITARY AIRCREW

Vanesa Garnelo-Rey[1], Tracy Grimshaw[2], Jonathan Boyd[2]
[1]*RAF CAM, Bedfordshire, United Kingdom;* [2]*QinetiQ LTD, Farnborough, United Kingdom*

(Original Research)

INTRODUCTION: For many years, aviation dissociative phenomena known as "break-off", "giant-hand" and "knife edge", were thought to be largely experienced by fast jet pilots flying high altitude transits. However, anecdotal evidence suggested these phenomena are experienced by a wider variety of aircrew and not just at high altitude. A survey of the prevalence of these phenomena was undertaken to understand the incidence across UK aircrew. **METHODS:** The UK Disorientation Incident Survey has been undertaken by the MOD since 2004. The latest survey included additional questions in order to capture across-career aircrew experiences of aviation dissociative phenomena. Aircrew were provided with a description ("usually known as "break-off", a "giant hand" controlling the aircraft or a feeling that the aircraft is finely balanced as if on a "knife edge" from which it might fall asked to describe any incident") and asked to describe in their own words any incidents that fitted that description. The survey was sent to serving military aircrew between January and April 2024. **RESULTS:** Six hundred and seventy-six survey responses were received in total. Of these, 26 reported experiences that matched the definition of aviation dissociative phenomena. Twenty-two occurrences were reported by pilots and four by other aircrew. Sixteen occurred in fast jet, seven in rotary wing, two in multi-engine aircraft, and one in a light training aircraft. Eighteen reports were identified as "break-off" episodes, seven as "knife-edge" and one as "giant-hand". No links were found to sortie profile or environmental condition (e.g. day, night. Episodes were reported over a wide range of altitudes. Eighteen reports described sensory constancy (the sensation of "nothing happening"). Fatigue was cited in only seven of the episodes. In nine reports, aircrew considered flight safety as severely compromised, for the remainder, the episodes were considered minor. Only one episode was reported through an official reporting channel. **DISCUSSION:** These results challenge previous assumptions that these phenomena are exclusive of fast jet aircrew flying high altitude transits and in low arousal states; survey results found that although predominant in pilots, other aircrew are also susceptible, and almost a third of the episodes were not in a low arousal state. Flight safety can be severely compromised but the lack of formal reporting poses an important challenge.

Learning Objectives

1. These survey results aid in understanding the nature of aviation dissociative phenomena moving away from specific platforms, altitudes, conditions, and aircrew roles.
2. Raising awareness and education can help promote formal reporting.

[272] ATTEMPT TO INDUCE THE LEANS DURING AIR-TO-AIR REFUELING IN A FIXED-BASE FLIGHT SIMULATOR

Eric Groen
TNO, Soesterberg, Netherlands

(Original Research)

INTRODUCTION: A fighter pilot of the Royal Netherlands Air Force experienced a serious incidence of the Leans when flying close to a tanker aircraft in poor visibility. According to a recent survey on spatial disorientation (this panel), military pilots in the UK also reported to have sensed the Leans during air-to-air refueling (AAR), often because the tanker aircraft is perceived as a 'false horizon'. In this case study

we explore the possibility to induce the Leans during AAR in a fixed-base flight simulator. **METHODS:** A military test pilot performed AAR formation flights in a fixed-base mock-up inside a Dome projection system. Each flight started and ended with straight and level flight, and contained a turn of either 10 or 30 deg angle of bank (left or right). Roll rate was varied between 5.7 deg/s (0.1 rad/s), 2.9 deg/s (0.05 rad/s), 0.57 deg/s (0.01 rad/s), and 0.2 deg/s (0.003 rad/s). The pilot was asked to comment on any maneuvering, disorientation or Leans sensations. The flight took place 'in the weather' and without the head-up-display (but with cockpit instruments). Two formation positions were tested: 'on the wing', which is about 30m from the tanker fuselage, and about 3m outside and behind the wing tip; and 'pre-contact' position, which is approximately 5m after, and slightly below, the tanker aircraft. **RESULTS:** At the highest roll rate (5.7 deg/s) the turn was easily detected, at 2.9 deg/s and 0.57 deg/s it was not always, or seldomly noticed, respectively; and at 0.2 deg/s the turn was never noticed. Turns were more difficult to detect in the 'pre-contact' position compared to 'on-the-wing'. Furthermore, turns of 30 deg angle of bank were more disorienting for the pilot, although he never experienced a 'bodily' sensation of the Leans. **DISCUSSION:** This study shows that it was possible to disorient the test pilot during an AAR scenario in a fixed-base flight simulator, although it did not induce true 'bodily' Leans. The most effective scenario was in pre-contact position, with turns of 30 deg angle of bank and roll rates below 0.57 deg/s. The results suggest that it can be useful to include an AAR scenario in a ground-based spatial awareness course, and further research on this topic will be conducted.

Learning Objectives

1. Participants will learn that fighter pilots may experience the Leans during air-to-air refueling.
2. Participants learn that it is difficult to induce a true sensation of the Leans in a fixed-base flight simulator.

[273] TYPE III SPATIAL DISORIENTATION: OVERWHELMING OR INCAPACITATING?

Angus Rupert
U.S. Army Aeromedical Research Lab, Fort Novosel, AL, United States

(Original Research)

INTRODUCTION: Spatial disorientation (SD) has sometimes been categorized into three types: Type I disorientation in which the pilot does not recognize they are disoriented until impact with the ground; Type II disorientation in which the pilot recognizes he/she is disoriented and is attempting to recover and lastly Type III in which the pilot is unable to recover either because they are totally incapacitated or the disorientation is so overwhelming they are unable to respond correctly. Within Type III the mechanisms of overwhelming disorientation differ from those of incapacitating disorientation and need to be differentiated since the approach to solving the two different Type III mechanisms must be tailored to the causal factors. **METHODS:** Several examples of Type III disorientation were culled from pilot testimonials to select two examples of Type III disorientation that fit into the category of overwhelming disorientation and two examples of the category of incapacitating disorientation in which the pilot is physically unable to make a properly coordinated response. **DISCUSSION:** When examined from the perspective of sensory inputs and motor responses these examples suggest solutions to prevention of both categories of Type III SD. During incapacitating SD in which vestibular reflex responses prevent the pilot from making correct inputs automation is the best solution. With overwhelming disorientation in which the pilot can still manipulate the controls but is unable to provide the correct response despite the availability of correct information due to the strength or salience of the perception, then prevention via multisensory cueing is likely the best approach. Although some may argue Type III disorientation is simply a sub category of Type II the differing mechanisms of the subtypes of Type III SD warrant a separate categorization.

Learning Objectives

1. Demonstrate an understanding that Type III Spatial Disorientation has more than one sensory etiology with differing solutions to address different causation factors.
2. Describe both sensory and mechanical solutions to Type III SD.

Wednesday, 06/04/2025 ***2:00 PM***
Regency VII

[S-50] PANEL: SYNERGY OF MULTIDISCIPLINARY COLLABORATION: PRINCIPLES & PRACTICES OF MARY F FOLEY

Chair: Marian B. Sides
Co-Chairs: J. Karen Klingenberger, Nora Johnson

Panel Overview: *This panel is the fourth educational event of the Mary F Foley Endowment. The collaborative panel will portray the principles and practices of Mary Foley, and will demonstrate how diverse skill sets from various disciplines can synergistically strengthen service outcomes and team performance. In 1955, Mary "Bunny" Foley R.N. became interested in the air transport of invalids. She traveled the world, meeting with airline medical directors, and surveying the handling of patients. She published "Air Travel for Patients," that established early standards for air travel. In 1958 she joined the United States Air Force and became a flight nurse. In 1960 she joined the research team at OH State University's Aviation Medicine Research Laboratory. During her career she conducted groundbreaking research on the effects of weightlessness and long-term acceleration on the human body. As a scientist and test subject, she flew in zero-gravity parabolas and operated the human centrifuge to understand G-force limits for pilots and the effects of weightlessness on pulmonary function and lung capacity. She studied the stress reduction benefits of head cooling helmets for F-16 fighter pilots and made advances in occupational medicine. As a past president and pioneer member of the Aerospace Physiology Society, Mary Foley was among the first class of physiologists to be granted Board certification in Aerospace Physiology, in 1977. Foley was a Fellow of the Aerospace Medical Association, AsMA, a pilot and a member of the International Association of Women Pilots. In the spirit of Mary Foley's legacy, the panel consisting of advance practice experts from five disciplines, will present and describe their supportive roles. Disciplines that form the team include Aerospace Physiology, Physical Therapy, Pharmaceutical Services, Occupational Health Nursing and Human Factors. Representatives will describe synergistic benefits that evolve from collaborative efforts related to effective communication, best practices, safety, innovation, skill expansion, adaptability, cooperation, mutual respect, team spirit, and more. Discussion will embellish awareness of the synergistic benefits. This event will offer illuminating insights, inspiration, mentoring, and leadership development for AsMA members.*

[274] MARY FOLEY - CUTTING EDGE APPLIED RESEARCH IN AEROSPACE PHYSIOLOGY

Lloyd Tripp
LDT-Consulting, Mount Holly, NC, United States

(Education - Program / Process Review)

BACKGROUND: The Aerospace air and ground environments are not without hazards to aircrew and groundcrew alike. Mary Foley recognized these issues early on and focused on lung function in fighter pilots and the mitigation of thermal loads in aircrew and groundcrews during pre-flight and flightline operations. **OVERVIEW:** Working with the 906 TFG Wright-Patterson AFB., Mary performed pre- and postflight pulmonary function tests on F-4 pilots. Her study examined the effects of high-G on pilot lung function. Although the pulmonary function study was unpublished the approach of having aircrew participate in a research study was a giant step forward for operational aerospace

physiology research. Mary's research interests also focused on the mitigation of thermal load related to environmental exposures. Working with industry, she introduced the re-freezable cooling headpiece (CHP) which provided head cooling during physical workload in hot environments. **DISCUSSION:** An assessment of the CHP looked at end-user comfort during physical work, in actual and simulated environments. Testing was conducted at Wright-Patterson and Brooks AFB. Her unpublished results showed CHP provided significant relief from thermal burden. Researchers at the U.S. Army Research Institute of Environmental Medicine (USARIEM) were interested in the CHP to mitigate heat load on soldiers. A collaborative study was conducted at USARIEM's climatic chamber exposing participants to 104-degree F. while exercising on a bicycle ergometer. Results indicated the CHP decreases physiological strain during thermal exposures. Mary saw the thermal burden created by the military's chemical protection suit or MOPP gear and partnered with Wright-State University's Aerospace Medicine Residency Program, to evaluate the efficacy of the CHP with subjects wearing MOPP gear. Participants were exposed to 100.4, 84.2 and 75.2o F. in an environmental chamber and rode a bicycle ergometer. Results revealed a reduction in CHP physiological strain while subjects maintained physical performance. This presentation will discuss how the application of principles in aerospace physiology can mitigate environmental stress on the human body. Mary Foley's collaborations between industry, academia, and military organizations is a model for successful aerospace physiology research programs across the DoD today.

Learning Objectives

1. The audience will gain an understanding of collaborative research across industry, academia and military can drive the development of a product to mitigate the adverse physiological effects of thermal loading.
2. The audience will learn about pertinent research that supports the underlying issues associated with thermal exposure.
3. The audience will be able to identify opportunities to improve upon the technologies described and the possibilities for future products.

[275] MARY F. FOLEY- FOUNDATIONAL MEDICAL CONSIDERATIONS AND PRINCIPLES OF PHYSICAL THERAPY FOR FLIGHT

Clint Copeland
U.S. Air Force, Yorktown, VA, United States

(Education - Program / Process Review)

BACKGROUND: As early as the 1970s, approximately 500 million passengers participated in air travel annually. Mary Foley was responsible for publishing the first formalized medical recommendations for air travel in 1973, setting baseline expectations for conditions spanning several major body systems. For many years afterwards, her work served as the sole resource describing medical considerations for commercial flight as a passenger. **OVERVIEW:** Mary's dedication to medical safety set the stage for deeper research on the physiological stresses of flight and enabled several efforts to better define and address risk factors for the execution of physical therapy solutions to provide the best care possible. Her work conveys a clear desire to minimize patient risk and to provide the best care possible. In line with this effort, she was an avid supporter of interdisciplinary care and strongly believed that the most effective way to address medical issues was for care teams to work collaboratively toward patient goals. **DISCUSSION:** The recommendations made by Foley in the 1970's have evolved to numerous flight guidelines spanning passenger, patient, and aircrew roles. A more robust form of these recommendations known as aviator medical standards now exist within the Federal Aviation Administration(FAA) and Department of Defense (DoD). These modern standards establish physiological minimums for initial flight qualification and return to flight duties following a physically limiting injury or pathology. In line with Mary's hopes, medical standard guidelines have fostered a greater sense of collaboration within interdisciplinary teams, by uniting practitioners across multiple disciplines toward a well defined goal. This presentation will discuss the benefits of Mary F Foley's work by highlighting how her initial recommendations laid the framework for modern day resources. Furthermore it will explain the role of physical therapy principles in aerospace medicine and will describe how the practice of physical therapy embodies Mary F Foley's legacy of interdisciplinary collaboration in the evolution of best practices in standards of care for quality outcomes.

Learning Objectives

1. The audience will gain an understanding of recommendations outlined in Mary Foley's 1973 publication Air Travel for Patients.
2. The audience will learn about modern day medical aviation standards made possible by Mary Foley's work.
3. The audience will understand the role of physical therapy in interdisciplinary care as it relates to maximizing outcomes relevant to the aerospace realm.

[276] OCCUPATIONAL NURSING PRACTICE IN AEROSPACE NURSING WITH APPLICATIONS FROM MARY F FOLEY

Cathy Dibiase
InoMedic Health Applications, Kennedy Space Center, Titusville, FL, United States

(Education - Program / Process Review)

BACKGROUND: Keeping the worker safe whether on the ground, in the air or in space, can be a difficult task. To inform our practice and to provide the best care to our patients we can look to the foundations laid by Mary Foley as she was a nursing trailblazer. **OVERVIEW:** Current practice guidelines in place today were built upon Mary's research work. As a nurse she became insightful to the challenges pilots and aircrew as well as passengers were facing after traveling for several months and seeing the issues firsthand. Her work with pulmonary function testing research was multidisciplinary and the research subjects multiracial. **DISCUSSION:** Worker and patient safety along with prevention through surveillance were some of the occupational nursing principals that Mary employed in her research. She understood that occupational exposures may not only allow the worker to not make it home whole each night, but that long term conditions and disease progression could be halted or lessened. Mary laid the foundation for lay person air travel in her original work and publication that outlined who should fly and contraindications for certain conditions. In this work, Mary outlines common flying effects and conditions that would be affected. Mary understood the importance of patient engagement and education to inspire change. Her work with the Heart Association helped show the correlation of uncontrolled hypertension as well as the long-term smoking effects on pulmonary and cardiovascular systems. My discussion of these principals will benefit the session attendee by increasing their knowledge of how all members of a team can contribute and work toward a common goal.

Learning Objectives

1. Attendees will be able to list at least three conditions from Mary's air travel paper that were contraindicated.
2. Audience will be able to cite relevant principals of occupational nursing employed by Mary.
3. Learners will identify the impact of education on patient engagement.

[277] PHARMACEUTICALS IN AEROSPACE MEDICINE: A PIECE OF THE WHOLISTIC APPROACH

Emma Ives
UNC Eshelman School of Pharmacy, Durham, NC, United States

(Education - Program / Process Review)

BACKGROUND: Pharmaceuticals have been a part of aviation since the earliest days of human flight. Their impacts on safety and performance have been extensively covered in the literature. This presentation will explain the historical role of pharmacy in aerospace medicine and describe how the practice embodies Mary F Foley's legacy of interdisciplinary collaboration in the advancement of the field. **OVERVIEW:** Pharmacy has been

involved with human pursuit of flight since its inception. During World War II, various players in aviation were concerned regarding pilot fatigue, necessitating the need for research into stimulants and their impact on performance. The FAA recognized the hazards related to pharmaceuticals in commercial pilots and published their first guide in 1962 to assist medical examiners in evaluation of pilot duties. Similarly, Mary F Foley had the foresight and vision to be engaged in a variety of topics that laid the groundwork on what is now known regarding aerospace physiology. While she did not directly study pharmaceuticals, she utilized an interdisciplinary approach to research evident in her paper "Air Travel For Patients" includes various aspects of patient care during flight, including the importance of medication access. Pharmacy, as a profession, is the most accessible form of patient care. The pharmacist serves as the drug specialist, health insurance expert, and patient care advocate, making them a vital part of the care team. **DISCUSSION:** Due to the pharmacist's extensive training, they can assist the care team in navigating the ever changing pharmacy landscape, making health care access easier for patients. Similar to Mary F Foley's legacy, pharmacy touches a variety of aerospace topics and is equipped to support aerospace medicine from a safety and performance perspective to advance the field. The multidisciplinary approach to integrating pharmaceuticals adds a team synergy, exponentially enhancing patient care.

Learning Objectives

1. The audience will gain insight into the historical role of pharmacy in aerospace medicine.
2. The Audience will learn about the role of pharmacy in a health care team.
3. The Audience will be able to identify opportunities for pharmacy to improve accessibility of patient care.

[278] INTERDISCIPLINARY HUMAN FACTORS CHALLENGES IN AIR TRANSPORT OF PATIENTS

Annette Sobel
Texas Tech University, Lubbock, TX, United States

(Education - Program / Process Review)

BACKGROUND: Mary Foley was a sentinel for interdisciplinary issues concerning aeromedical transport of patients. Her careful research identified several essential principles requiring human factors exploration and scientific analysis. **OVERVIEW:** This presentation will highlight the aerospace human factors educational and research advances identified through Mary Foley's work. As a pioneer in interdisciplinary advances, Mary needed to produce measurable human factors effects tied to improved patient outcome. A full taxonomy of research at Air Force Research Lab and other national labs has emerged. **DISCUSSION:** This presentation will discuss human factors issues and demonstrated countermeasures intended for early identification of physiologic stress such as hypoxia, vibration, gravitational forces, noise, hypothermia, circadian desynchrony, to name a few. In addition, specific examples of the human-computer and human-system interfaces needed and evaluated in the process of developing holistic patient care models. Notably, new approaches to sensing and early detection of medical problems and syndromic surveillance within the patient-aeromedical environment will be expounded upon. The emerging role of human-system centered Artificial Intelligence within this complex patient care environment will also be discussed. The audience will gain an understanding of the complex models fostered by Mary Foley. As a result of her ground-breaking work, critical synchronization of applied and basic interdisciplinary human-system research is now determined as necessary to optimize patient outcomes.

Learning Objectives

1. The audience will gain an understanding of the essential nature of interdisciplinary human factors work in improving outcomes of air transport of patients.
2. The audience will gain an understanding of the essential nature of interdisciplinary human factors work in improving outcomes of air transport of patients.
3. The audience will be able to identify opportunities for future human factors research synchronization.

Wednesday, 06/04/2025 ***2:00 PM***
Hanover F/G

[S-56] PANEL: RAM GRAND ROUNDS – PANEL III

Chair: Sonya Heidt
Co-Chairs: David Navel, Sadie Henry

Panel Overview: *Residency in Aerospace Medicine – Grand Rounds Panel III*

[421] CONSTANT ADJUSTMENT – DIAGNOSES ARE IMPORTANT: A CASE REPORT

Victor Parker, David Trindle
USAFSAM, Wright-Patterson AFB, OH, United States

(Original Research)

INTRODUCTION: This case study evaluates the aeromedical fitness of a senior pilot with a history of recurrent adjustment disorder with mixed anxiety and depression over the course of 5 years. **BACKGROUND:** A pilot with nearly 20 years of military service and close to 3000 flying hours self-removed from flight duties due to mental health challenges triggered by significant life stressors between 2019 and 2024. They received therapy and treatment, leading to symptom resolution, though administrative actions complicated their career. **CASE PRESENTATION:** The pilot underwent intensive therapy, with approximately 150 sessions of various therapeutic modalities. They also engaged in healthy lifestyle changes, contributing to full resolution of anxiety and depression symptoms by early-2024. Despite their mental health progress, they faced administrative actions, including an upcoming discharge board for vaccine refusal on sincerely held religious beliefs. Their psychotropic medications were discontinued in September 2023 and therapy was concluded in spring of 2024. During their nearly 5-year treatment, they experienced multiple life stressors that would present just as another stressor was controlled. They reported improved emotional resilience, enhanced family relationships, and the ability to apply therapeutic skills to assist others. Psychological testing revealed no psychiatric symptoms or fear of flying, and they remained motivated to return to operational duties. **DISCUSSION:** The USAF Aeromedical Consultation Service (ACS) recommended pilot disqualification from Flying Class II duties due to a history of adjustment disorder and recommended a waiver, valid for two years, contingent upon continued mitigation actions. Using the USAFSAM Aeromedical Risk Matrix, their risk was classified as "Serious" (score of 6), with mitigation strategies including resilience-building, follow-up care, and observation for symptom recurrence. This case highlights the complexity of managing aviators with mental health histories and the importance of diagnoses in disposition. The successful recovery and demonstrated coping strategies of the patient support a Flying Class II waiver, although administrative actions continue to pose professional challenges. Further data is needed to refine policies balancing mental health recovery and career viability in military aviators.

Learning Objectives

1. Identify the aeromedical risks and mitigation strategies for pilots diagnosed with Adjustment Disorder.
2. Evaluate the impact of Mental Health diagnoses on flight readiness and waiver eligibility.

[422] BINGE DRINKING BLUES: A FOLATE STORY

Kyle Richardson
Naval Aerospace Medical Institute, Pensacola, FL, United States

(Original Research)

INTRODUCTION: This case report describes the diagnosis and management of a Naval Aircrew Candidate (NAC) applicant who was found to have Alcohol Use Disorder secondary to being diagnosed with Folate Deficiency Macrocytic Anemia. **BACKGROUND:** Alcohol use disorder, which accounts for the majority of macrocytic anemia, poses a

significant threat to the safety of flight. Few individuals honestly report alcohol use on routine screening forms or questionnaires to Aeromedical Examiners AMEs) or Flight Surgeons (FS). Recognition of lab abnormalities within the screening complete blood count (CBC) should prompt AMEs and FS to investigate for underlying causes that may be disqualifying. **CASE PRESENTATION**: A 24-year-old male NAC applicant presented for special duty screening at the Recruit Training Command (RTC). During the initial screening complete blood count (CBC), he was found to have a hematocrit (Hct) at 39.6% and a mean corpuscular volume (MCV) of 113.1 fL. An anemia workup was completed, ruling out drug and thyroid-related causes, noting marginally low folate and iron, for which he was started on folate and iron supplementation. At his four-week follow-up, Hct and MCV were 39.1% and 104.8fL, requiring a general and aviation special duty waiver. Before transferring to Naval Air Station Pensacola, the general duty waiver was granted, and the aviation waiver was submitted to AERO for approval. Upon arrival to Pensacola, local FS evaluation noted a previous history of emergency room visits before enlistment, as well as a recent local emergency room visit, in which alcohol intoxication was noted at each visit, and one noted a breathalyzer of 0.283 g/L. After further questioning, the member endorsed excessive alcohol consumption and was referred to the substance abuse rehabilitation program (SARP) for further evaluation. The evaluation showed a moderate to severe alcohol use disorder, accounting for the folate-deficient anemia. **DISCUSSION:** This case will discuss the importance of routine screening for anemia and the workup for macrocytic anemia. It will also discuss the current aeromedical waiver considerations from civil and military governing authorities for alcohol use disorder. Additionally, this case will highlight the importance of a thorough review of patient records or the need to request additional labs or records before waiver submission or AME certification.

Learning Objectives

1. Reaffirming the necessity of screening labs for active-duty special duty applicants.
2. Educational insight on trends in complete blood count values that support further inquiry about alcohol use.

[423] THE JOINT CONSIDERATION: A HYPOTHETICAL CASE OF SPACEFLIGHT CERTIFICATION AFTER HIP ARTHROPLASTY

Samantha King, Christine Schwartz
UTMB, Galveston, TX, United States

(Original Research)

INTRODUCTION: This case reports on a HYPOTHETICAL career astronaut with prior short duration flight experience seeking re-certification for spaceflight after a total hip arthroplasty. **BACKGROUND:** Musculoskeletal symptoms are one of the most frequently noted medical complaints experienced by crewmembers during spaceflight. Additionally, the rigors of training and inflight activities, such as extra-vehicular activity (EVA), put additional musculoskeletal stress on crewmembers. The effect of spaceflight environment on cartilage is a current area of research. In addition to these stresses, crewmembers experience terrestrial degenerative changes of the joints. Advanced osteoarthritis can be treated with joint replacement. History of joint arthroplasty has unique considerations for certification for spaceflight. **CASE PRESENTATION:** A 50-year-old crewmember with prior short duration flight experience and EVA experience underwent a minimally invasive total right hip arthroplasty 24 months prior to recertification, for osteoarthritis which had failed conservative management. The crewmember completed post-operative physical therapy and has been cleared by the orthopedic surgeon for return to duty with continued routine yearly follow-up. The crewmember has no current restrictions on range of motion or limitations in training activities as evidenced by performance in dynamic functional testing. **DISCUSSION:** Current military wavier guidance exists for certification of pilots after joint arthroplasty, but such standards do not exist for spaceflight. The potential need to qualify individuals with a history of hip arthroplasty could increase with the expanding population of astronauts and spaceflight participants. Individuals considering surgical intervention should discuss the impact of surgical approach on dislocation risks, particularly in the context of re-entry and landing forces. After surgery, it is critical to assess any impact on function and performance. The decision for certification will need to consider bone remodeling surrounding the implant, risk of implant associated fracture, joint infection, and radiation impacts. Given the limited spaceflight data in individuals with joint arthroplasty, careful assessment will be needed when certifying crewmembers.

Learning Objectives

1. The audience will learn the differences between NASA, FAA, and DOD requirements for certification of crewmembers with hip arthroplasty.
2. The audience will understand the need for further research in joint arthroplasty in long-duration and exploration missions to fill knowledge gaps and inform future policy.

[424] WITHDRAWN

Wednesday, 06/04/2025 ***2:00 PM***
Grand Hall East Corridor - Posters Only

[S-52] POSTER : NO, YOU CAN'T FLY! YES, YOU CAN!

Chair: Amos Meyers
Co-Chair: Maybritt Kuypers

[285] DEVELOPMENT OF PREDICTIVE MODELS FOR EARLY DETECTION OF REASONS OF UNSUITABILITY FOR MILITARY AIRCREW MEMBERS BY MEANS OF MACHINE LEARNING

Claus Otto[1], Marcus Stiemer[2], Stefan Sammito[1]
[1]*German Air Force Centre of Aerospace Medicine, Cologne, Germany;*
[2]*Helmut Schmidt University / University of the Federal Armed Forces Hamburg, Hamburg, Germany*

(Original Research)

INTRODUCTION: Military aviation requires high health and fitness standards for all aircrew members because of the significant risks associated with minor health issues. To predict potential health risks among military aircrew, advanced machine learning models were created. The study used detailed data collected at the German Air Force Centre of Aerospace Medicine over 17 years, focusing on clinical, demographic, and biochemical parameters crucial for assessing cardiovascular risks. **METHODS:** Three machine learning methods – Random Forest, Long Short-Term Memory (LSTM), and Convolutional Neural Networks (CNN) – were employed to predict health risks based on clinical, demographic, and biochemical data. Corresponding models were trained using preprocessed data. Preprocessing addressed missing data and class imbalances using SMOTE and custom loss functions. Performance evaluation included accuracy, precision (specificity), recall (sensitivity), and F1-score. **RESULTS:** The Random Forest model demonstrated strong predictive capabilities for significant health outcomes, although it struggled with predicting membership to minority classes even after resampling. It achieved a precision of 0.80 and a recall of 0.97 for the majority class while fell back to a precision of 0.08 and a recall of 0.40 for the minority class. The LSTM and CNN models displayed moderate success but faced challenges with overfitting and instability during training. The best model achieved an overall accuracy of 0.62, with a precision of 0.21 and a recall of 0.58 for the minority class. **DISCUSSION:** The results highlight the importance of high data quality and completeness as well as balance over the considered classes to improve model accuracy and reduce bias. While all models showed promising values for the majority class, only the LSTM showed recall values beyond mere guessing for the minority class. The LSTM and CNN models require further refinement to enhance robustness and generalization across diverse datasets. Despite limitations, all models showed potential to enhance early health risk detection for military aircrew. The results of this study provide concrete hints how data acquisition processes can be enhanced in order to obtain robust models with higher predictive capability.

Learning Objectives
1. Demonstrate the application of machine learning in forecasting health risks within military aviation.
2. Assess the effectiveness of Random Forest, LSTM, and CNN models in predicting early health risks using real-world medical data.

[286] CLEARED FOR TAKEOFF: A 30-YEAR ANALYSIS OF CENTRAL SEROUS RETINOPATHY IN USAF AVIATORS

Lyndsey Vu, Jon Ellis, Mike Parsons
USAFSAM, Wright-Patterson AFB, OH, United States

(Original Research)

INTRODUCTION: Central serous chorioretinopathy (CSR) is an ocular disease that causes visual impairment, often temporary, and usually in one eye. CSR is characterized by the development of fluid within the inner layers of the retina, which results in a hyperopic refractive shift and visual distortion. Many cases of CSR resolve spontaneously, although reoccurrence has been reported in up to 50% of cases. The Air Force Aeromedical Consultation Service CSR management group database currently reports 218 aircrew members with CSR. The goal of this study is to obtain a better understanding of how CSR impacts the flying mission. **METHODS:** This is a retrospective study using subjects enrolled in the CSR management group. Parameters include gender, age, crew position, medications, affected eye, visual outcomes, flying status, treatment (if any), and reoccurrence episodes. No contact between investigators and subject occurred. **RESULTS:** Two hundred eighteen subjects were enrolled. Sixteen subjects were excluded due to insufficient documentation or outdated medical history. An additional 50 subjects were excluded due to incomplete data or were lost to follow-up. The study population consisted of individuals aged 36-40, with most participants being pilots. At the peak of the CSR event, 43% of the subjects had a best corrected visual acuity (BCVA) of 20/20, 19% had a BCVA of 20/30, and 18% had a BCVA of 20/25. After recovery, 92% of the subjects had a BCVA of 20/20, 5% had a BCVA of 20/30, and 2% had a BCVA of 20/25. Most cases (76.6%) resolved spontaneously without treatment, and 60% of the subjects did not experience a recurrence. The mean time from the initial event to waiver approval was 12.9 mo, with a median of 7 mo. **DISCUSSION:** This study provides valuable insights into the management and outcomes of CSR in a cohort of U.S. Air Force aviation personnel. Furthermore, the study demonstrates that a significant proportion of subjects were able to obtain a waiver. Overall, this study contributes to the growing body of knowledge on the management and outcomes of CSR in aviation personnel and highlights the need for further research in this area.

Learning Objectives
1. Understand the prevalence, visual outcomes, and recovery time of central serous chorioretinopathy (CSR) in U.S. Air Force aviation personnel.
2. Identify risk factors and the rate of recurrence of CSR in this specific population.
3. Evaluate the impact of CSR on the flying mission and the ability of affected individuals to obtain a waiver.

[287] WITHDRAWN

[288] IN-FLIGHT AND IN-SIMULATOR SPEECH INTELLIGIBILITY EVALUATION FOR HELICOPTER PILOT AND AIRCRAFT CAPTAIN WITH HEARING LOSS DUE TO OTOSLEROSIS

El Khalifa Sidi Mohamed, Mouna El Ghazy, Houda Echchachoui, Iloughmane Zakaria, Bennani Smires Fehd
Medical Expertise Center of Flight Personnel at The Mohamed V Military Teaching Hospital, Rabat, Morocco

(Education - Case Study)

INTRODUCTION: Those cases report describe a military helicopter pilot and aircraft captain whose have presented hearing loss due to otosclerosis, both of them off standards and they have been evaluated in-flight and in simulator. **BACKGROUND:** Correct hearing function is required to fitness in military pilot and aircraft crew members. Hearing loss in aircrew members is potential safety risk, and the detrimental effects of hearing loss on individual and unit performance can be significant. However, many pilots may be affected by hearing loss, as general population. Otosclerosis is a common cause of hearing loss. Aircrew member with otosclerosis, his flight fitness may be questionable. **CASE PRESENTATION:** The case one: a 46-yr old military helicopter pilot (Puma and Super Puma). He was an experienced pilot, with 3000 total flying hours. He has presented during his periodic visit a hearing-loss at the right ear in tonal audiometry which exceeds standards. The scanner of petrous bones objectified bilateral otosclerosis stage II. Vocal audiometry in noise (intelligibility threshold at 60 db) was also outside satandards. His file was presented for waiver, view his experience, an in-flight intelligiblity evaluation was conducted in helicopter and encompassed a variety of flight conditions. Recorded and live voice speech materials were presented to the pilote through the internal communication system. In flight test has shown a good understanding by the pilot of the words and phrases repeated during the in-flight test speech. A fitness with waiver was accorded to pilot with restriction. Case two: a 57-yr old aircraft captain at Royal Air Morocco. He is an experienced pilot also, with 18651 total flying hours. He has presented a bilateral hearing-loss in tonal audiometry during periodic visit exceeds standards of civil aviation authority of Morocco. Vocal audiometry has shown deafness in both silence and noise. The diagnosis of otosclerosis has beesn made. An in-simulator intelligibility test was conducted showed good understanding and good coordination with the crew members. Fitness with waiver was accorded. **DISCUSSION:** Those cases highlight the place of intellibility test in flight or in simulator for pilots with hearing loss, especially in pilot with otosclerosis and have high experience in duty. However the pilots with hearing-loss with good experience may get waiver to keep there places if they pass the test in flight with success.

Learning Objectives
1. To report our experience with two cases of hearing loss in aircrew pilots whom have otosclerosis.
2. To show the utility to do intelligibility evaluation in flight or in simulator for experienced pilots whose presented a hearing loss out side the standards.

[289] FUNCTIONAL AND MORPHOLOGICAL EFFECTS OF OCCUPATIONAL HYPOBARIA ON THE BRAIN – OUTCOME OF EUROPEAN MULTINATIONAL NATO-PARTNERS

Sven-Erik Sönksen[1], Frank Weber[2], Andre Gens[2], Carla Ledderhos[2], Sven Kühn[3]
[1]*German Federal Armed Forces Hospital Hamburg, Hamburg, Germany;*
[2]*German Air Force Center of Aerospace Medicine, Cologne, Germany;*
[3]*German Federal Armed Forces Hospital Koblenz, Koblenz, Germany*

(Original Research)

INTRODUCTION: Repetitive non-hypoxic hypobaria is a common occurrence in the aerospace environment and has been proven to be linked to subcortical white matter hyperintensities (WMH) on fluid-attenuated inversion recovery (FLAIR) magnetic resonance imaging (MRI) in the brain. This prompts the question of whether such exposures could have a deleterious impact on brain structure and function. **METHODS:** In a single-center study, 19 altitude chamber personnel (ACP) from four European countries in NATO with repetitive non-hypoxic hypobaric exposure were compared to a control group of 28 healthy individuals. MRI was performed to assess the occurrence, volume, and distribution of white matter hyperintensities (WMH), as well as white matter parcellation, cortical volume, and thickness. Furthermore, diffusion-weighted imaging (DWI) acquisitions were subjected to analysis. Additionally, neurophysiological tests, including

visual and auditory evoked potential (VEP/AEP), and ocular coherence tomography (OCT), and psychometric tests (Vienna test system, WinSCAT), were administered. **RESULTS:** Both groups demonstrated the presence of white matter hyperintensities (WMH), albeit to a lesser extent than has been reported in the general population. The number and volume of WMH increased with age and were positively but insignificant influenced by the cumulative chamber exposure time of the ACP. No differences in WMH characteristics (number, volume, and distribution) or in mean diffusivity and fractional anisotropy in DWI were observed between groups. However, there were notable reductions in lateral orbitofrontal cortical volume and thickness, as well as a decrease in volume of the pars opercularis of both hemispheres in the study group. Neurophysiological and -psychological findings revealed no differences between the two groups. **CONCLUSION:** Our study found no striking evidence to suggest that occupational non-hypoxic hypobaric exposure in ACP, as currently employed by participating NATO Air Forces, can lead to brain damage.

Learning Objectives

1. It is essential to comprehend the cerebral responses that indicate a neurotrophic (repair) response after hypobaria, which suggests recuperation from glial (white matter) injury. This is a consequence of the NATO HFM RTG-274.
2. It is imperative to comprehend the necessity for further investigation into the neuropathophysiology of brain injury resulting from repeated hypobaric exposure.

[290] FATAL PULMONARY BAROTRAUMA FROM A COMMERCIAL FLIGHT

Graham Stevens, Alicia Tucker
Royal Hobart Hospital, Hobart, Australia

(Education - Case Study)

INTRODUCTION: This case report describes a case of fatal pulmonary barotrauma in a commercial airline passenger. **BACKGROUND:** There is a paucity of cases of infectious causes of pulmonary barotrauma in the literature unless the patient is mechanically ventilated. Here we report a presumed pulmonary barotrauma caused by gas expanding as barometric pressure reduced during a commercial flight, with tragic consequences. Further information gleaned months later from the next of kin sheds more light on the cause. **CASE REPORT:** A 71-year-old female lost consciousness on a commercial flight from Melbourne, Australia to Hobart,Tasmania, Australia. Subsequent hospital investigations reveal a large cavitating lesion in the left lung and free gas in the brain, suggestive of pulmonary barotrauma and cerebral arterial gas embolism (CAGE). Progression of the hypoxic brain injury caused death. Subsequent details emerged months later of a pre-existing large pulmonary cyst. **DISCUSSION:** The likely cause of death was a combination of infection in a pre-existing pulmonary cyst which was then ruptured by either equalisation, cough suppression, change in barometric pressure or a combination of all three, causing cerebral arterial gas emboli (CAGE). This case highlights the vulnerability of individuals with either unknown or undisclosed medical conditions which may be affected by the flight environment resulting in significant morbidity or more over, mortality.

Learning Objectives

1. The audience will understand the risk and origin of pulmonary barotrauma in commercial air travel.
2. The audience will learn about the challenges of differentiating a diagnosis and managing passengers who collapse during commercial air travel.

[291] PLACE OF CARDIOVASCULAR MAGNETIC RESONANCE (CMR) IN CARDIOVASCULAR PATHOLOGY AND ITS INTEREST IN AERONAUTICAL EXPERTISE.

Bennani Smires Fehd, Houda Echchachoui
Aeromedical Expertise Center of the Military Hospital of Rabat, Rabat, Morocco

(Education - Tutorial / Review)

INTRODUCTION: In cardiovascular pathology, cardiovascular magnetic resonance has emerged over time as a test with single potential, it finds all its interest in aeronautical medicine because cardiology expertise plays an important role in aeronautical fitness visits, the priority of the aviation medicine expert is to maintain the highest level of air safety, by limiting the risk of sudden or subtle incapacitation in flight due to cardiac pathologies. **TOPIC:** This non-invasive, non-irradiating, with few contraindications, and economically reasoned examination, allows a static and dynamic analysis of the cardiovascular system, providing complementary data to cardiac ultrasonography. Thanks to a good spatial and temporal resolution, a three-dimensional approach, and an excellent contrast between circulating blood and the myocardium, cardiovascular magnetic resonance is a reference method for imaging congenital heart disease, heart tumors, large vessels and pericardium, its major advantage is to be able to associate the study of the myocardial viability, to the analysis of the myocardial perfusion, and to a functional approach of the cardiac muscle by the study of the right and left ventricular functions. **APPLICATION:** Cardiovascular magnetic resonance finds all its interest in aeronautical expertise of flight crew, in addition to first-line examinations, including electrocardiogram and echocardiography, which do not always allow to decide on the absence of underlying cardiac disease, which would have a consequent impact on the decision of aptitude either in admission or revisional visit,the first interest of Cardiovascular magnetic resonance in aeronautics, resides in case of suspicion of Arhytmogenic Right Ventricular Dysplasia, and this in front of a bundle of clinical arguments or some electrophysiological arguments in particular: complex ventricular extrasystoles from the right ventricle, presence of epsilon wave. This examination may be used in aircrew, for diagnostic purposes, if there is suspicion of coronary insufficiency, with a contentious, sub maximal or not feasible stress test, and may be used also for the evaluation of a coronary known flight crew, for example remote from a revascularization procedure as part of its professional rehabilitation.cFor flight crew members suffering from sarcoidosis, regular Cardiovascular Magnetic Resonance monitoring is essential, because cardiac involvement in sarcoidosis is symptomatic in only 5% of cases.

Learning Objectives

1. The participant will be able to undersatnd that Cardiovascular magnetic resonance have a significant impact on the aeronautics aptitude decisions whether in admission visit or periodic, in addition, it presents a real added value in doubtful cases, compared to echocardiography, with a favorable cost / profitability ratio.
2. The first interest of Cardiovascular magnetic resonance in aeronautics, resides in case of suspicion of Arhytmogenic Right Ventricular Dysplasia ,namely, in front of family history of sudden death or one of the following electrophysiological arguments in particular: complex ventricular extrasystoles from the right ventricle, presence of epsilon wave.
3. The audience will learn about the great help of Cardiovascular magnetic resonance, in the context of the cardiomyopathie screening especially hypertrophic, in case of significant repolarization disorders and limits left ventricular hypertrophy without further explanation.

[292] MANAGING MUSCULOSKELETAL PAIN IN HIGH-PERFORMANCE PILOTS: REHABILITATION AND EXERCISE INTERVENTIONS

Di Huang[1], Kai Sheng Khor[1], Justin Nast[2]
[1]*Johns Hopkins University, Baltimore, MD, United States;* [2]*NorthBay Medical Center, Fairfield, CA, United States*

(Education - Program / Process Review)

BACKGROUND: Musculoskeletal pain, particularly in the neck and lower back, is highly prevalent among fighter jet and helicopter pilots due to prolonged sitting, vibration exposure, and high G-forces. These issues negatively impact pilot performance, safety, and operational readiness, making them critical concerns for Aviation Medicine. The increased

frequency of musculoskeletal disorders in pilots has led to grounding and underscores the need for effective, evidence-based rehabilitation interventions. Addressing these issues is critical, as demands on pilots continue to grow, and gaps in standardized rehabilitation protocols remain unfilled. **OVERVIEW:** This scoping review synthesizes current literatures and recent studies on rehabilitation interventions designed to mitigate musculoskeletal pain in pilots. Key studies focus on exercise regimens, stretching protocols, and physical therapy programs that target pain reduction and improve muscular endurance in pilots suffering from neck and back pain. By reviewing a broad array of evidence, including studies on military helicopter and fighter-jet pilots, this review identifies both current practices and gaps in addressing pilot musculoskeletal health. This work seeks to inform future efforts to standardize rehabilitation protocols tailored to the specific occupational needs of aircrew. **DISCUSSION:** The operational significance of this research lies in its potential to enhance pilot performance, reduce flight-related injuries, and improve operational readiness. Musculoskeletal pain is a widespread issue across all services and international aircrews, and this scoping review provides insights into how targeted rehabilitation can extend a pilot's career and improve mission effectiveness. From a clinical perspective, it emphasizes the need for cross-service collaboration to implement standardized rehabilitation programs that could be applied in military and civilian aviation spheres. This work advances aeromedicine by proposing evidence-based solutions to enhance human performance, ultimately reducing medical downtimes and preventing pilot attrition due to musculoskeletal injuries.

Learning Objectives

1. The audience will be able to understand the effectiveness of rehabilitation interventions in reducing musculoskeletal pain among high-performance pilots.
2. The audience will be able to identify gaps in current rehabilitation protocols and understand the need for cross-service collaboration in addressing pilot musculoskeletal health.

[293] CONSIDERING PRESCRIPTION STIMULANT MEDICATION TO MITIGATE FATIGUE IN NASA PILOTS

Emily Ricks[1], James Locke[2]
[1]*Texas Tech University Health Sciences Center- El Paso, El Paso, TX, United States;* [2]*NASA, Houston, TX, United States*

(Original Research)

INTRODUCTION: Stimulants have been used to combat fatigue in military pilots since World War II. They continue to be in use by United States military pilots today. Previously, this was also a practice employed by NASA flight surgeons for NASA pilots. However, following a friendly fire USAF incident in 2003, the practice of prescribing stimulants for NASA pilots to combat fatigue was halted due to uncertainty about the safety of stimulant usage in pilots. Since then, despite following all other fatigue mitigation policies, NASA pilots flying to and from Kazakhstan for astronaut retrieval have raised concerns about the impact of persistent fatigue on flight operations and safety. Our study aimed to determine what, if any, was the safest and most effective prescription treatment for pilot fatigue. **METHODS:** A thorough literature review was conducted to determine the efficacy, benefits, and deficits of various stimulant medications for use in pilots. In addition, a review of recent flight mission schedules was conducted to determine the cause of persistent fatigue in pilots. **RESULTS:** Current literature suggests that modafinil appears to have a low incidence of adverse reactions, does not appear to have a significant potential for addiction or abuse, has a long-duration half-life, and does not seem to affect recovery sleep. Some studies have even suggested cognitive benefits, including decreased impulsivity and improved fluid reasoning. **DISCUSSION:** Fatigue remains a severe concern in aviation, suspected to be the cause of 21-24% of major civil and military aviation accidents in the last twenty years. Fatigue is greatest during the window of circadian low (WOCL) and is worsened when flying at night. Due to the nature of space capsule landings, mission operations routinely must schedule flights at times that include night-time flights, and flights that occur during NASA pilots' WOCL, even with circadian rhythm shifting methods. The US Air Force and Navy routinely prescribe stimulant medications to aid their pilots in combating fatigue while flying. We propose that in addition to non-medication fatigue mitigation procedures, NASA pilots be prescribed Modafinil during long-haul, nighttime flights, to ensure flight safety. Due to the long onset of action, we propose a single, scheduled dose of Modafinil be built into the flight schedule at least two hours prior to the pilots' WOCL, to ensure maximum blood levels of Modafinil when the risk of fatigue is greatest.

Learning Objectives

1. The audience will learn the main contributing factors to persistent fatigue in NASA pilots.
2. The audience will learn the currently used stimulant medications in US Air Force policy for pilots.
3. The audience will learn the benefits and concerns around prescription of stimulants in pilots.

[294] MICRODOSING: ALTERNATIVE DOSING SCHEDULES FOR MODAFINIL IN AIRCREW

Patrick Edwards
RCAF - USAFSAM RAM, Wright-Patterson AFB, OH, United States

(Original Research)

INTRODUCTION: This literature review investigates the existence of past research into alternative dosing schedules for modafinil in aircrew. Modafinil, a eugeroic drug that mimics amphetamines with respect to wakefulness, has been studied extensively since its creation in the late 1980s. As a non-amphetamine stimulant, modafinil represents an acceptable alternative to caffeine however, only standard dosing schedules (typically 50, 100, or 200 mg, twice or three times per day) are followed. Unfortunately, these dosing paradigms often disrupt subsequent intentional sleep cycles. **METHODS:** The literature search on alternative dosing of modafinil was completed in late April 2024. Databases searched were PubMed, ProQuest, Academic Search Complete, Web of Science, CINAHL Complete, Cochrane Central Register of Controlled Trials/Cochrane Clinical Answers/Cochrane Database of Systematic Reviews/Cochrane Methodology Register PsychInfo, and the Defense Technical Information Center R&E Gateway. No publication date limit was applied. Results were derived from one search string per database and all results were included. (Search terms included modafinil, aviation, aerospace medicine, pilots, aircraft pilots, aviators, military personnel, medicine, military, dosage, low dose, off-label, "fatigue countermeasure," countermeasure, dose-response relationship.) There were 717 total results across all databases and 493 when deduplicated. All articles were reviewed. **RESULTS:** This literature review included 493 articles from 1988 to 2024. Only one article considered doses less than 50 mg (16.7 mg/8 h for 24 h). Notably, others demonstrated that 50 mg once was not sufficient. To date, no research has considered a loading dose followed by smaller maintenance doses. **DISCUSSION:** The importance of wakefulness in aviation cannot be overstated, particularly in combat operations. Moreover, in the context of near-peer adversaries, the notion of fighting a war built around an aviator's ideal sleep schedule is unrealistic. Thus, more research is urgently needed to determine the best dosing schedule for wakefulness aids, including modafinil, to maximize both mission success and subsequent rest while avoiding abuse. This objective might be met with an initial loading dose followed by smaller hourly doses, titrating to mission length. As a result, shortened or aborted missions would not commit the aircrew to lengthy periods of wakefulness.

Learning Objectives

1. Understand the current state of research into modafinil dosing schedules in aircrew.
2. Realize the importance of wakefulness in aviation, particularly in combat operations.
3. Appreciate the need for further research into alternative dosing schedules.

[295] ASSESSMENT OF THE G TOLERANCE PREDICTIVE MODEL BASED ON THE CARDIAC FORCE INDEX

Chung-Yu Lai[1], Wun-Wei Huang[2], Wan-Yi Yang[1], Kwo-Tsao Chiang[3], Kuo-Kuang Jen[4], Nian-Shen Chen[4], Chun-Jui Su[4], Chun-Ting Kuo[4], Fang-Ling Li[5]
[1]*National Defense Medical Center, Taipei City, Taiwan (Greater China);* [2]*Kaohsiung Armed Forces General Hospital Gangshan Branch, Kaohsiung city, Taiwan (Greater China);* [3]*Taipei Veterans General Hospital Fonglin Branch, Hualien County, Taiwan (Greater China);* [4]*National Chung-Shan Institute of Science and Technology, Taoyuan City, Taiwan (Greater China);* [5]*Tri-Service General Hospital Beitou Branch, Taipei City, Taiwan (Greater China)*

(Original Research)

INTRODUCTION: Initially, the cardiac force index (CFI) was developed to monitor the running performance and prevent adverse events among military academic students. The CFI serves as an effective measure for collecting the cardiovascular changes during dynamic physical activities. In previous research, we consistently identified a relationship between the G tolerance and relaxed walking CFI (WCFI). The purpose of this study was to evaluate the effectiveness of the developed model for predicting the G tolerance prior to the centrifuge training. **METHODS:** The predictive model for the relaxed G tolerance (RGT) was published in 2023 and is defined by the following equation: 0.066 × age + 0.043 × (WCFI × 100) – 0.037 × height + 0.015 × systolic blood pressure – 0.010 × HR + 7.724. To validate this model, an additional 53 flight cadets (test group) were enrolled in this study. Before the high G training, the test group wore the Zephyr Biomodule devices (Medtronic, Minneapolis, MN, USA) to collect two minutes of resting and walking data used to generate the CFI values. Blood pressure and heart rate (HR) measurements were also taken prior to the high G training. The RGT was assessed under a gradual onset profile. The SPSS 24.0 software was utilized to evaluate the consistency between the estimated and observed RGT values. **RESULTS:** A total of 213 subjects (model group) were recruited for the establishment of the RGT predictive model. The mean age of both the model and test groups was approximately 25 years, and there were no significant differences in demographic and physiological data between the two groups. The average RGT in the model group was 4.9 ± 0.9 G, with 44.6% of subjects exceeding 5 G. Similarly, the test group had an average RGT of 4.9 ± 0.9 G, with 45.3% exceeding this threshold. The estimated value of the RGT was 4.8 ± 0.3 G, which closely matched the observed value. **DISCUSSION:** In this small study, we began by evaluating the CFI-related model for estimating the G tolerance. The actual and predictive averages of the RGT demonstrated a strong consistency between the two groups. In the next work, improving the accuracy of interval estimation and establishing the cut-off values for determining the high or low G tolerance will enhance the practical application of this model in the high G training.

Learning Objectives

1. Introduce another innovative cardiovascular parameter to predict the G tolerance.
2. Understand the considerations and mechanisms of the novel cardiac data in relation to G tolerance.

Wednesday, 06/04/2025 ***3:30 PM***
Lennox

[S-71] PANEL: AEROSPACE MEDICINE ADVANCES IN IBEROAMERICA

Chair: Rocio Del Pilar Garzon Ayala
Co-Chair: Beatriz Puente Espada

Panel Overview: *This panel brings together prominent researchers from several Latin American countries, continuing the tradition of presenting advances in the field in their native language. The session covers topics in human performance and applied aerospace medicine, highlighting the importance of regional collaboration to address common problems and improve practices in this discipline. The active participation reflects the growing interest and commitment towards the development of aerospace medicine in the region. This panel is consolidated as a fundamental space for the advancement and dissemination of knowledge in the aerospace field.*

[390] COGNITIVE IMPAIRMENTS DISCRIBED IN NORMOBARIC HIGH ALTITUDE CHAMBER IN LATINOAMERICAN CIVIL AVIATIONA AND THE FIRST IN ANTIOQUIA (COLOMBIA)

David Puerta-Malca[1], Diana Gutierrez[2], Orlando Gracias[3], Juan Camacho[2], Tatiana De la Hoz[2], Adriana Zuluaga[2]
[1]*MAISO, Bogotá, Colombia;* [2]*MAISO, Medellin, Colombia;* [3]*GRANCOLOMBIANA, Bogotá, Colombia*

(Original Research)

INTRODUCTION: Hypoxia, defined as an oxygen deficiency in the blood, tissues, and cells, compromises physiological functions and is particularly concerning in aviation. Factors contributing to hypoxia include issues with oxygen transport, usage, or binding, often exacerbated at higher altitudes where atmospheric pressure decreases. Aeronautical personnel are at risk, especially as hypoxia can cause cognitive impairments and sudden incapacitation. This report aims to explore cognitive changes after exposure to hypoxia, assessed in the first normobaric hypoxia chamber in Antioquia, Colombia. **METHODS:** In October 2021, during a hypoxia training session in Medellín, Colombia, a female cabin crew member volunteered to undergo neuropsychological testing before and after exposure to hypoxia. The test, was administered two hours prior and immediately following the session, which simulated an oxygen pressure equivalent to an altitude of 8,000 ft, with exposure up to 33,000 ft. **RESULTS:** The participant reached a maximum altitude of 33,000 ft with a minimum oxygen saturation of 83%. Despite no self-reported symptoms, cyanosis was observed by the training team. Post-exposure neuropsychological tests showed a significant decrease in estimation scores, indicating reduced capacities for abstract reasoning, trajectory anticipation, and energy management of the aircraft. **DISCUSSION:** This case highlights the potential cognitive impacts of hypoxia on flight crew members, even in the absence of reported symptoms. The observed cognitive decline post-exposure underscores the importance of hypoxia awareness and training to prepare aeronautical personnel for high-altitude conditions.

Learning Objectives

1. Identify the physiological and cognitive effects of hypoxia.
2. Evaluate the impact of hypoxia on cognitive functions in aviation personnel.
3. Develop strategies for hypoxia awareness and training in aviation.

[391] CARDIOVASCULAR RISK FACTORS EVALUATION IN AGRICULTURAL PILOTS OF COLOMBIA WITH CURRENT MEDICAL CERTIFICATION, 2024

Maria Angelita Salamanca[1], Luis Arteaga[2]
[1]*Civil Aviation Authority of Colombia, Bogotá, Colombia;* [2]*Aeronautica Civil de Colombia, Bogotá, Colombia*

(Original Research)

INTRODUCTION: Cardiovascular diseases, mainly coronary disease, are a leading cause of medical disqualification and sudden incapacitation in pilots, linked to cardiovascular risk factors (1, 2). The prevalence of these factors among agricultural aviation pilots, who have a high accident rate in Colombia, has not been characterized (3). Previously, 10% of first-class pilots were found to be at medium/high risk according to the Framingham

scale, with variables such as smoking, age over 45 years, blood pressure, body mass index, and cholesterol levels (4). **METHODS:** This cross-sectional descriptive study used data from medical records completed during the aeromedical certification process. Of 139 records of agricultural aviation pilots with current certification in October 2024, 2 were excluded for incomplete information. Data on sociodemographic, anthropometric, and cardiovascular risk factors were analyzed using the Epi Info statistical package. **RESULTS:** All pilots were male, with a median age of 37 years (IQR 31-54). According to the AHA-ASCVD score, 12.4% had borderline cardiovascular risk, 7.3% intermediate risk, and 0.7% high risk. 80% had low cardiovascular risk. Prevalences of risk factors included: 58% older than 40 years, 5% smokers, 6% with a history of high blood pressure, 73% with high blood pressure as a risk factor, 32% with total cholesterol ≥200 mg/dl, 22% with HDL cholesterol <40 mg/dl, 31% with triglycerides ≥150 mg/dl, and 2% with diabetes mellitus. Additionally, 16% were obese. Pilots with higher cardiovascular risk had significantly higher median age, systolic pressure, total cholesterol, triglycerides, and blood sugar compared to those with low risk. **DISCUSSION:** 80% of agricultural aviation pilots have low cardiovascular risk. Given their acrobatic, solo flight operations and accident rates, managing operational risk and addressing modifiable cardiovascular risk factors in the remaining 20% is crucial. Optimizing the implementation of protocols by the Colombian civil aviation authority for managing cardiovascular risk factors in medical certificate holders is recommended.

Learning Objectives

1. evaluate the cardiovascular risk factors in agricultural aviation pilots of Colombia using de AHA/ASCVD.
2. evaluate cardiovascular risk factors in the group of agricultural pilots with high cardiovascular risk.

[392] HOMOZYGOUS FAMILY HYPERCHOLESTEROLEMIA AS AN ORPHAN DISEASE IN COMMERCIAL PILOTS IN LATIN AMERICA

Jean Carlos Duenes[1], Jorge Serrano[2], Priscila Pratto[2], Carlos Arciniegas[3], Guillermo Lara[3]

[1]*Venezuelan Civil Aviation Institute, Kissimmee, FL, United States;* [2]*Venezuelan Civil Aviation Institute, Caracas, Venezuela;* [3]*CEMAE, Santiago de Chile, Chile*

(Original Research)

INTRODUCTION: Orphan diseases are also called rare diseases that affect a small number of people compared to the general population. Rare diseases are life-threatening, or long-term debilitating, diseases of low prevalence and high level of complexity. Most of them are genetic diseases; others are rare cancers, autoimmune, or toxic and infectious diseases. These diseases experience difficulty in obtaining precise diagnoses, as well as obtaining an exact diagnosis since information is generally scarce. At the cardiovascular level, Homozygous Familial Hypercholesterolemia is a rare and potentially fatal disease that is characterized by plasma levels of total cholesterol > 500 mg/dl, extensive xanthomas and cardiovascular disease. **OBJECTIVES:** • Know the number of commercial pilots without LDL and HDL • Register number Pilots who receive Statins and PCSK9 Inhibitors • Know how many pilots failed treatment with PCSK9 inhibitors • Confirm diagnosis of Homozygous Familial Hypercholesterolemia through Genetic Testing **METHODS:** It is a retrospective descriptive study, carried out between June 2020 and June 2023 with the Aeronautical population only Commercial Pilots: Chile, Colombia, United States, Mexico, Peru and Venezuela, through analyzing the results of Total Cholesterol, LDL, HDL. In those pilots without goals, Molecular studies were carried out for LDLR, APOB, PCSK9, APOE LDLRAP1 genes. **CONCLUSION:** Our research confirmed the high CLDL level in the absence and presence of coronary heart disease, even with low risk factors, 70% of the pilots began treatment with high-intensity statins, 34% of the population received reinforced treatment with PCSK9 Inhibitors for three months with favorable results in 97% of pilots. The favorable results were 97% of the sample of 34% of the pilots who received booster treatment. However, 0.33% of the population has Homozygous Familial Hypercholesterolemia demonstrated by these Genetic tests, this would be the first publication related to Commercial Pilots in the world. Due to its high level of complexity and prognosis of developing serious coronary disease, it would be a dilemma to certify our pilots or approve them with certain restrictions.

Learning Objectives

1. Understand the implications of Homozygous Familial Hypercholesterolemia as a rare disease in commercial pilots, including its diagnosis, treatment options, and prevalence in the aeronautical population of Latin America.
2. Analyze the effectiveness of high-intensity statins and PCSK9 inhibitors in managing cholesterol levels in commercial pilots, and evaluate the impact of genetic testing on confirming diagnoses and informing treatment decisions.

[393] COMPREHENSIVE CARE PROGRAM FOR AERONAUTICAL PERSONNEL

Johana Giraldo-Alzate, Mateo González-Agudelo, Diego M. García

National University of Colombia., Bogotá, Colombia

(Education - Program / Process Review)

BACKGROUND: Mental health conditions are critical in the aviation industry, as they can impair cognitive performance, potentially leading to incidents or accidents. Studies show that the longest medical leaves are often linked to psychiatric conditions. Reports from the Colombian CAA indicate that mental health cases are the second leading cause of medical sick leave and the primary cause for denial of aeromedical certification (AMC), accounting for 18% of all cases. Research further suggests that pilots frequently avoid disclosing mental health concerns due to stigma and fear of AMC loss, highlighting a critical need for trusted, supportive programs. **OVERVIEW:** Recognizing the gap in mental health support from authorities and airlines, pilot associations established a support network to provide comprehensive care for all crew members. This network creates a safe space where individuals can address mental health issues in an environment built on confidentiality, transparency, trust, and mutual respect. Although funded by the airline to support all personnel, the program operates with full independence and confidentiality. It focuses on substance use, and sleep disorders, while also providing support for mental health emergencies. Remote guidance is available through an aerospace medicine specialist, offering access to psychiatry, psychology, couples therapy, and other services to ensure comprehensive care as needed. In the first 8 months of the program, follow-up rates included 63% for mental health, 13% for substance use, 10% for sleep disorders, and 13% for other issues. Of these, 57% are actively engaged in flight operations, and 13% have completed their follow-up. Additionally, emergency mental health support has been offered in two cases. A Peer Pilot Support Program is also part of this initiative. **DISCUSSION:** This innovative program provides a valuable alternative to traditional wellness initiatives by authorities and airlines, offering a new model for mental health support networks in Latin America. It fosters a culture of biopsychosocial well-being, positively influencing crew members and their social and family lives. The program has a cost-effective impact by reducing medical leaves, AMC suspensions, and preventing mental health disorders. This model enhances crew members' trust, promotes careseeking behaviors, and contributes to both human performance and operational safety.

Learning Objectives

1. Understand the structure and objectives of a comprehensive care program designed to support the mental health and well-being of aeronautical personnel in Colombia and Latin America.
2. Identify the benefits of implementing an independent mental health support program for aviation personnel in reducing medical leaves and promoting operational safety.

[394] SYNCOPE AND AEROMEDICAL FITNESS: OUTCOMES FROM A 23-CASES IN COLOMBIAN AVIATION PERSONNEL

Alexandra Mejia Delgado
Civil Aviation Authority of Colombia, Bogotá, Colombia

(Original Research)

INTRODUCTION: Syncope is a common condition in the general population, with an occurrence rate of over 3% in the general population, affects both the general and working-age populations, where the relapse risk in patients with vasovagal syncope is about 4% per year. yet it is a disqualifying condition for most aerospace personnel due to the risk of incapacitation in inflight. Recent changes in aeromedical policy have opened pathways for certification in cases of single, well-documented, and controlled syncope episodes. Restricted certification may be allowed after 3-6 months, with full certification only after five years without recurrence. Most favorable aeromedical dispositions occur in cases with non-recurrent mechanisms. **METHODS:** occurrence of syncope reported to the Civil Aviation Authority was 23 medical records were reviewed. The aeromedical decision process for certificate holders with syncopal episodes is described. **RESULTS:** The Colombian Civil Aviation Authority (ColCAA) evaluated 23 syncope cases in aviation personnel reported since 2018-2024 (n=23), using both medical evidence on syncope and international certification protocols. The median age of affected personnel was 32, including 7 cabin crew, 7 captains, 5 first officers, and 4 flight school students. Definitive disqualification occurred in five cases due to cardiogenic syncope (1 case) and recurrence or student status (4 cases). The remaining 18 cases (78%) were cleared for resuming flight activities. Vasovagal syncope, with identifiable and avoidable triggers, was diagnosed in 19 cases. The average wait time for clearance was 5.18 months. **DISCUSSION:** The syncope recurrence risk varies by case, with individual factors like episode frequency and underlying conditions affecting outcomes. ColCAA conducted case assessments following ICAO standards, deeming most personnel fit to resume duties under periodic follow-up. This case series emphasizes the need for individualized assessments in aviation medicine, showing that personnel with benign, well-managed syncope may safely return to duty, enhancing policy refinement for syncope certification.

Learning Objectives

1. To understand the importance of individualized assessment in cases syncope.
2. To understand the approach to risk stratification in the aeromedical decision process.

[395] COLOMBIAN COGNITIVE SCALES: A NEW HORIZON IN OPERATIONAL SAFETY

Gloria Quiñones
Civil Aviation Authority of Colombia, Bogotá, Colombia

(Original Research)

INTRODUCTION: The Civil Aeronautics of Colombia has launched an innovative human factors intervention program through its Aeronautical Medicine program. This initiative assesses personality, stress perception, and higher cognitive processes in air traffic controllers (ATCs) to enhance operational safety and well-being (1, 2, 3,4). The program is tailored to Colombian cultural factors, resulting in specific scales to improve occupational competencies. (5) **METHODS:** The neuropsychological battery was piloted in Colombia to assess critical aviation skills such as attention, visual tracking, memory, and logical reasoning. (2) The Civil Aeronautical Authority of Colombia selected and acquired the rights to use a computerized neuropsychological assessment. The cross-sectional study based on a convenience sample with sequential selection initially involved 157 air traffic controllers (ATCs), but only data from 142 participants were usable. This included 42 women and 100 men, aged 19 to 66 (mean 41.51 +/- 9.17), over a period of three years. The evaluation was tailored to meet job demands and organizational challenges, with a focus on competencies and teamwork. Additionally, personality tests (TEA-TPT) and the Work Stress Questionnaire (JSS) were administered. **RESULTS:** The computerized neuropsychological assessment effectively assessed the cognitive abilities of ATCs, providing key data for decision-making and development plans. The data highlighted areas for improvement and strengths in occupational competencies, reducing operational risk due to human factors. The creation of Colombian-specific scales allowed for more accurate evaluations of aeromedically certified personnel. **DISCUSSION:** Implementing the computerized neuropsychological assessment in Colombia advances human factors evaluation in aviation. The tool's ability to detect subtle cognitive changes is crucial for operational safety. (2, 3) Colombian-specific scales enable more accurate evaluations, enhancing aviation safety, promoting ATC well-being, and supporting decision-making. This program strengthens occupational competencies and minimizes operational risk due to human factors, establishing a database for psychophysical fitness decisions.

Learning Objectives

1. Evaluate the performance of aeromedically certified personnel in comparison with the results of exploration tests to establish intervention programs that strengthen the weaknesses found.
2. To develop and use specific scales for Colombia in the exploration of the cognitive domains of aeromedically certified personnel.
3. Create a baseline for the neuropsychological evaluation of personnel, allowing continuous monitoring of their operational performance as appropriate.

Wednesday, 06/04/2025 ***4:00 PM***
Centennial Ballroom I & II

[S-53] PANEL: THE 15TH ANNUAL RAM BOWL

Chair: Allen Parmet
Co-Chair: Rebecca Blue

Panel Overview: *The 15th Annual RAM Bowl features participants from the Air Force, Navy, Army, Mayo Clinic, UTMB and international representatives competing for the Louis H. Bauer Trophy. Aerospace Medicine Residents are required to demonstrate multiple competencies to satisfy the requirements of ACGME and ABPM and serve as specialists in the field. Multiple tools are available for developing appropriate didactic knowledge in aerospace medicine, public health, epidemiology, biostatistics and health care management. Residents participate in a college bowl format that test aerospace medicine competencies including the flight environment (atmosphere, radiation, vibration, acceleration, and microgravity), clinical aerospace medicine, aircraft and space vehicle systems/operations, accident investigation, historical events, aerospace physiology, human factors, ergonomics, medical standards, Federal Aviation Administration regulations, passenger transport, restraint and escape, cockpit resource management and aeromedical transportation. Questions are divided into toss-up and bonus questions. Multiple rounds of competition will lead to the selection of an individual victor and awarding of the Louis H. Bauer Trophy to the top team, sponsored by the American Society of Aerospace Medicine Specialists.*

[296] THE 15TH ANNUAL RAM BOWL

Allen Parmet[1], Rebecca Blue[2], Rahul Suresh[3], Alex Garbino[4], Walter Dalitsch III[5], Mary Cimrmancic[6], Joanna Helms[7], Roy Hoffman[8], Jan Stepanek[9]
[1]*University of Southern CA, Kansas City, MO, United States;* [2]*University of Texas Medical Branch, Scottsdale, AZ, United States;* [3]*NASA JSC, Houston, TX, United States;* [4]*Geocontrol, Houston, TX, United States;* [5]*Dalitsch Aviation, Moose Factory and Sled Racing Corporation, Moosepoo, AK, United States;* [6]*Marquette University, Milwaukee, WI, United States;* [7]*Texas Air National Guard, Houston, TX, United States;* [8]*U.S. Navy, Pensacola, FL, United States;* [9]*Mayo Clinic, Scottsdale, AZ, United States*

(Education - Tutorial / Review)

The 15th Annual RAM Bowl features participants from the Air Force, Navy, Army, Mayo Clinic, UTMB and international representatives competing for the Louis H. Bauer Trophy. Aerospace Medicine Residents are required to demonstrate multiple competencies to satisfy the requirements of ACGME and ABPM and serve as specialists in the field. Multiple tools are available for developing appropriate didactic knowledge in aerospace medicine, public health, epidemiology, biostatistics and health care management. Residents participate in a college bowl format that test aerospace medicine competencies including the flight environment (atmosphere, radiation, vibration, acceleration, and microgravity), clinical aerospace medicine, aircraft and space vehicle systems/operations, accident investigation, historical events, aerospace physiology, human factors, ergonomics, medical standards, Federal Aviation Administration regulations, passenger transport, restraint and escape, cockpit resource management and aeromedical transportation. Questions are divided into toss-up and bonus questions. Multiple rounds of competition will lead to the selection of an individual victor and awarding of the Louis H. Bauer Trophy to the top team, sponsored by the American Society of Aerospace Medicine Specialists.

Learning Objectives

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

THURSDAY, JUNE 05, 2025

Thursday, 06/05/2025 ***10:00 AM***
Centennial Ballroom I

[S-54] PANEL: THE FAST AND THE CURIOUS: CHARTING NEW FRONTIERS IN AVIATION MEDICINE

Chair: Sandra Salzman
Co-Chair: Zachary Masters

Panel Overview: *The Fast and the Curious: Charting New Frontiers in Aviation Medicine: Join the International Association of Military Flight Surgeon Pilots discussing forward leaning research on optimizing human performance in aviation as well as case studies of their application. As mechanical airframes push the boundaries of speed, endurance, and agility, it's crucial to understand how the human body and mind can keep pace with the evolving mission set. With an eye on both ops and medicine, IAMFSP will explore cutting-edge strategies in aviation medicine, from enhancing cognitive function to improving physical resilience, ensuring that the operators of tomorrow's aircraft can handle the intense demands of high-speed missions. Don't miss this chance to hear from those uniquely qualified to merge flight expertise with medical innovation!*

[297] MILITARY AVIATOR PEER SUPPORT PROGRAM: FOSTERING A CULTURE OF MUTUAL SUPPORT – WINGMEN, ALWAYS

Sandra Salzman[1], Darrell Zaugg[1], Aedrian Bekker[2], Gerhard Fahnenbruck[3], Keith Frank[4], William Hoffman[5]
[1]*U.S. Air Force, Ramstein AB, Germany;* [2]*Centre for Aviation Psychology, London, United Kingdom;* [3]*Stiftung Mayday, Frankfurt am Main, Germany;* [4]*U.S. Air Force Aeromedical Research Lab, Red Feather Lakes, CA, United States;* [5]*U.S. Air Force, Fort Sam Houston, TX, United States*

(Education - Program / Process Review)

BACKGROUND: Military aviator culture has historically endorsed a persona of an always ready, unwavering, and healthy. Pilots suffering from stress or mental health conditions may worry about seeking medical care due to potential professional or social repercussions, including losing their medical certificate and facing expensive evaluations. A 2019 study reported that 78.6% of pilots felt worried about seeking medical care, and 60.2% delayed care due to concerns about their pilot status. 2023 Stiftung Mayday data finds that 92.5% of stressful events can be completely resolved through a timely discussion with an empathetic and understanding peer. The Andersen Behavioral Model of Health Services Use suggests that pilots' attitudes, social norms, and perceived control may contribute to their reluctance to seek care. Most often, military aviators discuss problems with trusted peers, rather than trained professionals, to prevent any impact of an issue on their ability to fly. **OVERVIEW:** This presentation discusses establishment and utilization of a Military Aviator Peer Support Programs within the USAF, based on those that exist in the United States and European Union civilian aviation. This will include a discussion of the volunteer selection, training, and utilization within the 86th Operations Group at Ramstein Air Base. It will highlight some of the metrics monitored to identify success and challenges and trends in perception, trust, resource utilization and impact on the mission. Finally, we will look at potential short- and long-term considerations if MAPS programs were implemented across the military flying force and how that may build a stronger wingman culture within the USAF. **DISCUSSION:** The operational significance of aircrew culture on mission readiness and aviation safety is one of perception. By training wingmen who are already the social center of their aviation peers to be empathetic listeners armed with knowledge of the many resources available to handle problems of daily life, we may begin to see increased peer connectedness, resilience, and decreased stress index. Applying lessons learned from civilian culture and sharing knowledge with the aviators who already advise their peers, may provide a way for aviators to help each other, and triage those who need professional assistance.

Learning Objectives

1. The participant should be able to describe cultural challenges aviators meet when requesting assistance for non-flying issues.
2. Audience members should understand the key differences between peer support programs and other types of mental health medical care.
3. Participants should be able to discuss the specific reduction in risk of long-term mental health problems gained through early contact with peer support.

[298] UPDATE: INTEGRATED PERFORMANCE AND CARE TEAMS IN A SPECIAL OPERATIONS AIRCREW TRAINING SETTING

Zachary Masters
U. S. Air Force, Navarre, FL, United States

(Education - Program / Process Review)

BACKGROUND: Aeromedical Providers are key in aligning medical support aligns with the mission of the unit they support and furthering aviation safety throughout their organization . In the case of aircrew formal training units, the mission is to produce trained aircrew for operational units throughout the world. The efficiency and effectiveness of the training pipeline at that one unit affects every other unit in the community. The opportunity to establish healthy lifestyle and habits and an understanding of proper protocol relating to changes in health status, initiation of medications and aeromedical disposition early in these flyers careers can have a lasting effect on aviation safety. The reorganization of the military medical system and the U.S. Air Force operational structure necessitates leaders at all levels to re-examine the components of their organization and the value added by each. **OVERVIEW:** This presentation will provide updates on the status of the embedded healthcare and performance optimization team at the largest Aircrew Formal Training Unit in U.S. Air Force Special Operations Command. This will include a discussion of the makeup of the team and why that has evolved along with the process of