

traditional data storage and processing versus the newer big data methods. **TOPIC:** This panel discussion explores some of the latest technologies and designs associated with big data storage, defines what is and is not meant by big data, and examines when and why you would want to use each architecture for predictive and prescriptive analyses. Several technologies and methods will be defined and described, with a focus on the advantages and disadvantages of each choice based upon the type and amount of data being stored and the types of answers that are desired. The benefits and disadvantages of traditional relational databases, stored on traditional file systems versus the newer methods using distributed file systems such as Hadoop Distributed File System (HDFS) will be discussed. We will also briefly discuss some of the new and interesting ethical challenges associated with the storage and use of the big data from personal medical devices. The information landscape for medical data has changed significantly in the past 10 years, with the popularity of personal health devices, from FitBits and the Fitness application on the iWatch, to Pacemakers that record patient data and send it out for analysis. While these devices and the big data opportunities that they provide are intriguing, they also pose some interesting ethical dilemmas, which will be identified with a brief discussion of the issues. **APPLICATIONS:** Big data analytics methodologies promise to mine large datasets, looking for previously hidden or unknown correlations and hence hypotheses. Currently, there is a great deal of confusion about big data analytics, and if it will replace the traditional methods of analyzing medical data stored in relational databases and tables. This talk seeks to explain the differences between traditional data storage and analysis versus big data to clear up the confusion, to identify the advantages and disadvantages of each technique, and to briefly discuss some of the unique ethical considerations that come with the push to big data, and the new sensors from the internet of things that enable it.

Learning Objectives:

1. After the conclusion of this presentation the audience members will be able to describe what is meant by the term "Big Data", and describe at least one advantage of using it versus traditional relational databases, and describe at least one ethical concern over the storage of "Big Data" from personal medical devices.

5:15 PM

[223] WHAT YOU NEED TO KNOW ABOUT BIG DATA ANALYTICS IN AEROSPACE MEDICINE

R. Greenhaw² and S.L. Zinke-McKee¹

¹FAA CAMI, Oklahoma City, OK; ²Medical Research Division, FAA CAMI, Oklahoma City, OK

(EDUCATION - TUTORIAL)

TOPIC: In the past few years, big data analytics has received attention as a general set of methodologies applicable to many areas of research. It turns out that researchers in aerospace medicine have been applying many of these techniques in the course of their work over the past few years. The use of big data sources and analysis techniques provides both benefits and problems for medical research in aviation. There are the benefits of access to very large, high-dimensional data sets that can provide insights into otherwise invisible subtle patterns. On the other hand, there are issues of storage, access, scalability, information noise, validity, record matching, ownership, security, and privacy with the data and experimental design and processing capacity issues with the analysis that, while always present in research, are exacerbated by the scale of the data. We will discuss the general field of big data analytics as background to its applicability in aeromedical research. We will follow that discussion with examples of its use in specific aeromedical research studies, including discussion of the benefits it provides and issues that it raises for such studies. **APPLICATIONS:** Many of the big data analytics methodologies can now provide information and results previously unavailable. Therefore, there are likely questions in aerospace medicine that were unasked previously because members of the community assumed their answers were unavailable. Many of those types of questions can now be asked; and some of them answered.

Learning Objectives:

1. To understand the primary benefits and issues related to the use of big data in aerospace medical research.

Tuesday, May 08

4:00 PM

Senators

S-049: PANEL: AEROSPACE MEDICINE BOARD REVIEW SERIES #3

Sponsored by ASAMS

Chair: Timothy Burkhardt

Annapolis, MD

PANEL OVERVIEW: The Aerospace Medicine Board Review series will review core topics in Aerospace Medicine and is designed to prepare Aerospace Medicine specialists for the ABPM re-certification exam.

WEDNESDAY, MAY 9, 2018

Wednesday, May 09

8:30 AM

Ballroom D

S-050: PANEL: FOCUS ASPECTS IN AEROSPACE MEDICINE: THE DGLRM PANEL (GERMAN & ENGLISH LANGUAGE)

Chair: Torsten Pippig

Fuerstenfeldbruck, Germany

Chair: Oliver Ullrich

Zurich, Switzerland

PANEL OVERVIEW: This session is organized by the German Society of Aerospace Medicine (DGLR; Deutsche Gesellschaft für Luft- und Raumfahrtmedizin e.V.). In this session, five presentations are included showing activities and focuses of Aerospace Medicine in Germany. The session consists of 5 Abstracts and is presented in German language.

[224] HEINZ VON DIRINGSHOFEN (1900-1967): GERMAN PIONEER IN AEROSPACE MEDICINE.

V. Harsch

Center for Aviation and Travel Medicine, Neubrandenburg, Germany

(ORIGINAL RESEARCH)

INTRODUCTION: Heinz von Diringshofen contributed to aerospace medicine through his research on the effects of acceleration and weightlessness on pilots. Beside laboratory examinations he performed acceleration research by in-flight test in the 30s. As well he introduced parabolic flights to simulate 0G in the scientific scope of aerospace medicine research even before WW II. **METHODS:** Archive research, literature research, oral history. Presentation concerns also medical ethical aspects of the use of results gained in human experiments in WW II. **RESULTS:** Heinz von Diringshofen was born in Magdeburg on January 22, 1900, the German city known from Otto von Guericke vacuum experiments in 1654. Von Diringshofen served as a lieutenant in WW I. Thereafter he studied medicine at the Universities of Berlin and Munich. A maritime medical service with the HAPAG Co. followed before he re-entered service in the "Reichswehr" in 1927. Thereafter von Diringshofen started his military flight training in Lipezk, USSR. In the "Luftwaffe" he later became a colonel and served also at the east-front involved in strategic air medivac. After WW II von Diringshofen lectured aviation medicine at the universities of Frankfurt and Munich. He didn't become a paperclip specialist but contributed as a consultant to the Aeromedical Institute of the Argentinean Air Force from 1951 to 1956. Back in Germany he introduced the term "human performance engineering" while active for German aerospace companies. He became first president of Germanys Society for Aviation and Space Medicine (DGLRM) in 1961, an affiliated association to AsMA since the 60s. **DISCUSSION:** Heinz von Diringshofen is one of the German pioneers in aerospace medicine. It can be assumed that he was not part of the U.S. paperclip

program due to his biographical links to USSR. However he contributed to western aerospace medicine in many fields, especially through his experimental flights to examine multiple to zero G effects on humans starting in the early 30s. To our knowledge von Diringshofen was neither involved in nor used results from unethical medical experiments in WW II. Undoubtedly worth highlighting remain his pioneering contributions to aerospace medicine specifically in acceleration research.

Learning Objectives:

1. Learn about history of early acceleration research.
2. Learn about early aerospace medicine research.
3. Learn about medical ethical topics.

[225] BONE DISORDERS (OSTEOLOGY) AND AEROMEDICAL FITNESS

T.M. Pippig

German Air Force Institute of Aviation Medicine, Fuerstenfeldbruck, Germany

(EDUCATION - CASE STUDY CLINICAL)

INTRODUCTION: The medical Osteology, the study of the construction and the disease of the bones of the skeletal system, is the intersection of Orthopedics and Endocrinology. In the medical Osteology, the bone is not considered an isolated organ, but is explored with respect to its interaction with other organ systems such as the muscles or the central nervous system. Many local and systemic diseases of the bone are associated with an increased risk of fracture. This risk needs to be considered in any aeromedical assessment. **AEROMEDICAL RELEVANCE:** Aircrew are exposed to high levels of physical stress especially in military aircraft, and here bone resilience and strength play an important role. The "Acceptable Means of Compliance and Guidance Material to Part-MED1 of the European Aviation Safety Agency AMC1 MED.B.050 Musculoskeletal system" states: "An applicant with any significant sequela from disease, injury or congenital abnormality affecting the bones, joints, muscles or tendons with or without surgery requires full evaluation prior to a fit assessment." **METHODS:** The presentation discusses the current knowledge of the physiology (bone remodeling, bone homeostasis) and pathology (RANK-RANKL-OPG) of the bone metabolism, classification of systemic and local osteopathies, as well as diagnosis (clinical examination, bone density measurement, laboratory investigations, imaging) and treatment (basic medication, indication, risk and benefit of bisphosphonates, strontium ranelate, SERMs, parathyroid hormone) of bone diseases. **RESULTS:** The following examples from the medical examination are presented: Case 1: Woman, 20 years, Morbus Perthes right hip. Case 2: Man, 19 years old, malformation of the dens axis. Case 3: Woman, 24 years old, Fibrous Dysplasia os sacrum. Case 4: Man, 19 years old, Fibrous Dysplasia of right humerus. **SUMMARY:** Local or systemic bone disorders are rare in the aeromedical assessment (yet). They need to be clarified to a conformal diagnosis, often a supplementary biopsy is required. In addition to pain, growth retardation, malformation and functional limitation the aeromedical assessment focuses on the risk of fracture. Bone diseases detected on pilots require long-term observation and must be included in all annual aeromedical examinations.

Learning Objectives:

1. Bone Disorders.
2. Risk of bone fracture.
3. Aeromedical assessment and aeromedical fitness.

[226] MOLECULAR BASICS AND CLINICAL CONSEQUENCES AFTER TEMPORARY HYPEROXIA

J. Hinkelbein^{1,2}

¹University Hospital of Cologne, Cologne, Germany; ²German Society of Aerospace Medicine (DGLRM), Munich, Germany

(EDUCATION - TUTORIAL)

INTRODUCTION: Whereas the risk of hypoxia in aviation was carefully investigated in the recent decades, hyperoxia and resulting problems have not been thoroughly analyzed although being present in specific situations. In all tissues and organs, high oxygen pressure levels may cause deleterious consequences on a molecular and cellular level (e.g. cell growth inhibition, inflammation, or apoptosis). This problem is called "Paul Bert effect" and was first described at the end of the

19th century. After long exposure to hyperoxia, induced affection of cells and related free radicals may potentially contribute to organ failure and significant problems. The aim of this study was to analyze the alteration of the protein expression after short-term and long-term hyperoxia and to describe relevant problems developing. **MATERIAL AND METHODS:** Identification and analysis of published literature from the databases PubMed and EMBASE. Description of molecular basics as well as clinical consequences after short-term and long-term hyperoxia. Interpretation of the results with two-dimensional gel electrophoresis (2D-DIGE) followed by peptide mass fingerprinting (MALDI-TOF). **RESULTS AND CONCLUSIONS:** Significant alterations in protein expression was demonstrated in several studies for up to 7 days after hyperoxia. Bioinformatic analyses in published papers revealed an association of regulated proteins with inflammation signaling cascades. Furthermore, proteins were associated with pathways in "cell death, cancer, and signaling" as well as "growth inhibition", "regulation of apoptosis", and "structural cell integrity".

Learning Objectives:

1. What are the molecular basics and clinical consequences after hyperoxia.

[227] MOLECULAR ADAPTATION IN CELLS OF THE IMMUNE SYSTEM IN MICROGRAVITY

O. Ullrich and C.S. Thiel

Faculty of Medicine, University of Zurich, Zurich, Switzerland

(ORIGINAL RESEARCH)

To understand the biology and homeostasis of immune modulation under spaceflight conditions is mandatory for appropriate integrated risk assessment for human spaceflight. We investigated signal transduction cascades, metabolism, function, and transcriptome responses in human lymphocytes and macrophages in different gravity environments through a multi-platform approach (parabolic flights, suborbital ballistic rockets, International Space Station), including rigorous control experiments. A multi-platform approach not only allows for cross-validation of findings in independent experiment platforms, but also for understanding the time-course of mechanisms. In primary T lymphocytes, membrane proximal, cytosolic and nuclear signaling were not severely altered. Primary human macrophages exhibited neither quantitative nor structural changes of the cytoskeleton after 11 days in microgravity. Investigation of transcriptome dynamics in response to different gravitational environments revealed that nearly 100% of all initially altered transcripts in Jurkat T cells and 92.7% in U937 cells adapted after 5min microgravity. We identified three gravity-regulated genes, cross-validated in independent experiment missions: The vacuolar H⁺-ATPase ATP6V1A/D,IGHD3-3/IGHD3-10 immunoglobulin diversity genes, and the long intergenic non-protein coding RNA LINC00837. We revealed an overall high stability of gene expression in microgravity and identified olfactory gene expression in the chromosomal region 11p15.4 as particularly robust to altered gravity. Neither sensitivity nor stability of gene expression in altered gravity was randomly distributed in the chromatin, suggesting that the spatial chromatin organization may play an important role in transduction of the non-specific gravitational force into a specific gene expression and transcriptome response. The ultra-fast adaptation response and the cytoskeletal stability after long-term microgravity exposure suggest the existence of rapid force transduction into a cellular response, followed by adaptation processes. We therefore assume that microgravity does not impose an unacceptable risk during long-term space missions.

Learning Objectives:

1. The participant will be able to list and discuss potential cellular and molecular adaptation processes to microgravity.

[228] TRANSCRIPTOME RESPONSE IN HUMAN MONOCYTIC CELLS TO ALTERED GRAVITY

O. Ullrich and C.S. Thiel

Faculty of Medicine, University of Zurich, Zurich, Switzerland

(ORIGINAL RESEARCH)

Gene expression studies so far were mostly end-point measurements after time periods of hours or longer in microgravity, which

focused on the identification of gravity-responsive genes. In our studies, we investigated the extent and robustness of transcriptional response to altered gravity at an integrative level in human myelomonocytic cells. We used a multi-platform approach and combined parabolic flights, suborbital ballistic rocket and 2D clinostat and centrifuge experiments, with strict controls for excluding all possible other factors of influence. In these experiments, we detected a significant high number of differentially regulated transcripts already after 20s. In microgravity and in hypergravity, 92.7% and 78.0%, respectively, of all initially altered transcripts adapted after 5min. Therefore, we identified two pools of altered transcripts: One responding after seconds and one responding after minutes, suggesting that the second pool is either initiated by slower transduction cascades than the primary pool, or is representing secondary or feedback reactions. Feedback and adaptation reactions to microgravity can be as fast as 42s after the onset of microgravity, as we have demonstrated recently through real-time on orbit measurements aboard the International Space Station (ISS). We furthermore identified 57 annotated transcripts that were differentially regulated in all conditions, the corresponding genes are mainly involved in intracellular signaling, transcriptional regulation, RNA modification and mRNA decay. Among these genes, we also identified the vacuolar H⁺-ATPase (V-ATPase) ATP6V1E1, which was identified as gravity regulated in previous studies with human Jurkat T cells. In conclusion, profound alterations of the transcriptome could be detected as early as 20s after the onset of altered gravitational force in independent cell models and independent experiment campaigns, suggesting fast-reacting transduction cascades between the gravitational force and the regulation of the transcriptome.

Learning Objectives:

1. The transcriptome in human monocytic cells reacts to altered gravity within seconds.

Wednesday, May 09
Ballroom E

8:30 AM

S-051: SLIDE: CARDIOVASCULAR RISK

Chair: Dara Regn
Beavercreek, OH

Chair: Warren Silberman
Oklahoma City, OK

8:30 AM [229] POST AORTIC SURGERY FITNESS CERTIFICATION IN COMMERCIAL FLYING: NEED FOR CHANGE IN POLICY – CASE REPORTS

K. Ganapathy Bhat
Medicine and Cardiology, AFCME, Indian Air Force, New Delhi, India

(EDUCATION - CASE STUDY CLINICAL)

PROBLEM STATEMENT: These case reports describe commercial airline pilots who even after clinical cure for the disease of aorta and heart had to wait for prolonged periods before certification due to oral anticoagulation and absence of uniform policy on re-flying. **BACKGROUND:** Atherosclerotic Aortic and heart diseases are the common causes cardiovascular diseases which often affect aircrew in their middle age and result in loss of employment for the individual and loss of experienced aircrew to the organization. Many pilots even after complete clinical recovery, are unable to come back to flying due to medications that are “not permitted” for flying (ICAO -2012). There is no uniform policy. **CASE PRESENTATION:** A 46-year-old male airline pilot, chronic smoker presented with Bluish discoloration of toes and intermittent claudication in right leg in Jan 2015; Extensively evaluated. In May 15, Doppler study of aorta and of lower extremity showed stenosis at the bifurcation of the abdominal aorta and less flow in right leg. Aortic CT Angiogram showed Critical stenosis of descending thoracic aorta (Aortic Angiogram Video and image will be shown). In May 2015, Abdominal aortic angioplasty with stenting was done (Video and image). In Nov 2015, Claudication recurred. CT angio showed restenosis. In Jan 2016, Aorto Bi-iliac bypass and right iliac anastomosis were done.

Developed hemoperitoneum post-op, exploratory laparotomy done. Hemoperitoneum drained and leak sealed. Subsequent recovery was uneventful. He was started on Conventional oral anticoagulant Warfarin and Rosuvastatin. Warfarin started on 7mg post-op, then tapered. INR maintained between 2-3 (Ideal 2-3). In May and Jul 16- Doppler and CT angiograms showed good flow and he remained asymptomatic. In Nov-Dec 16, Thrombophilia profile - Factor V Leiden and other factors negative. CT angiogram showed normal flows. TMT - negative for inducible ischemia. Good effort tolerance, No claudication. CT angio-Normal Flows. On Warfarin; INR stable – 2.5. The dilemma is whether he is Fit or Unfit for flying? As per ICAO – UNFIT; Fit as per FAA. No uniform policy. Considered Fit to fly (after multidisciplinary synergy) with restriction; “PIC with QEP”. Flight safety was not compromised while preserving trained manpower. A 45-yr-old pilot had Myocardial infarction with LV clot requiring anticoagulation. Underwent stenting. Completely recovered in 12 months. Reflighting delayed due to oral anticoagulation. Policy needs revision.

Learning Objectives:

1. There is no uniform international policy regarding flying and oral anticoagulation in commercial airline pilots.
2. Middle age diseases, especially of the heart and aorta warrant life-long medications like oral anticoagulation for optimal functioning.
3. It is time to move with time permitting oral anticoagulants in stable cases without bleeding manifestations when PT/INR is consistently stable between 2 - 3.

8:45 AM

[230] RETURN TO COMBAT FLIGHT AFTER MITRAL VALVE REPAIR: A CASE REPORT

B. Gordon^{1,2}, T. Kats¹, Y. Frenkel-Nir¹, R. Beinrat³, D. Spiegelstein¹, L. Segev¹ and Y. Erlich-Shoham⁴

¹Aeromedical Center, Israeli Air Force and the Medical Corps, Israeli Defense Forces, Shoham, Israel; ²Faculty of Medicine, Hebrew University, Jerusalem, Israel; ³The Heart Center, Chaim Sheba Medical Center, Ramat Gan, Israel; ⁴Surgeon General Headquarters, Israeli Air Force and Medical Corps, Israeli Defense Forces, Ramat Gan, Israel

(EDUCATION - CASE STUDY CLINICAL)

PROBLEM STATEMENT: This case report describes two Israeli Air Force (IAF) combat pilots who underwent surgical mitral valve repair. **BACKGROUND / LITERATURE REVIEW:** Mitral valve repair surgery is indicated for symptomatic or severe mitral regurgitation (MR) and patient outcomes are mostly excellent. In military aviation, some series assumed relation between high performance flight and MR progression, possibly due to increased strain on the valve and supporting structures during accelerations or isometric physical activity. Mitral valve repair surgery is a disqualifying condition for all flying classes, with tendency for a waiver restricted to low performance aircrafts. **CASE PRESENTATION:** A 37-yr-old reserve military F16 pilot was presented in the ER with severe weakness, fever and vomiting. Diagnosis of infective endocarditis was made based on a TEE that demonstrated moderate-severe mitral regurgitation with a perforation of the anterior valve leaflet. Along with an antibiotic treatment, the valve was surgically repaired by an annuloplasty and a pericardial patch. In 12 months follow-up normal cardiac function was demonstrated on stress echocardiogram. A 50-yr-old reserve military jet-fighter flight instructor had known asymptomatic MVP with mild MR which progressed to moderate-severe MR with borderline LVEF of 50-55% during 16 years of surveillance. The pilot underwent a minimal invasive mitral valve repair followed by a 3 months of anticoagulation treatment. In 6 months follow-up the pilot returned to full activity and normal cardiac function was demonstrated on stress echocardiogram. Both pilots were given unrestricted waiver for 6 months. **OPERATIONAL / CLINICAL RELEVANCE:** Valvular surgery in pilots poses concerns regarding stability of the repair and risk for recurrence or complication such as clot, due to flight environment and G-force in particular. On the other hand, when taking into account the pre-operative otherwise healthy heart in the first case presented, and the normal current cardiac function, risk for sudden incapacitation is low and acceptable for a waiver. The second case accepted a waiver after understanding that yearly G-force exposure for a reserve military flight instructor is negligible and therefore acceptable.

Learning Objectives:

1. The participants will understand the aeromedical considerations concerning return to flight decisions in cases of mitral valve repair.

9:00 AM**[231] CARDIOVASCULAR RISK FACTORS EVALUATION IN CIVIL PILOTS OF COLOMBIA WITH CURRENT MEDICAL CERTIFICATION, 2016**

M. Salamanca^{1,2} and E. Navarro²

¹Grupo Factores Humanos, Educación y Certificación Aeromédica, UAEAC Aerocivil Colombia, Bogota, Colombia; ²Universidad del Norte, Barranquilla, Colombia

(ORIGINAL RESEARCH)

INTRODUCTION: Aviators are subject to periodic medical check-ups, however, there are studies that have found accidents caused by sudden incapacitation in flight as a result of cerebrovascular and cardiac events. In Colombia, in 2005, it was found that 8% of the pilots had a high cardiovascular risk according to the Framingham score and during 2015, the Colombian Civil Aeronautics Authority (UAEAC) suspended the medical certificate of six pilots for cardiovascular events. Therefore, it is necessary to establish cardiovascular risk factors in Colombian civil pilots, which contribute to increase the probability of presenting a cardiovascular event in the next ten years and implement effective countermeasures in order to prevent the suspension of their aeronautical activities and reduce the risk of sudden incapacitation in flight. **METHODS:** Descriptive cross-sectional study. A random sample of 550 civilian pilots with current Colombian first-class medical certificate was selected in 2016. The socio-demographic, anthropometric, occupational and cardiovascular risk information was obtained through the aviation medicine area database of the UAEAC. The data were analyzed using the SPSS statistical package and the results were expressed according to the descriptive statistics.

RESULTS: Of the 550 records reviewed, 94.4% corresponded to male pilots, the median age was 34.4 years. According to the Framingham score, 8% presented moderate cardiovascular risk and 11 pilots (2%) presented high cardiovascular risk. In general, the characteristics that were found associated with a high/moderate cardiovascular risk were: age in men equal to or greater than 40 years and in women equal to or greater than 50 years (OR 127), systolic blood pressure equal to or greater than 130mmHg without having treatment or because it was equal to or greater than 120 mmHg having antihypertensive treatment (OR 15.2), employment with agricultural companies (OR 5.7), smoking (OR 4.5), PTL license (OR 3.5), overweight (OR 2.18), total cholesterol (OR 1.01), LDL cholesterol (OR 1007), and as a protective factor HDL cholesterol (OR 0.035). **DISCUSSION:** The cardiovascular risk is lower in first class pilots compared to the general population, however, it is necessary to intervene in a timely manner the cardiovascular risk factors presented by this population in order to avoid the premature suspension of their aeronautical activities and reduce the risk of sudden incapacitation in flight.

Learning Objectives:

1. Establish the cardiovascular risk factors that contribute to the increase the probability of presenting a cardiovascular event in the next ten years among civil pilots who have a first class medical certificate.

9:15 AM**[232] PREVALENCE OF CORONARY ATHEROSCLEROSIS IN U. S. PILOTS AUTOPSIED AFTER FATAL CIVIL AVIATION CRASHES**

I. Akparibo and A. Stolfi

Wright State University, Dayton, OH

(ORIGINAL RESEARCH)

INTRODUCTION: Cardiovascular disease (CVD) is the leading cause of loss of license or restriction to fly in civilian and military aviation. The most common reason for special issuance or waiver to fly due to CVD is coronary artery atherosclerosis (ATH). The prevalence of significant ATH in pilots, and associations with known CVD risk factors

is of importance because these pilots may be at risk for inflight incapacitation due to a cardiac event. The objectives of the study were to determine the prevalence of hypertension (HT), dyslipidemia (DL), and diabetes (DB) in pilots prior to fatal crashes, and the associations with ATH at autopsy after fatal crashes. **METHODS:** The NTSB Aviation Accident Database was searched from January 1, 2008 to December 31, 2016 for U.S. pilots fatally injured in crashes. Pilots were included if the crash investigation was final, and toxicology and autopsy reports were available for review. Medical history, and medications for HT, DL, and DB listed in the toxicology report were used as surrogate measures for CVD risk factors. Autopsy reports were reviewed for presence and severity of ATH. Multiple logistic regression was used to determine the independent associations between the CVD risk factors and ATH at autopsy after controlling for age. **RESULTS:** From Jan 2008-Dec 2016, 1897 pilots in command were killed in civilian aviation crashes. Of these, 1769 (93.3%) were included in the study. The mean (SD) age was 55 (14) years and 98.1% were male. 270 (15.3%) pilots were taking medications for 1 or more CVD risk factors; the prevalence was 12.2% HT, 4.0% DL, and 2.1% DB. Of the 270, 62 (23.0%) had evidence of ATH at autopsy. Eighty-two of the 1417 pilots (5.5%) without CVD history or medications had autopsy findings of ATH. Overall, the prevalence of ATH was 8.1% (144/1769), with 5.9% classified as severe. Adjusted ORs (95% CI) for presence of ATH were 3.5 (2.0-6.2) for DL, 3.2 (2.1-4.9) for HT, 1.8 (0.8-4.2) for DB, and 1.05 (1.03-1.06) for age. A cardiac event was listed as the probable cause in 28 crashes and a contributing cause in 10. In 19 of these 38 there was no prior indication the pilot had CVD. **DISCUSSION:** In this study dyslipidemia was the strongest predictor of ATH at autopsy, but more than 5% of pilots without CVD risk factors showed ATH at autopsy. These findings may be important for determining CVD criteria for fitness to fly.

Learning Objectives:

1. Determine the prevalence of hypertension, diabetes mellitus and dyslipidemia in pilots fatally injured in civil aviation crashes.
2. Determine the prevalence of atherosclerosis in fatally injured pilots in the U.S.
3. know the proportion of pilots without known cardiovascular risk factors but determined to have atherosclerosis at autopsy.

9:30 AM**[233] THE EFFECT OF WORKLOAD AND OTHER RISK FACTORS OF METABOLIC SYNDROME AMONG SHORT-HAUL COMMERCIAL PILOTS IN INDONESIA.**

I. Yuliawati^{1,2}

¹Medical, Civil Aviation Medical Center, Greater Jakarta, Indonesia;

²Community Medicine Department, Universitas Indonesia, Jakarta, Indonesia

(ORIGINAL RESEARCH)

INTRODUCTION: Metabolic syndrome is associated with cardiovascular disease and diabetes mellitus which could cause sudden incapacitation among pilots in Indonesia, where short-haul flights between cities and small islands plays an important role. The aim of this study was to identify risk factors of metabolic syndrome among short-haul commercial pilots in Indonesia. **METHODS:** Cross-sectional study with purposive sampling was conducted at the Civil Aviation Medical Center, Jakarta from July 27-August 30th, 2014. Metabolic syndrome was assessed according to the National Cholesterol Education Program Adult Treatment panel III criteria which data including waist circumference, blood pressure, fasting blood glucose and lipid profile were collected from medical records. Risk factors were collected using anonymous self-reporting questionnaire on age, smoking habits, flight time, number of sectors, unplanned flights and Fatigue Severity Scale. Cox regression was used to identify dominant risk factors of metabolic syndrome. **RESULTS:** During data collection, 1545 pilots willing to participate, 891 male Asian pilots met the inclusion criteria of operating short-haul flight duty in the last 7 days and 27 were excluded because of diabetes mellitus. Total subject was 864 pilots. Prevalence of metabolic syndrome was 18.28%. Age group, flight time and number of sectors in 24 hours were the dominant factors of metabolic syndrome. Risk for

metabolic syndrome was 88% higher among pilots aged 56-65 year-old [Adjusted Relative Risk (RRa)= 1.883; p=0.019] and 66% higher among pilots flying more than 6-7 sectors in 24 hours (RRa=1.661; p=0.33). While pilots flying 6-8 hours in 24 hours had 33% lower risk for metabolic syndrome (RRa=0.671; p=0.009). **DISCUSSION:** Age as one of the unmodifiable risk factor to metabolic syndrome was the highest dominant factor to significantly increase the risk of metabolic syndrome in this study. Furthermore, this study showed that short haul pilots flying multiple take-offs and landings as critical phase of flight induced an elevated cortisol level that accumulatively associated with fatigue as one of the primary causes of hypercortisolism and has been linked to metabolic syndrome.

Learning Objectives:

1. Identify the risk factors of metabolic syndrome among short-haul pilots in Indonesia.
2. Understand fatigue could induced an elevated cortisol level that has been linked to metabolic syndrome.
3. Formulate preventive measure for fatigue and metabolic syndrome among short-haul pilots in Indonesia.

9:45 AM

[234] YOUNG AVIATOR WITH NEW ONSET DYSARTHRIA AND PATENT FORAMEN OVALE

D.R. Pizzino

U.S. Air Force, Biloxi, MS

(EDUCATION - CASE STUDY CLINICAL)

PROBLEM STATEMENT: This case report describes a military instructor pilot who experienced a single episode of dysarthria and hand tremor, and subsequently was found to have a patent foramen ovale with right-to-left shunt. **BACKGROUND / LITERATURE REVIEW:** Patent foramen ovale has been found to be a risk factor for cryptogenic stroke by allowing emboli to pass through a right-to-left shunt. Several studies have examined if PFO closure effectively reduces future stroke risk. Initial studies failed to show significant benefit in PFO closure versus medical anticoagulation therapy. However, more recent studies do show advantage of PFO closure plus anticoagulation over anticoagulation alone. **CASE PRESENTATION:** The subject pilot is a 30 year old experienced T-6 instructor pilot, with 1400 total flying hours. The pilot woke one morning with difficulty speaking, facial weakness, and a right hand tremor. He was directed by the flight surgeon on-call to the local emergency department for potential stroke. Head CT scan and MRI were both negative, and he was given one dose of low molecular weight heparin. Symptoms resolved in the ED, and he was discharge home. He described his symptoms as several seconds of right hand tremor, followed by difficulty speaking. He reports that he knew what he wished to say, and comprehension was not impaired, but he had difficulty enunciating words. He had no other associated symptoms such as headache, vision changes, or other sensory/motor changes. Since the original presentation, he reports feeling well and has had no recurrence of symptoms. During neurological workup, he was found to have a normal EEG and Head CT-scan. An echocardiogram with bubble study showed a patent foramen ovale, but otherwise a normal cardiac exam. All other exams and tests have been within normal limits. **OPERATIONAL / CLINICAL RELEVANCE:** This case highlights potential conflicts in appropriate standard of care medical management of the patient versus management designed for flight safety risk mitigation. In this case, recurrence of a cryptogenic stroke during flight operations would put the pilot and crew at risk for an aircraft mishap. Whether for long-term anticoagulation or PFO closure surgery, this pilot will require a flying waiver for continue flight duties. Current standard of care advocates long-term anticoagulation. However, definitive surgical closure of the PFO would eliminate right-to-left embolic risk.

Learning Objectives:

1. Patent Foramen Ovale is a congenital cardiac abnormality which is usually does not cause symptoms in adulthood. One potential risk associated with PFO is cryptogenic stroke.
2. Patent Foramen Ovale can allow venous to arterial communication via a right-to-left shunt, and can allow venous emboli into arterial pathways.
3. Incidentally found PFOs do not require treatment, but people at risk for embolic event require either antiplatelet/anticoagulation or surgical closure.

Wednesday, May 09

Wedgewood

8:30 AM

S-052: PANEL: BELLAGIO II AEROSPACE MEDICINE SUMMIT: TERRESTRIAL APPLICATIONS FOR HUMAN HEALTH PERFORMANCE AND LONGEVITY – 1

Chair: Smith Johnston

Houston, TX

Chair: Marian Sides

Grayslake, IL

PANEL OVERVIEW: BODY: The Bellagio II summit sought to identify mature data in the literature and published NASA technical resources with significant clinical implications for terrestrial populations. During the development of areas and topics of interest, significant cross-domain correlations were noted that shaped the final product. Members from the Bellagio II summit were assigned to five teams, including genetics, environmental hazards, nutrition, physiological fitness, and behavioral health. Each team reviewed current NASA standards and available literature for mature clinical topics with potential translational benefits within terrestrial medical applications. The five stage National Institutes of Health(NIH) Translation Model and the NASA two stage translation model were used to determine maturity of topics and readiness for translation. Following summation of literature reviews, teams analyzed inter-disciplinary findings and identified the most significant and mature evidence-based topics ready for knowledge transfer. This panel will present space medicine findings and countermeasures with highest probability for future terrestrial application to promote human health, performance and longevity. We will present the translation science models and the cardiovascular findings collected by the Bellagio II team.

[235] TRANSLATIONAL SCIENCE MODEL SHOWING STAGES OF RESEARCH DEVELOPMENT FROM LABORATORY TO TERRESTRIAL APPLICATION

M. Sides^{3,2} and A. Florom-Smith^{1,4}

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²USAF(Ret.), Grayslake, IL; ³University of Chicago, Chicago, IL;

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(EDUCATION - PROCESS)

PROBLEM STATEMENT: We sought to identify risk mitigation methodologies for astronauts with potential terrestrial application. The National Institute of Health (NIH) Translational Science Model, was used, showing the progression of research through five stages, from basic research to readiness to translate to clinical operations on earth. A continuum for the discovery and evolution of Vitamin D to mitigate risks for osteoporosis is demonstrated. **TOPIC:** The translational science spectrum, representing research in five stages, was used to gauge maturity of data. These stages include basic research, pre-clinical research, clinical research, implementation and public health. Each stage provides insight for the next level, towards maturation for terrestrial application. A basic research (stage 1) experimental demonstration by McCollum et al. (1922) tested the hypothesis that vitamin A could cure rickets, leading to the discovery of Vitamin D. A preclinical study in 1955 by VanLoon (stage 2) showed decreased mineralization and increased calcium release in isolated murine long bones, under near weightlessness. A clinical research study (stage 3) conducted by Smith et al. (2004) examining nutritional changes, bone metabolism and vitamin D status of astronauts aboard the International Space Station, concluded that bone loss and decreased Vitamin D are critical concerns for long-term spaceflight. A clinical implementation study (stage 4) in 2009 by Smith et al. showed efficacy of Vitamin D supplementation for bone health in an Antarctic ground analog of spaceflight. A 2017 public health review (stage 5) by Hilligsmann et al. described public health impact of Vitamin D-fortified dairy products for fracture prevention. **APPLICATIONS:** The Translational Science

Spectrum is a structured framework for tracking research through stages that build upon previously identified gaps in knowledge while providing insight for the next stage of research. However, the process of bringing data to maturation for terrestrial translation does not always flow through all five phases, but may extend from NASA's two-stage translational model of basic science to operational medicine. **RESOURCES:** 1. NASA's Evidence Report: Risk of Early Onset Osteoporosis Due to Space Flight. Human Resource Program Exploration Medical Capabilities Element, 2017. 2. Hilligsmann *et al.*, A Scoping review of the Public Health Impact of Vitamin D Fortified Dairy Products or Fracture Prevention and Osteoporosis, 2017.

Learning Objectives:

1. Participants will define the stages of the NIH five stage Translational Science Model for readiness to translate to terrestrial medicine.
2. Explain the two stage NASA translation Science Model.
3. Describe how Vitamin D developed through five stages of translation from laboratory discovery to public health impact on fracture prevention.

[236] TERRESTRIAL CORONARY ARTERY DISEASE (CAD) SCREENING, TREATMENT AND RISK MITIGATION-LESSONS LEARNED FROM SPACE MEDICINE

S.L. Johnston³, J. Locke³, G. Gray¹, B.D. Levine⁵, A.E. Sargsyan⁷, J. Stepanek², P. Lee⁴, E.D. Davenport⁶ and S. Nissen⁸
¹CAF- CFEME, Toronto, ON, Canada; ²Mayo Clinic, Scottsdale, AZ; ³NASA JSC, Houston, TX; ⁴Surgery, The Ohio State University Wexner Medical Center, Columbus, OH; ⁵Institute for Exercise and Environmental Medicine, UT Southwestern/Texas Health Resources, Dallas, TX; ⁶USAFSAM, U.S. Air Force, Wright-Patterson AFB, OH; ⁷KBRwyle, Houston, TX; ⁸Department of Cardiology, Cleveland Clinic, Cleveland, OH

(ORIGINAL RESEARCH)

INTRODUCTION: The Bellagio II Summit sought to correlate current ISS Space Medicine practice in the screening/assessment and management of CAD and to identify terrestrial applications for the general population pertaining to primary, secondary and tertiary diagnoses and treatments. We identified current Space Medicine practice for screening and monitoring astronauts and cosmonauts in the pre-, in-, and post-flight mission phases. We will discuss current Space Medicine standards and guidelines in the recognition and monitoring of CAD development, stabilization, and regression. **METHODS:** We reviewed current Space Medicine standards, medical records, expert panels, and available literature for monitoring of cardiovascular health in astronauts and cosmonauts during ISS selection, mission operations, post space-flight, and lifetime surveillance. **RESULTS:** Space Medicine utilizes a number of CAD screening techniques to identify subtle and cumulative changes to cardiovascular health. Cardiovascular screening efforts include review of family history, use of risk-stratification scores, exercise stress testing, echocardiography, biomarkers, and standard hemodynamic monitoring. Further, astronauts and cosmonauts undergo regular monitoring of coronary artery calcium (CAC) scores, carotid intimal media thickness (CIMT) measurements, and cardiovascular angiographic imaging techniques if clinically indicated. To date, there have been 16 individuals diagnosed with asymptomatic CAD with anatomic calcium scoring. These individuals underwent risk stratification for ISS mission selection/qualification and lifetime surveillance and will be discussed. **DISCUSSION:** ISS Space Medicine monitoring techniques address the numerous screening tools that indicate overall coronary health for astronauts and cosmonauts. Accumulated data provides an integrated awareness of CAD and its management and will be presented. Many of these techniques can be applied to the terrestrial population for primary, secondary, and tertiary screening, monitoring, and treatment of CAD.

Learning Objectives:

1. Understand the development of the MMOP CAD primary, secondary, and tertiary guidelines for ISS Missions.
2. Understand the risk assessments for CAD and ISS mission qualification.
3. Understand the pathophysiology for CAD plaque development, stabilization, and regression.

[237] A NASA DEVELOPED RISK SCORE CALCULATOR FOR CORONARY ARTERY DISEASE (CAD): APPLICATION TO TERRESTRIAL PRACTICE

A. Khera¹, B.D. Levine² and J. Locke³

¹Department of Cardiology, UT Southwestern Medical Center, Dallas, TX; ²Institute for Exercise and Environmental Medicine, UT Southwestern/Texas Health Resources, Dallas, TX; ³Space Medicine, NASA JSC, Houston, TX

(ORIGINAL RESEARCH)

INTRODUCTION: CAD surveillance has led to the development of risk stratification tools that drive clinical mitigation efforts for CAD risk. As common risk assessment tools, including the Framingham Risk Score (FRS) or Pooled Cohort Risk Equations, have insufficient accuracy on an individual level to meet NASA's stringent screening guidelines, NASA has required new approaches to address the risk of catastrophic cardiovascular (CV) medical events among astronauts. Coronary artery calcium (CAC) scanning has emerged as the current best tool to enhance CV risk assessment in asymptomatic individuals. **METHODS:** We sought to identify current methods of risk stratification for CAD in high-performance military and spaceflight populations, to identify potential terrestrial applications of such tools. We reviewed NASA risk stratification tools and clinical mitigation strategies, comparing techniques with generalized and military terrestrial approaches and guidelines. **RESULTS:** Current NASA screening and monitoring techniques have led to the development of the astronaut CV health and risk modification (ASTRO-CHARM) model, a risk assessment tool developed specific to the astronaut population for comprehensive assessment of atherosclerotic CV (ASCVD) disease. To develop ASTRO-CHARM, Khera *et al.* combined participant level data from three population-based cohorts: the Dallas Heart Study, Multiethnic Study of Atherosclerosis (MESA), and the Prospective Army Coronary Calcium (PACC) study. Cox proportional hazard models were created with traditional risk factors as the independent variables (age, sex, race, total cholesterol, HDL, systolic blood pressure, use of antihypertensive medications, smoking history, and glucose). Family history of myocardial infarction, C-reactive protein, and statin use were also tested to determine if they were independently associated with the outcome and improved model-fit statistics. This risk model has been internally and externally (from Framingham CAC cohort) validated. **DISCUSSION:** The ASTRO-CHARM tool is the first integrated ASCVD risk calculator to incorporate risk factor and CAC data. While developed for specific application in the astronaut population, clinical assessment tools and associated mitigation techniques provide a comprehensive understanding of CV risk and subsequent clinical interventions. These tools can be implemented for terrestrial applications to augment current clinical practice in patients of similar age and sex.

Learning Objectives:

1. Understand the development of ASTRO-CHARM cardiac risk assessment.
2. Understand the use of AC for assessing astronaut risk for a 6 month to 1 year mission to the ISS.
3. Understand how this risk assessment tool can be translated to the terrestrial environment for clinical utilization.

[238] ORTHOSTATIC INTOLERANCE AFTER SPACEFLIGHT: COUNTERMEASURES FOR ASTRONAUTS AND CLINICAL POPULATIONS

S.M. Lee¹, M.B. Stenger², S.H. Platts², B.D. Levine^{3,4}, Q. Fu^{3,4} and P. Nork⁵

¹KBRwyle, Houston, TX; ²NASA JSC, Houston, TX; ³University of Texas Southwest Medical Center, Dallas, TX; ⁴Institute for Exercise and Environmental Medicine, Texas Health Presbyterian Hospital, Dallas, TX; ⁵Baylor College of Medicine, Houston, TX

(ORIGINAL RESEARCH)

INTRODUCTION: Orthostatic intolerance (OI) after spaceflight is a potentially serious health risk during re-entry and landing. Approximately 25% of astronauts participating in short-duration and >60% of astronauts who complete long-duration spaceflight experience OI on landing day during a tilt test. Countermeasures include inflight exercise,

fluid loading, whole body cooling, and lower body compression garments. Similar interventions have been prescribed to combat OI in patient populations. **METHODS:** A series of studies were conducted by the Johnson Space Center Cardiovascular and Vision Laboratory to determine the efficacy of lower body compression garments to prevent OI. Test subjects participated in an 80° head-up tilt test with and without compression garments after simulated microgravity deconditioning (furosemide-induced hypovolemia or 14 d of bed rest). Astronauts participated in stand tests on landing day with or without compression garments. Patients with a range of maladies inducing OI or orthostatic hypotension participated in either a stand test or a tilt test with and without compression garments. **RESULTS:** Operational garments, NASA's anti-gravity suit and the Russian Kentavr, completely protected against OI in hypovolemic subjects during a 15-min tilt test. A one-piece abdomen-high gradient compression garment also provided complete protection during a tilt test in hypovolemic subjects, but was difficult to don. An abdomen-high gradient compression garment modified to be donned as three pieces protected against OI during 15-min of HUT after 14 d of bed rest and prevented the elevated heart rate and decreased stroke volume associated with spaceflight in astronauts during a 3.5-min stand test on landing day. High-high compression garments tested in a separate group of astronauts prevented presyncope during a 10-min tilt test but the level of protection appears less than abdomen-high garments. Patients wearing a three-piece gradient compression garment experienced fewer symptoms, lower heart rates, and/or better blood pressure control during a short orthostatic challenge compared to their experiences when they attempted the same test without garments. **DISCUSSION:** Interventions that protect astronauts during orthostasis after spaceflight benefit in relevant clinical populations, including individuals with autonomic failure, recurrent syncope, and Postural Orthostatic Tachycardia Syndrome as well as those who are bedridden for an extended duration.

Learning Objectives:

1. To be familiar with the challenges of orthostatic intolerance after spaceflight and how countermeasures to orthostatic intolerance can be applied to patient populations.

Wednesday, May 09
Ballroom B

8:30 AM

S-053: PANEL: HIGH-PERFORMANCE AIRCRAFT PHYSIOLOGY: IN-FLIGHT UNEXPLAINED PHYSIOLOGIC EVENTS AND SENSING

Chair: Ryan Mayes
Upper Arlington, OH

Chair: George Rice
Pensacola, FL

Chair: Duncan Hughes
Fairfax, VA

PANEL OVERVIEW: As aerospace medicine celebrates 100 years of supporting aerial operations, this panel will focus where aerospace medicine began—with tactical aviation. In the last decade, multiple unexplained physiologic events (UPEs) have been noted among 4th- and 5th-generation fighter pilots in the U.S. Air Force (USAF) and U.S. Navy (USN) that do not appear to be connected to one of the typical historical attributions (hypoxia or G-induced loss of consciousness). This panel will cover multiple aspects of the USAF and USN approach to UPEs; presentations will include modernized incident response protocols and an operator's perspective on the state of science for UPEs. In addition, a critical component of the strategy involves characterizing the challenging environment in which our pilots perform. Accurately sensing the high-performance aircraft environment and physiologic responses to that environment are critical objectives to providing aeromedical support. Presentations on sensing will cover toxicological characterizations of breathing gas, assessments of in-flight electroencephalographic monitoring, and an assessment of a visual physiologic feedback system.

[239] HAVE HOPE: A PRELIMINARY EVALUATION OF PROVIDING HIGH-PERFORMANCE AIRCRAFT PILOTS CONTINUOUS, REAL-TIME BIOFEEDBACK IN FLIGHT

M. Fritts³, M. Clayton Gallo², D.S. Burch¹, R.S. Mayes¹, W. Hanoka³, P. Downing³, M. Shaker³, A. Franck³, D. Pohlman¹ and C. Harding¹
¹USAFSAM, Wright-Patterson AFB, OH; ²Naval Medical Research Unit Dayton, Wright-Patterson AFB, OH; ³USAF Test Pilot School, Edwards AFB, CA

(ORIGINAL RESEARCH)

INTRODUCTION: The notion of pilots attending to displays for situational awareness has been fundamental since the beginning of flight. These displays provide an update of what is happening with the aircraft; however, pilots are reliant on themselves as both sensor and adjudicator for what is happening physiologically during flight. Recent physiologic events have driven a deluge of in-flight physiologic sensors development efforts, but few address how to present this information to the pilot, or if presented, would it affect the pilot's decisions. In a collaborative effort between the USAF Test Pilot School, the 711th Human Performance Wing, and the Naval Medical Research Unit Dayton, test pilots school students evaluated a preliminary display for physiologic data during high-performance flight. **METHODS:** Three Air Force student test pilots flew six sorties in an F-16 wearing an electrocardiography (ECG) system that output the individual's unique percent heart rate reserve (%HRR) to a tablet display, and three sorties without wearing the ECG and display. Each sortie consisted of four test sets of high-g maneuvers, a modified cognitive battery task, a self-assessment, and self-determined rest period before the next maneuver. Aircraft data, including adherence to the g-profile, as well as user evaluation comments were recorded. **RESULTS:** The pilots noted that monitoring the HRR display was a lower priority when compared to other tasks in flight. Issues involving display luminance in natural light, display placement, and ECG electrode adhesiveness drove the pilots to attend to the display only when necessary for the test. Data show that pilots took more rest between high-g maneuvers with the biofeedback and that the short-term memory recall task accuracies were greater. No other task accuracies or durations, nor the effort scores reported, were different between the conditions. **DISCUSSION:** While the data suggest that the biofeedback did have an effect on the pilots' decisions, this effect was not salient, as the exertional fatigue experienced could be managed largely with the recovery time provided during the cognitive battery. This effort highlights that the utility of in-flight physiologic displays is predicated on the accessibility of the information, i.e., does the display follow human factors design recommendations for flight and is it comprehensible to the user, as well as the applicability of that information to the pilot's life and mission.

Learning Objectives:

1. Gain knowledge about preliminary testing of biofeedback displays of real-time aircrew physiology during high performance aircraft flight.

[240] IMPLEMENTATION OF A REAL-TIME AIR QUALITY SENSOR (RTAQ) PACKAGE TO MEASURE BREATHING AIR QUALITY DURING FLIGHT

J. Martin², G.M. Slusher⁴, B. Geier⁴, K. Fullerton³, D.K. Ott³ and C.C. Grigsby¹

¹Airmen Systems Directorate, 711th Human Performance Wing, Wright-Patterson AFB, OH; ²AFRL, Wright-Patterson AFB, OH; ³USAFSAM, Wright-Patterson AFB, OH; ⁴711 Human Performance Wing/RHXB, U.S. Air Force, Wright-Patterson AFB, OH

(ORIGINAL RESEARCH)

INTRODUCTION: Physiological events reported by pilots of high-performance aircraft during flight can negatively impact operator health and performance and compromise mission success. Aircraft contaminants are one factor potentially contributing to physiological events, yet there are currently no tools available which can monitor the quality of pilot breathing air in real-time to understand the role exposures may play in manifestation of symptomology. This effort will describe teaming between the line, medical, and operational communities to develop and test the sensor package to monitor breathing air quality during flight on a high-performance aircraft. **METHODS:** RTAQ was installed within the breathing line of a high-performance aircraft at Edwards AFB for 32 sorties. Sensor data

from oxygen, carbon monoxide (CO), carbon dioxide, nitrogen oxide, and hydrocarbon volatiles, in addition to environmental sensors for temperature, pressure, and humidity were parsed, processed, and time-synced with aircraft integrity data. A removable sorbent media tube was incorporated into RTAQs to provide a capability for more comprehensive contaminant testing using established laboratory based gas chromatography-mass spectrometry methods. The intensity values of sorbent tubes collected during flight were compared with a blank tube which was not installed during flight to control results for adsorption during installation. **RESULTS:** A total of 55 compounds were detected at >70% frequency from flight sorbent tubes compared to blank, or the intensity values were statistically significant ($p < 0.05$) with regard to paired signal ratios between flight and blank tubes. Extreme flight conditions led to fluctuations in %O₂ and spikes in CO which could be correlated with G-forces and oxygen variation using preliminary models.

DISCUSSION: Occupational exposures in the aerospace environment include a variety of confounding factors which make it difficult to predict the impact to overall health, or contribution to physiological events. This research is a first step toward understanding the types of exposures experienced in the aerospace environment to inform risk assessment characterizations under the rigors of flight. Future studies will involve implementing RTAQs within varied airframes to assist in building a baseline of contaminants across the USAF fleet, as well as understanding how these specific exposures may contribute to physiological events.

Learning Objectives:

1. The participant will be able to understand the challenges associated with real-time sensing during the rigors of flight.

[241] DRY EEG MANIFESTATIONS OF CHANGES IN INSPIRED OXYGEN AND COGNITIVE WORKLOAD

G. Rice¹, D.H. Snider², S. Drollinger¹, C. Greil¹, F. Bogni¹, J.B. Phillips³, G. Gibson⁴ and A. Raj⁵

¹Aviation Medicine, NAMI, Pensacola, FL; ²Computer Science, University of West Florida, Pensacola, FL; ³Institute of Human and Machine Cognition, Pensacola, FL; ⁴U.S. Naval School of Aviation Safety, Pensacola, FL; ⁵Institute of Human and Machine Cognition, Pensacola, FL

(ORIGINAL RESEARCH)

During calendar year 2016, over 120 physiologic events occurred in Naval aircraft utilizing Onboard Oxygen Generating Systems (an increase by 400% over the last 5 years) yet the physiologic data from the aviators needed to substantiate/characterize these events is not collected. Recently, portable dry electroencephalographs (dry EEGs) have demonstrated their ability to discriminate cognitive workload, stress, fatigue and drowsiness for operators such as truck drivers and dismounted soldiers. This project seeks to characterize significant changes in brainwave EEG morphology that occur in response to the hypoxia levels experienced in military aviation and how they relate to changes in cognitive workload and cognitive performance. **METHODS:** Student and designated Naval aviators were exposed to increasing levels of normobaric hypoxia and monitored with dry EEG (DSI-7, Wearable Sensing, LLC, San Diego CA) while flying a fixed base flight simulation. Cognitive workload and changes in brainwave frequencies were quantified and analyzed utilizing the included Q-States classifier software and MATLAB (The Mathworks, Natick, MA). Changes in flight and cognitive performance were analyzed via simulation tasks and with a cognitive test battery validated under hypoxia (Hypoxia Edition, Cog-Screen, LLC, St. Petersburg, FL). Normobaric hypoxia and O₂ saturation (SpO₂) were produced and monitored using the Reduced Oxygen Breathing Device (ROBD2, Environics, Inc., Tolland, CT). **RESULTS:** Trends manifest with decreasing SpO₂ including increasing cognitive workload state and decreasing power in higher frequency brain waves, but at the present time these changes do not reach statistical significance. Increases in reaction time and decreases in accuracy were also observed with decreasing SpO₂ and correlated with increasing cognitive workload state determined by Q-States. **DISCUSSION:** The ability to monitor brain waves in operational environments has previously been technologically unfeasible due to the cumbersome nature of EEG equipment. This research suggests that current dry EEG technology holds the potential to acquire brainwaves in simulated flight environments and identify increasing workload states that correlate with cognitive decrements and hypoxia. Future efforts to mature this technology and transition to next generation helmets are underway.

Learning Objectives:

1. Identify the five basic types of brainwaves that are analyzed from dry-electroencephalographs (dry-EEGs).
2. Characterize the changes in brainwave that occur with increasing levels of hypoxia.
3. Characterize the changes in reaction time, accuracy, flight simulation tasks that occur with increasing work load environments and decreasing levels of SpO₂.

[242] STANDARDIZED RESPONSE TO AND REPORTING ON UNEXPLAINED PHYSIOLOGIC EVENTS (UPES) IN USAF HIGH PERFORMANCE AIRCRAFT

D. Hughes

ACC, U.S. Air Force, Williamsburg, VA

(EDUCATION - PROCESS)

MOTIVATION: Historically, in-flight unexplained physiologic events (UPEs) among high-performance aircraft pilots have typically been attributed to hypoxia or g-induced loss of consciousness. Accordingly, training, pilot selection, and incident response investigations have been focused on these etiologies. However, as jet life support systems and aircrew flight equipment and technology have advanced, it now appears that these traditional beliefs regarding causes of in-flight physiologic events may have been incomplete. **OVERVIEW:** Evidence-based decision making requires a repeatable, traceable, and documented process to produce trusted recommendations. In the USAF, there is currently no central data repository for the collection of data related to UPEs in high performance aircraft. This makes it difficult to make evidence-based decisions other than on an anecdotal, case-by-case basis. The Air Force Safety Automated System (AFSAS) is the system of record for data collection related to aircraft mishaps used by the USAF Safety Center. However, AFSAS does not currently collect and store data on UPEs. Furthermore, the USAF guidance on how UPEs are responded to, the members of the response team and the required response documentation are lacking and/or not specific enough to use for big data analysis and evidence-based decision making. This panel topic will summarize COPE FIGHTER efforts to: a) standardize the duties and team composition of UPE responders, b) standardize the data collected during UPE responses, c) create a standardized form for data collection and reporting, and d) synchronize efforts with the USAF Safety Center to have this data stored in AFSAS as an official record of UPE response which will enable future data mining related to UPEs enabling scientific analysis and evidence-based decision making. **SIGNIFICANCE:** Standardization of the response, documentation and reporting related to UPEs in the USAF will greatly add to the quality of aviator support while simultaneously enabling big data analysis of these events not previously possible. Rather than anecdotal, case-by-case analysis of individual events, the culmination of these efforts will allow enhanced scientific data analysis and decision making. This work is of broad interest to: professionals in a position to respond to UPEs operationally, responsible for data collection and reporting of UPEs, and those interested in the study and analysis of these ongoing events in high performance aircraft.

Learning Objectives:

1. Familiarize audience with efforts to standardize USAF response to UPEs
2. Familiarize audience with efforts to create standardized USAF documentation and reporting of UPEs.
3. Familiarize audience with efforts to have UPE reporting catalogued at the USAF Safety Center for data mining and evidence-based decision making.

[243] UNEXPLAINED FIGHTER AIRCREW PHYSIOLOGICAL EVENTS: AN OPERATOR'S PERSPECTIVE

J.J. Elliott¹ and D. Schmitt²

¹Flight Test, U.S. Air Force, Arlington, VA; ²Flight Test, U.S. Air Force, Edwards AFB, CA

(EDUCATION - PROCESS)

MOTIVATION: The last decade has seen a rapid rise in concerning physiological episodes in high performance fighter aircrew, beginning with the F-22 and more recently causing safety investigations and

publicized groundings across the USAF (F-35, F-15) and USN fighter/trainer (F-35, F-18, T-45) fleets. Classically understood aeromedical phenomena (hypoxia, DCS), which have been the focus of pilot aeromedical training for decades, have failed to fully explain the frequency and severity of these events. This presentation will leverage operational fighter pilot experience to identify what factors are at play, discuss how current AF training does or does not prepare aviators for these risks, and provide a way forward for future research. **OVERVIEW:** Response and research efforts in support of military investigations into the causes of unexplained physiological events have typically narrowly focused on a specific airframe. This has created multiple stovepipes of information that lack the appropriate scope and authority to make necessary and substantive holistic changes to prevent future events across the force. A review of events across the spectrum of aviation revealed several focus areas that are likely factors, while also highlighting significant areas of concern in the depth of training provided to current aviators (hypocapnia, atelectasis, etc.). Operational qualitative evidence, in the form of aircrew physiological anecdotes, have also revealed that current knowledge of atelectasis as a whole may be lacking, with symptoms that do not strictly adhere to classic acceleration and absorption literature.

SIGNIFICANCE: Understanding the full spectrum of current fighter physiological shortfalls is the first step in current crisis management and in creating the next generation of manned aircraft. As a holistic look at current events and training, this work will break down barriers preventing effective information sharing, while hopefully providing a catalyst for future research in an emerging field.

Learning Objectives:

1. Participants will learn to think critically about the multi-factorial nature of physiological cases in the high-performance fighter environment.
2. Participants will be encouraged to challenge traditional in-air checklist methods aimed at diagnosing and curing physiological incidents using absolute steps.
3. Participants will learn the psychological impact of a failed checklist on a pilot who is out of prescribed options when affected by a physiological issue.

Wednesday, May 09
Topaz

8:30 AM

S-054: PANEL: OPERATIONAL LASER EFFECTS AND LASER EYE PROTECTION

Chair: Julie Lovell
San Antonio, TX

Chair: Leon McLin
JBSA Fort Sam Houston, TX

PANEL OVERVIEW: During the last decade, there has been an increase in the proliferation of low-cost, high-power handheld laser attacks on commercial, civilian, police and military pilots. These incidents can cause severe visual obscuration, evoke a startle response in aircrew, disrupt chromatic adaptation and in the worst case damage the eye. Especially worrisome are laser strikes during critical phases of flight. Laser eye protection (LEP) is provided to military aircrew to mitigate these effects but the LEP itself can impact the visual abilities of the aircrew. This panel presents information that will be useful to flight surgeons, aerospace physiologists and aircrew to understand issues impacting vision and human performance during the execution of mission relevant tasks when lasers are encountered and when wearing LEP. The first presentation will explain laser dazzle effects, nominal ocular hazard distances (NOHD), and nominal ocular dazzle distance (NODD). This presentation will include a tutorial on the Laser Dazzle Calculator that predicts safe NODD and can be utilized by practitioners to determine LEP requirements in order to prevent the effects of laser dazzle. If a visual exam is required to determine if tissue damage has occurred, our next presentation is on the Information Bioeffects Atlas of Laser Lesions otherwise known as IBALL. IBALL provides clinicians and researchers an extensive database on retinal lesions that can aid in clinical diagnosis. Understanding the effects is just a part of the equation. The third presentation will cover the importance of thoroughly testing LEP in order

to ensure it has the required optical properties. This presentation will include the multiple phases of testing LEP. Our final presentation will take the measurement of LEP a step further to the impact of wearing LEP on human performance. We will review efforts to develop task and performance metrics in a simulator environment to understand the impact on aircrew performance that goes beyond the impact on visual acuity and focuses on task impact. Distribution A: Approved for public release; distribution unlimited. PA Case No: TSRL-PA-2017-0232. "The opinions expressed on this document, electronic or otherwise, are solely those of the author(s). They do not represent an endorsement by or the views of the United States Air Force, the Department of Defense, or the United States Government."

[244] LASER EYE PROTECTION – TRADITIONAL AND ADVANCED OPTICAL TESTING

P.A. Smith², W.R. Brockmeier² and L.N. McLin¹

¹Optical Radiation Bioeffects Branch, 711th Human Performance Wing, JBSA Fort Sam Houston, TX; ²BioSciences, Engility Corporation, JBSA Fort Sam Houston, TX

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: Laser eye protection devices must meet the same optical standards as prescription ophthalmic lenses and personal eye protection devices. However, there are areas where standards do not exist, do not relate directly to operational performance, or are inappropriate for laser eye protective devices. In such cases, new or improved metrics and standards need to be developed. **TOPIC:** Diverse measurement procedures are used to compare specific optical attributes of laser eye protection devices with various existing standards, such as those for prescription ophthalmic lenses or personal eye and face protection devices. The instruments and systems used in these measurements vary in sophistication and complexity from off-the-shelf metrology systems (for power, prism, haze and distortion), to world-class vendor provided measurement systems (for absorption and transmission), and complex in-house designed and fabricated systems (for laser densitometry). Some of the measurement schemes employed have remained essentially unchanged for decades, while others have been modified and improved as technology advances, and enhanced with computer simulations (for coverage and vulnerability). Current metrics for haze and distortion do not have any specific correlation with visual performance, and new approaches are being investigated. **APPLICATIONS:** Optical performance metrics are used to support design or manufacturing optimization processes, to ensure compatibility with the aircrew mission, and to develop paths to new and improved standards. Although the measurement systems and processes have primarily been aimed at laser eye protection, some of them have more recently been applied to the measurement of ballistic eye protection with equal success. **RESOURCES:**

1. American National Standards Institute (2015). Ophthalmics - Prescription Ophthalmic Lenses - Recommendations. (ANSI Z80.1).
2. American National Standards Institute (2015). American National Standard Practice for Occupational and Educational Eye and Face Protection. (ANSI Z87.1).
3. American Standard for Testing Materials. (1975). Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics (ASTM D1003-61).
4. Kuyk, T. K., Smith, P. A., Engler, S., Garcia, P. V., Brockmeier, W. R., Novar, B. J., Putnam, C.M., McLin, L. N. (2013). The effects of scattered light from optical components on visual function. (AFRL-RH-FS-TR-2016-0018). Fort Sam Houston, TX 78234: Air Force Research Laboratory.

Learning Objectives:

1. Understand the various metrics used to define optical quality in prescription ophthalmic lenses and personal eye protection devices.
2. Relate optical quality metrics in protective eyewear to aspects of human visual performance.
3. Gain an appreciation of areas where standard optical quality metrics are inappropriate for laser eye protective devices.

[245] LASER DAZZLE CALCULATOR

L.N. McLin¹, C.A. Williamson³ and P.A. Smith²

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(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: Laser dazzle is the temporary impairment of human performance that is caused by visible laser light. An easy way to predict degradation in human performance from the effects of laser dazzle does not exist. **TOPIC:** A simple Laser Dazzle Calculator has been developed and is available online. Experiments were conducted to quantify the effects of specific laser wavelength and ambient luminance on the severity of laser eye dazzle experienced by human subjects. Three terms have been defined for a laser dazzle safety framework: Dazzle Level (DL), Maximum Dazzle Exposure (MDE), and Nominal Ocular Dazzle Distance (NODD). DLs quantify the extent of visual obscuration experienced, ranging from Very Low (2° diameter dazzle field, centered on the laser source) where a laser can be seen, but it only obscures a minor extent of the visual field, and Low (10°), Medium (20°), and High (40°), which represent increasing extents of visual disruption. The NODD is defined as the distance beyond which the irradiance delivered by a laser is below the MDE. The laser dazzle calculator will be explained along with some examples of software operation. Inputs to the calculator are laser wavelength, power, and divergence. Outputs of the calculator are MDE, NODD, and Optical Density for any specified laser eye protection level and specified ambient light condition (cd/m^2). **APPLICATIONS:** The calculator predicts a safe distance (NODD) for operating in the presence of laser dazzle, depending on the DL that is considered acceptable for any given application. This calculator may be used by laser safety officers, bioenvironmental engineers, and other laser users to determine safety zones for assurance of safe operation of visible lasers. The calculator also can determine the optical density required for laser eye protection to prevent undesirable laser dazzle effects.

RESOURCES: 1. C. A. Williamson and L. N. McLin, dataset "Laser safety calculator for laser eye dazzle effects and protection", figshare (2017) [retrieved 20 Jul 2017], <https://doi.org/10.6084/m9.figshare.5226115>. 2. C. A. Williamson and L. N. McLin, "Nominal Ocular Dazzle Distance (NODD)," *Applied Optics*, 54, 1564–1572 (2015). 3. C. A. Williamson, L. N. McLin, J. M. Rickman, M. A. Manka, P. V. Garcia, W. T. Kinerk and P. A. Smith, "Wavelength and ambient luminance dependence of laser eye dazzle," *Applied Optics* 56(29), 8135-8147 (2017)

Learning Objectives:

1. Understand the use of the laser dazzle calculator for laser safety applications.
2. Understand the parameters that affect the dazzle level from a laser exposure.

[246] ATLAS OF RETINAL LASER LESIONS: A WEB-BASED CLINICAL EDUCATION TOOL

J.N. Bixler², M.A. Keppler⁴, A.R. Boretsky⁴, A. Peterson⁴, A. Shingledecker⁴, L.N. McLin¹ and C. Putnam³

¹Optical Radiation Bioeffects Branch, 711th Human Performance Wing, JBSA Fort Sam Houston, TX; ²Air Force Research Laboratory, JBSA Fort Sam Houston, TX; ³Tri-Service Research Laboratory, JBSA Fort Sam Houston, TX; ⁴Engility Corp., San Antonio, TX

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: The increasing presence of laser toys and pointers, industrial processes using lasers, and specialized military use of lasers represents a growing safety threat because of the potential damage to biological tissue, particularly the eye. The ocular laser injury process varies based on the parameters of the laser, location of the laser exposure, and biological variability. Despite the availability of ocular laser injury data in the literature, no single source exists to help clinicians identify, diagnose, and treat ocular laser injuries when they encounter them in clinical settings. **TOPIC:** The Informational Bioeffects Atlas of Laser Lesions (IBALL) is a web-based tool that categorizes retinal laser injury imaging data with the goal of making imaging resources easily accessible by Department of Defense researchers and clinicians. Currently, the database contains images collected using six clinical imaging methods prior to and up to 10 days after the placement of

photothermal and photomechanical retinal lesions. Imaging systems included spectral domain optical coherence tomography (SD-OCT), fundus photography and autofluorescence, and hyperspectral imaging. The data generated was compared and contrasted to establish the optimal technique(s) for diagnosing laser lesions of a given type. Image processing software tools were developed that allow for automated registration, fusion, and manipulation of images from multiple clinical instruments to help identify laser lesions. **APPLICATIONS:** The web-based atlas provides retinal images comparing laser damage across different imaging modalities and the time course of changes after injury. The retinal images contained in the atlas will allow clinicians an improved ability to confirm or rule out laser damage and may help to inform treatment options. For researchers, this atlas amasses existing laser lesion imaging data into a central location, improving the efficiency of subsequent research studies by identifying knowledge gaps to guide future investigation.

Learning Objectives:

1. This discussion will provide attendees with a better understanding of how different types of laser lesions appear with commonly used clinical imaging systems, and will recommend best practices for detection of photothermal and photomechanical damage.

[247] FLIGHT METRICS FOR ASSESSING LASER EYE PROTECTION

B.P. Goettl¹, T.K. Kuyk², S. Engler², P.A. Smith² and J.A. Lovell¹

¹Optical Radiation Bioeffects, Air Force Research Laboratory, JBSA Fort Sam Houston, TX; ²BioSciences, Engility Corporation, JBSA Fort Sam Houston, TX

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: Aircrew Laser Eye Protection (ALEP) devices must provide protection against eye damage and glare effects while minimizing potentially negative impact on pilot and crew flight performance. Most cockpit evaluation and certification procedures use subjective ratings and may not directly address actual cockpit performance. New approaches and metrics are used to better understand and objectively measure the potential ways in which ALEP can impact cockpit performance. **TOPIC:** ALEP devices, like all life support equipment, must be tested, evaluated and certified safe-to-fly. Certification of ALEP for the Air Force includes ground and flight evaluations to investigate their operational impact on aircrew performance. Cockpit evaluations primarily use subjective ratings to assess visibility of cockpit displays and indicators and often focus on visual sensing disruption including color shifts and color confusion. While valuable, these subjective assessments provide little information related to the impact of ALEP on the performance of flight tasks and flight related skills. For example, reduced transmission of light can reduce legibility of displays, disrupt normal visual scanning patterns and delay responses to warning indicators that fall within the blocked range of the spectrum. We will describe some of the potential problems that these devices can impose on flight performance and review potential methods for objectively assessing the impact of ALEP on skills and tasks related to pilot activities in flight performance. **APPLICATIONS:** Development of objective flight-relevant performance metrics will provide a better understanding of how ALEP impact flight crew performance. This knowledge will improve the design and development of ALEP, improve the certification process, and better educate pilots on the proper use of ALEP. **RESOURCES:** 1. Kumagai, J. K., Williams, S., & Kline, D. (2005). *Vision standards for aircrew: Visual acuity for pilots*. (CR 2005-142). Toronto, Canada: DRDC Toronto. 2. Moacdieh, N. M., & Sarter, N. B. (2012). *Eye tracking metrics: A toolbox for assessing the effects of clutter on attention allocation*. Paper presented at the Human Factors and Ergonomics Society Annual Meeting, Los Angeles, CA.

Learning Objectives:

1. Understand the importance of safe-to-fly certification of Aircrew Laser Eye Protection (ALEP).
2. Understand the potential impact of ALEP filters on pilot performance.

Wednesday, May 09
Sapphire

8:30 AM

**S-055: PANEL: U.S. NAVY AEROMEDICAL
DISPOSITION – CHALLENGING CASES FROM
NAVAL AEROSPACE MEDICAL INSTITUTE (NAMI):
PANEL #1**

Chair: Kai Yan Cheng
Pensacola, FL

Chair: Joseph LaVan
Pensacola, FL

PANEL OVERVIEW: This panel represents selected challenging cases from the Naval Aerospace Medical Institute (NAMI). NAMI is the center of excellence for U.S. Navy (USN) and Marine Corps (USMC) aerospace medicine and is staffed by flight surgeons, aerospace clinical specialists, and support personnel. All USN and USMC aerospace medicine dispositions are made at NAMI. Annually, NAMI receives approximately 50,000 flight physicals from fleet flight surgeons throughout the world and conducts more than 5,500 clinical encounters in Pensacola, Florida. This multi-disciplinary panel will highlight five challenging cases dispositioned by NAMI in the past year. Case 1 concerns pilots with color vision deficiencies, case 2 involves a student naval applicant on humira for psoriasis, case 3 leads a discussion on the use of SSRI in naval aviation, case 4 concerns an aviator with parsonage-turner syndrome, and case 5 is a case of a pilot with essential thrombocytosis. Disclaimer: The views expressed in this panel are those of the authors and do not necessarily reflect the official position of the Department of the Navy, Department of Defense, nor the U.S. government.

**[248] NAVAL AEROSPACE MEDICAL INSTITUTE (NAMI)
CHALLENGING CASES: COLOR VISION DEFICIENCY AND
PERFORMANCE-BASED ASSESSMENT**

K. Dohm

Eye Clinic, NAMI, Pensacola, FL

(EDUCATION - CASE STUDY CLINICAL)

BACKGROUND / LITERATURE REVIEW: Accurate color perception is a vital aspect of safe flight operations. Aviators with moderate and severe color vision deficiencies have less accurate and slower reaction times compared to those with normal or mild color vision deficiency. **CASE PRESENTATION:** Two cases involving performance based color vision testing of a helicopter pilot and a C-40 loadmaster with color vision deficiencies will be discussed. Both aviators initially failed the pseudo-isochromatic plate (PIP) color vision test, but passed the Farnsworth Lantern (FALANT) test at their initial flight physicals. The FALANT test is designed to pass mildly color vision deficient individuals, with moderate and severe color deficient individuals occasionally passing. Upon subsequent testing at annual flight physicals, both aviators failed the FALANT and were administered the Waggoner Computerized Color Vision Test (Waggoner CCVT), which gives qualification and quantification information on color vision perception. The pilot was deemed to have a moderate protan (red) deficiency and the loadmaster was deemed to have a severe deutan (green) deficiency. Both aviators scored well below their control group counterparts in the practical color vision performance-based testing regimen, and were both grounded without a recommendation for continued Naval flight duties. **OPERATIONAL / CLINICAL RELEVANCE:** These cases highlight the importance of color perception for safe flight operations. Congenital color vision deficiency exists in approximately eight percent of the population, with males being affected much more than females due to the X-linked pattern of inheritance. Through studies performed at the Naval Medical Research Unit in Dayton, OH, it has been demonstrated that individuals with moderate and severe color vision deficiency are less accurate and have slower reaction times for aviation-related tasks compared to those with normal color perception or with mild color vision deficiency. The performance-based color vision assessment that was used in the study as well as for the practical

tests given to the aviators for these case reports will be reviewed. Information on how to set up a performance-based color vision assessment will be shared. The Naval Aviation color vision standards will be reviewed, as will information on the new digital color vision tests that are available.

Learning Objectives:

1. Explain the significance of color vision deficiencies for duties involving flight.
2. Describe an aviation-related performance-based assessment for color vision deficiency.

**[249] SNA WITH NEW-ONSET GUTTATE PSORIASIS
ON ADALIMUMAB**

P. Adriano and K. Richmond
53PX, NAMI, Pensacola, FL

(EDUCATION - CASE STUDY CLINICAL)

PROBLEM STATEMENT: This case report describes a student naval aviator with new-onset guttate psoriasis requiring adalimumab treatment and the aeromedical considerations. **BACKGROUND / LITERATURE REVIEW:** This case highlights the challenges in aeromedical decision making regarding medication, an inflammatory disease process, and a student aviator. The development of TNF-alpha inhibitors has opened up new treatment options for inflammatory conditions and has increased the probability of reaching a state of remission. However, a balance must be established between the underlying condition, the treatment, and the aviator in order to best preserve aviation safety and yet serve the aviation mission. **CASE PRESENTATION:** The student pilot was a 22-year-old male recent graduate initially diagnosed following the eruption of a rash consisting of round, palpable erythematous blanchable papules with overlying scale present on the extremities, trunk, hands and feet including palms and soles. A biopsy was taken and he was started on topical triamcinolone. At repeat visit, the exam and biopsy were consistent with guttate psoriasis and UVB therapy was initiated. After 5 months of UVB treatments, some improvement was noted, but flares continued especially with stress. Adalimumab was started with complete clearance of the lesions after 2 weeks. Following five months of treatment, adalimumab was discontinued in order to pursue an aviation waiver. **OPERATIONAL / CLINICAL RELEVANCE:** Guttate psoriasis is a common manifestation of psoriasis in the young (<30) frequently as a reaction to strep infection in a susceptible individual. Treatment includes UV therapy, topical corticosteroids, and systemic immunosuppression. Although responsive to treatment and permanent clearance occurring frequently, approximately 25% develop plaque psoriasis. For this condition, the arrival of TNF-alpha inhibitors has brought symptomatic remission to patients who previously would have been unsuccessfully treated. However, these medications are not without their side effects including neutropenia, serious infection (pneumonia, zoster, TB, opportunistic), and malignancy. Additionally, we must consider the operational requirements of the service members requiring these medications, specifically medications requiring refrigeration and the need to provide a regular injection in an austere environment. This case examines the balance between service member, condition, and treatment.

Learning Objectives:

1. Understand the aeromedical considerations regarding both guttate psoriasis and TNF-alpha inhibitors as they relate to aviation safety and deployability.

[250] CLASS IV SSRI WAIVER

D. De Cecchis

Psychiatry, NMOTC/ NAMI, Pensacola, FL

(EDUCATION - CASE STUDY CLINICAL)

PROBLEM STATEMENT: This case report describes a Class I aviator who requested to transition to Class IV and to work as a mission commander while continuing to take a selective serotonin reuptake inhibitor (SSRI) to continue to treat obsessive-compulsive disorder (OCD). **BACKGROUND / LITERATURE REVIEW:** The use of SSRI's, and other steady-state psychotropic medications, for treatment of non-psychotic psychiatric conditions has found relevance in many realms of U.S. aviation. The Federal Aviation Administration (FAA) approved the use of certain SSRI's for treatment of depression and anxiety in 2010. The U.S. Air

Force and U.S. Army have similar policies. **CASE PRESENTATION:** The patient is a designated Class I aviator who was medically disqualified from flight duty after developing OCD. In addition to psychotherapy, the patient was treated with an SSRI. After undergoing an extensive psychiatric and neuropsychological evaluation, a favorable recommendation was made to return to flight duties as a Class IV mission commander while continuing to take the SSRI and while continuing in psychotherapy. **OPERATIONAL / CLINICAL RELEVANCE:** The current Naval Aeromedical Psychiatric policy does not allow those on flight status to continue to take prescribed steady-state psychotropic medications for non-psychotic conditions after symptom remission and return to flight status. In the case of a designated aviation asset, this represents a significant loss of experience within the aviation community as well as financial losses for the organization and the patient. After a thorough psychiatric and neuropsychological assessment, and with appropriate risk control measures, it is reasonable to consider waivers on a case-by-case basis.

Learning Objectives:

1. Describe the U.S. Naval Aviation policy regarding SSRI use and those on flight status.

[251] PARSONAGE TURNER SYNDROME: A RARE DISORDER OFTEN MISDIAGNOSED

M. Mathew

NAMI, Pensacola, FL

(EDUCATION - CASE STUDY CLINICAL)

A 52-year-old male presented to urgent care with acute atraumatic dull aching left shoulder pain that progressed to sharp worsening pain at night. He was diagnosed with cervicgia and treated prednisone and NSAIDs. One week later he saw his PCM for worsening symptoms of pain. He was diagnosed with impingement syndrome, given a subacromial steroid injection, and referred to physical therapy. The therapist was concerned for a rotator cuff tear because of his severe weakness. Patient was evaluated by orthopedics two months from onset and complained primarily of weakness. His exam revealed pertinent findings full motion, 4 out of 5 strength of supraspinatus and infraspinatus, positive Neer, and no muscular atrophy. An MRI was obtained. One month later the patient demonstrated atrophy and wasting of the supraspinatus and infraspinatus with 3 out of 5 strength. The MRI revealed increased T2 signal throughout the infraspinatus consistent with denervation edema, tendinopathy but no tears, no paralabral cyst. The patient's clinical presentation and imaging are consistent with Parsonage Turner Syndrome. He is pending an EMG/NCS for confirmation. Careful history revealed the patient had experienced viral symptoms, which could have been a potential infectious source. Parsonage-Turner Syndrome (PTS), also known as brachial neuritis, is a rare disorder with abrupt onset of unilateral shoulder pain, night pain, and progressive neurologic deficits of motor weakness, dysesthesias, and numbness. Various etiologies including: idiopathic, postoperative, post-infectious, post-traumatic, and post-vaccination. It is generally self-limiting with favorable functional recovery. MRI and EMG studies confirm the diagnosis. Proper diagnosis avoids additional testing, surgical referral, and unnecessary procedures. This is relevant in military medicine where there's a higher incidence of shoulder surgeries, commonly for shoulder impingement (7.77/1000 person-years) and SLAP (superior labrum anterior-posterior) tears (2.13/1,000 person-years). PTS is 30-50 times more common than previously thought. Unawareness of the disorder and the similar clinical presentation to cervical and other shoulder pathology results in misdiagnosis and delays in proper treatment.

Learning Objectives:

1. Proper diagnosis of this disorder avoids unnecessary additional testing, or surgical exploration referral, and unnecessary procedures. This is very relevant in aviation medicine where there is a higher incidence of shoulder surgeries for active duty and retired populations.

[252] ESSENTIAL THROMBOCYTOSIS IN AN AVIATOR

K. Cheng

Internal Medicine, NAMI, Pensacola, FL

(EDUCATION - CASE STUDY CLINICAL)

PROBLEM STATEMENT: This is a case report describing a military fix-wing pilot with essential thrombocytosis. **BACKGROUND /**

LITERATURE REVIEW: Essential thrombocytosis is a chronic myeloproliferative disorder characterized by clonal production of abnormal platelets causing an increase in risk of thrombosis and hemorrhages. In rare instances essential thrombocytosis may develop into acute myeloid leukemia or myelofibrosis. This condition presents a unique challenge for Naval Aerospace Medicine. **CASE PRESENTATION:** The subject is a 36 years old Navy instructor pilot with over 2000 total flying hours was found to have an elevated platelet count of 500,000/ μ L as part of a routine screening due to a family history of acute leukemia. He has no significant past medical history. The pilot underwent an evaluation by Hematology and was diagnosed with essential thrombocytosis based on results of the bone marrow biopsy and a positive JAK 2 mutation. The pilot was determined to be at low risk of complications and cytoreductive therapy was not recommended. The pilot was placed on a daily 81mg aspirin and returned to full duty with close follow-up. **OPERATIONAL / CLINICAL RELEVANCE:** It is generally recognized that conditions which may predispose pilots to thrombosis and hemorrhages are disqualifying for Naval Aviation. Occurrence of these complications in flight may be catastrophic. The risk of transformation to acute myeloid leukemia or myelofibrosis presents additional concerns for the applicant pool. However, it may be reasonable to consider a waiver for designated aviators who are considered to be at low risk for complications.

Learning Objectives:

1. Review aeromedical implications of essential thrombocytopenia.

Wednesday, May 09

8:30 AM

Chantilly East

S-056: PANEL: RESIDENT GRAND ROUNDS I

Sponsored by The American Society of Aerospace Medicine Specialists

Chair: Richard Allnutt

Beavercreek, OH

Chair: Mark Coakwell

Beavercreek, OH

PANEL OVERVIEW: This panel will consist of pairs of Aerospace Medicine residents presenting clinical cases of aeromedical interest or significance. During their residency practicum years, residents conduct evaluations of patients with diverse medical problems. Residents prepare and present a case report based on a patient encounter undertaken during their practicum experience. One resident from each pair presents the history of the presented problem. The other resident presents the physical findings and a discussion of the aeromedical policies associated with the condition. Learning Aerospace Medicine at the specialist level involves understanding the impact of medical conditions on aircrew health and mission accomplishment. The cases presented will not only be of academic interest but will also illustrate aeromedical decision making in the operational environment.

Wednesday, May 09

8:30 AM

Chantilly Foyer

S-057: POSTER: ALTITUDE & SPACE EFFECTS

Chair: Frederick Bonato

Montclair, NJ

Chair: Volker Damann

Königswinter, Germany

[253] RESULTS OF THE 2016 AVIATION MEDICAL EXAMINATION OF SOUTH KOREA

Y. Kwon^{1,2} and Y. Ha^{3,2}

¹Aeromedical Center, Korean Air, Gangseo-gu, Republic of Korea;

²Aerospace Medical Association of Korea, Seoul, Republic of Korea;

³Yonsei University College of Medicine, Seoul, Republic of Korea

(ORIGINAL RESEARCH)

INTRODUCTION: The purpose of the aviation medical examination is to determine that no physical or mental condition exists which may reduce the applicant's medical fitness to a significant degree during the period of validity of the medical assessment. The results of the aviation medical examination are helpful to identify the common disqualifying conditions and to provide airman health care. **METHODS:** South Korea has an online aviation medical examination system. We analyzed the results of the 2016 aviation medical examination of South Korea.

RESULTS: The following is the classes of airman medical certificates applied. Of the total 11,284 cases, 10,761 cases (95%) were applied for first-class, 119 cases (1%) were for second-class and 404 cases (4%) were for third-class. Of the total 11,284 cases, fit to flight was 10,103 cases (90%), special issuance was 1,162 cases (10%) and denial was 19 cases (0.001%), respectively. The special issuance cases are listed in the following order. There were 276 cases (23.8%) of hypertension, 112 cases (9.6%) of hearing loss, 84 cases (7.2%) of refractory surgery, 70 cases (6.0%) of diabetes, 63 cases (5.4%) of kidney stones, 53 cases (4.6%) of gall bladder stones, 44 cases (3.8%) of glaucoma, 40 cases (3.4%) of cataract, 32 cases (2.8%) of thyroid cancer surgery and 30 cases (2.6%) of macular degeneration. Of the total 11,284 cases, 18 were denied, six of them were not submitted requested medical records (abandonment), and two were unfit due to the short observation period. In fact, there were 10 cases of disqualifying disease or unfit for flight conditions. The causes of denial cases were mainly ophthalmologic diseases, acute myocardial infarction, head trauma and cerebral hemorrhage, and psychiatric disorders. **DISCUSSION:** The most common special issuance cases were cardiovascular diseases, and ophthalmology. The common causes of denial cases were ophthalmologic diseases, acute myocardial infarction, head trauma and cerebral hemorrhage, and psychiatric disorders. Based on the analysis results of the aviation medical examination, it is the plan to establish the health management plan of the airman.

Learning Objectives:

1. To establish the health management plan of the airman, based on the analysis results of the aviation medical examination.

[254] ASSESSING THE COMPLETENESS OF OCCUPATIONAL EXPOSURE DATA IN THE LIFETIME SURVEILLANCE OF ASTRO-NAUT HEALTH

J. Sieker³, J. Shafer⁴, L.R. Lee², M.L. Wear¹ and M. Van Baalen⁵
¹Flight and Medical Operations, KBRWyle, Houston, TX; ²NASA/Wyle, Houston, TX; ³University of California, San Diego School of Medicine, La Jolla, CA; ⁴MEI Technologies, Houston, TX; ⁵NASA JSC, Houston, TX

(ORIGINAL RESEARCH)

INTRODUCTION: Longitudinal analysis on how spaceflight affects human health requires significant amounts of data. Missing data, especially if missing in a non-random fashion, could be a significant challenge to the success and validity of ongoing occupational surveillance and research. Astronaut occupational health data have been collected since 1959 in various formats and as part of several flight programs. As a result of changing methodologies over this span, epidemiologists in the NASA Lifetime Surveillance of Astronaut Health (LSAH) project regularly compile data sets with important exposure or outcome data missing. **METHODS:** NASA medical records of astronauts participating in voluntary annual LSAH examinations were reviewed and compiled to develop Individual Exposure Profiles (IEP) for each astronaut. These data were supplemented by an interview. If the interview yielded medically-relevant information that was absent from the medical record, that information was considered an update. The IEPs were analyzed to identify trends regarding the characteristics of astronauts who provided updates and what kinds of information were consistently being updated. **RESULTS:** To date, 190 astronauts have participated in the IEP project. Medical information was updated for 119 individuals during these interviews. The astronauts' likelihood of updating their record upon interview was not significantly related to their spaceflight experience, era of active spaceflight, or duration of longest spaceflight. The most commonly updated categories of medical information were issues encountered during spaceflights, including CO₂ symptoms, vision changes, back pain, headaches, and space motion sickness. **DISCUSSION:** The most commonly updated categories correspond to areas where LSAH has ongoing analysis efforts and therefore do not appear to have been

reported at random. This presentation will address identification of missing astronaut health data and trends, forward work identified by the IEP project and how this information may be used for future LSAH data gap analyses.

Learning Objectives:

1. The completeness of longitudinal data in aerospace medicine may be affected by the relative youth and quick growth of the field, which is an important analytical consideration.

[255] SYNERGISTIC RESEARCH SYNTHESIS ENABLING EVIDENCE BASED PRACTICE THE AEROSPACE MEDICINE SYSTEMATIC REVIEW GROUP

A.J. Winnard⁴, C. Richter¹, T. Weber², B. Braunstein³, M. Nasser⁵, R. Velho⁶ and N. Caplan⁴
¹Space Medicine Office, European Astronaut Center, Cologne, Germany; ²European Astronaut Center, European Space Agency, Cologne, Germany; ³Institute of Biomechanics and Orthopaedics, German Sport University, Cologne, Germany; ⁴Northumbria University, Newcastle upon Tyne, United Kingdom; ⁵Peninsula Dental School, Plymouth, United Kingdom; ⁶Aerospace Medicine Systematic Review Group, Newcastle, United Kingdom

(ORIGINAL RESEARCH)

INTRODUCTION: Evidence based practice requires showing upon what we are basing medical opinions and guidelines, or recognizing when evidence is absent that guidance is "expert opinion" and research is required to fill evidence gaps. Aerospace is one of the final medical fields to begin organizing a critical summary, adapted periodically, of evidence underpinning operations, and the Aerospace Medicine Systematic Review Group is a new initiative to fill this gap. This group facilitates high quality, transparent synthesis of evidence, to inform operational medical guidelines in best practice, while simultaneously guiding future research by identifying research gaps. The group has (A) facilitated a second review with the European Space Agency Medical Office to inform human Lunar and Martian mission medical considerations and (B) developed and published, open access, new review methods to aid others to undertake aerospace medicine systematic reviews. **METHODS:** (A) Electronic databases were searched from the start of records to April 2016. Studies were assessed with the Cochrane risk of bias tool. Effect size analysis was used to assess the effect of various gravity loading on human biomechanical and cardiopulmonary systems. (B) A new rating scale to appraise technical principles of studies to simulate partial gravity was implemented. Additional method guides for developing questions, protocol drafting, data extracting, quantifying effects and scoring a bed rest study quality were also developed. **RESULTS:** (A) The review identified 43 studies that found partial gravity appears unable to protect against cardiovascular and biomechanical changes. (B) The group designed and developed a website (www.aerospacemed.rehab/systematic-review-group) to provide free access to methods developed by the group and provide links to wider resources. **DISCUSSION:** The systematic review informed medical considerations for future human exploration missions and demonstrates how systematic synthesis of the evidence base more strongly and better informs medical operations than expert opinion, basic reviews or disordered individual studies. Limitations in the current conduct and reporting of aerospace medicine research are also highlighted. Continuing development of review methods, published as open access guides on the group website and working with review teams globally, will help bring synergy to, and enable high quality summary, of the aerospace medicine evidence base.

Learning Objectives:

1. Describe the effect of various g loading on human physiology.
2. Understand how to review aerospace medicine primary research and be able to apply this knowledge.
3. Employ high quality and transparent systematic review skills when synthesising aerospace medicine primary research.

[256] A CONCEPT FOR AEROSPACE MEDICINE EDUCATION IN MEDICAL SCHOOL

M. Boyle, N.G. Economos, M. Ghani, A. Singh and L. Kaye
 Yale School of Medicine, New Haven, CT

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: The vast majority of medical students in the U.S. have no curricular or extracurricular opportunities for exposure or education in concepts of aerospace medicine. This gap is a missed opportunity to educate and recruit a large volume of potential high-quality practitioners and researchers to the field. **TOPIC:** In order to thrive and advance, all fields of medicine depend on the ability to recruit and educate and young talent to produce the next generation of practitioners and researchers. To accomplish such a task requires organization and resources such as educators, curriculum, educational materials, and qualified student participants. Mobilizing such resources can often be difficult in medical institutions, especially at those with few to no faculty representatives from the field of aerospace medicine. Here we describe a cost-effective, supplemental, seminar-based education model at the Yale School of Medicine. A small cohort of medical and PA students participated in a monthly problem-based learning (PBL) style seminar that supplemented current topics in the medical school curriculum using available text material to educate students on concepts pertaining to aerospace medicine. This model afforded future healthcare providers a basic education and exposure to this otherwise obscure field at an institution with few resources and faculty associated with aerospace medicine and human performance. **APPLICATIONS:** The need to identify, educate, and recruit quality future trainees is a necessity for all medical fields. Aerospace medicine faces specific challenges in accomplishing this important task, especially at institutions with few resources or faculty in this field. We offer a cost-effective, easily-implementable educational model that can be expanded to medical schools across the country to address this need. **RESOURCES:** Grenon SM, Saary J. Challenges in aerospace medicine education. *Aviat Space Environ Med.* 82:1071-2, 2011.

Learning Objectives:

1. Be able to describe at least two key features of a successful integration of an aerospace medicine seminar into undergraduate medical education.
2. Be able to list at least three factors likely limiting entry into the field of Aerospace Medicine by medical trainees.

[257] THE NEW VOCABULARY OF AEROSPACE MEDICINE

D. Zito

FAA, Wantagh, NY

(EDUCATION - TUTORIAL)

The field of medicine has undergone several revolutionary changes within just the past decade. Many of these involve concepts that were inconceivable until recently such as fecal transplants and the microbiome. Others: the glymphatic system of the brain, the pharmacology of anandamide receptors, the use of epigenetics or gene editing to treat cancer, and the development of novel growth-accommodating implants for valvular annuloplasty in juveniles, have opened up incredible opportunities for patients but may be challenging for the aerospace medicine practitioner. As aerospace medicine evolves, those practitioners have to become familiar with these and other terms so they will understand which novel approaches can be accommodated or accepted within the extreme environments of our field and, at the least, be able to converse with other specialists outside of Aerospace Medicine.

Learning Objectives:

1. To define and describe new terminology within the fields of medicine and surgery and demonstrate how that terminology will be useful for the Aerospace Medicine specialist.
2. Discuss how the new concepts were discovered and developed and their possible futures.
3. Generate dialogues with our peers about their exciting forays into new science.

[258] INDICATION AND SIZE ANALYSIS FOR RENAL STONE INTERVENTION IN A LARGE REFERRAL CENTER APPLIED TO ASTRONAUT STONE SCREENINGK. Albaba¹, D.J. Lerner^{1,3} and A.J. Parmet²¹Radiology, University of Missouri Kansas City, Prairie Village, KS;²Aviation Safety and Security, University of Southern California, Kansas City, MO; ³Radiology, Hays Medical Center, Hays, KS**(ORIGINAL RESEARCH)**

INTRODUCTION: Nephrolithiasis could be potentially devastating on an Exploration Class Mission. Complications include superinfection and sepsis, obstruction and functional kidney loss, as well as incapacitating colic. Stone size plays a large role in determining the need for intervention and ultimate outcome. **METHODS:** A retrospective chart review was performed of all stone interventions over the course of one year at a large referral center hospital. Each patient had three dimensional stone analysis performed for size and volume, maximum stone size and its relation to the size cutoff of concern at the NASA Astronaut Program for Exploration Class Missions. Indications for intervention were also analyzed, including clinical concern for sepsis/pyonephrosis, obstructive uropathy/hydronephrosis, incapacitating colic, and failure of stone passage following a "watch and wait" approach. **RESULTS:** After discarding patients that had planned retrieval for asymptomatic, non-obstructing stones, 125 patients remained. Of these, 16 (12.8%) stones requiring intervention were 3mm or less in size. 2 of 16 required intervention for clinical concerns of sepsis/pyonephrosis. 6 of 16 required intervention after failed "watch and wait" approach. The other 8 of 16 required intervention for either severe colic or concerns for obstructive uropathy. **DISCUSSION:** While previous studies have reported an inversely proportional relationship between renal stone size and rate of spontaneous passage, this is the first that directly addresses nephroureteral intervention pertaining to the stone size cutoff of 3mm discussed for the Astronaut Program in Exploration Class Missions. In the examined patient population, 12.5% had stones that would have potentially been accepted in the initial screening but eventually required intervention for incapacitating or potentially fatal complications. While waiting for spontaneous passage is reasonable for those with access to emergent intervention, failure of passage carries a much higher risk when intervention is not readily available. Further risk to benefit ratio assessment and research into methods of interventional microgravity techniques could be critical for an additional safety net in the case of subsequent obstruction caused by a stone of 3mm or less.

Learning Objectives:

1. Understand the inverse size of nephrolithiasis in association with risk of obstruction requiring intervention.
2. Understand risk assessment and clinical factors leading to intervention in stone size below potential suggested screening parameters.
3. Understand potential further research required to treat obstructing stones in microgravity.

[259] MATHEMATICAL MODEL OF HIF-1ALPHA PATHWAY, OXYGEN TRANSPORT, AND HYPOXIAP. Robinson^{1,2}, E.A. Merrill¹, M. Chappleau^{1,2}, T.R. Sterner^{1,2} and D.R. Mattie¹¹71st Human Performance Wing/RHDJ, AFRL, Wright-Patterson AFB, OH; ²Henry M. Jackson Foundation, Dayton, OH**(ORIGINAL RESEARCH)**

INTRODUCTION: Hypoxia-like events experienced by F-22 pilots after training missions have raised questions about pilot exposures and mission accomplishment. These episodes identified data gaps in the understanding of pilot exposures in high performance aircraft. We therefore need to understand how low oxygen levels at pressures lower than standard atmospheric pressure cause physiological hypoxia, and how this relates to alterations in cognition. Oxygen sensing pathways, particularly those involving the oxygen sensing cytosolic gene transcription factor (hypoxia inducible factor) HIF-1 α , are key to understanding these responses. **METHODS:** A mathematical model was developed to integrate experimental measurements and provide a description of the mechanisms of hypoxia and the mammalian (human) response. The initial iteration of our model focuses on oxygen delivery to the brain. It includes delivery of oxygen to the blood via hemoglobin binding, breathing rate and cardiac output, delivery of oxygen from the blood to the brain tissue, and finally the response of the HIF-1 α signaling pathway in terms of alterations in gene expression and other end-points. **RESULTS:** The model simulates time courses of tissue (brain) oxygen, intracellular HIF-1 α , transport to the nucleus, binding to hypoxia responsive element (HRE) and generation of transcription signal, under altered blood oxygen levels. The HIF-1 α model is partially parameterized based on experimental data in the literature. The model has been fitted to (literature)

steady-state dose/response data for vascular endothelial growth factor (VEGF) and VEGF mRNA. The model also describes angiogenesis data (longer term changes in capillary densities in response to prolonged exposures), while assuming linearity of dose/response for gene transcription process. **DISCUSSION:** *In vitro* cell-based studies are useful for elucidating elements of these processes. These parameters need to be integrated and applied (extrapolated) to relevant human exposure scenarios in order to assess the relevance of hypoxia to the above mentioned Air Force issues. Mathematical models of the kind described here are essential both for the understanding of *in vitro* results in terms of underlying response mechanisms, and in order to extrapolate these results to *in vivo* and relevant human scenarios.

Learning Objectives:

1. Understand quantitatively the mechanistic basis for hypoxia signaling and responses in the brain.

[260] EFFECT OF NATIONALITY AND ASTRONAUT'S USE OF ANTIEMETIC DRUGS ON WTF SCORE IN A COMMERCIAL SPACE FLIGHT SCENARIO

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(ORIGINAL RESEARCH)

INTRODUCTION: Space Motion Sickness (SMS) is a common occurrence among astronauts during their first 72 hours of microgravity exposure. Antiemetic agents commonly used to attenuate the potentially hazardous symptoms of SMS include both scopolamine and promethazine. An unexplored issue thus far, the impact that the use of these drugs may have on the general population's view of spaceflight was examined. Given the risk of cognitive impairment due to use of the current antiemetic drugs, it is the authors' prediction that astronaut's use of these drugs will have an effect on the general population's willingness to fly (WTF) score in the presented commercial space flight scenario. **METHODS:** Participants were presented with one of two hypothetical scenarios. One scenario included astronauts using antiemetic drugs while the other scenario included no use of antiemetic drugs. The prevalence of SMS as well as the efficacy and side-effects of scopolamine and promethazine were presented. A 7 question Likert Scale, the WTF scale was used to assess participant's level of comfort, fear, and willingness to fly in a given situation. IRB approval was obtained. **RESULTS:** The data was analyzed with a 2x2 ANOVA. There was a significant main effect, $F(1,199) = 33.507$, $p < 0.001$ such that individuals from India reported a higher WTF score in the commercial space flight scenario than individuals from the U.S. regardless of drug condition (India $M = 0.57$, $SD = 0.95$, U.S. $M = -0.27$, $SD = 1.1$) $p < 0.0005$, $\eta^2 = .144$. There was a significant interaction effect, $F(1,199) = 8.508$, $p < 0.05$ such that those in the drug condition from India reported a higher WTF score in the commercial space flight scenario than those in the drug condition from the U.S. (India x Drug Condition $M = 0.67$, $SD = 0.95$, U.S. x Drug Condition $M = -0.58$, $SD = 1.1$) $p = 0.004$. **DISCUSSION:** Based on the findings of this paper, there is a clear difference in willingness to participate in commercial space flight between potential Indian consumers and potential U.S. consumers when pharmaceutical interventions are used. The reason for this difference is beyond the scope of this paper, however, it would behoove the commercial spaceflight industry to pursue future research to understand the disparity between Indians and Americans in their WTF score.

Learning Objectives:

1. To examine the effect of nationality and the use of antiemetic drugs on individual's willingness to fly in a commercial space flight scenario.

[261] NEURO-ELECTROPHYSIOLOGICAL EFFECTS OF HYPOBARIC AND HYPEROXEMIC EXPOSURE IN A SWINE MODEL

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(ORIGINAL RESEARCH)

INTRODUCTION: Neurological impairments such as confusion, headache and repeated vomiting have been reported in U-2 pilots during high altitude missions. A direct assessment of neuronal function using an electrophysiological approach in an animal model exposed to simulated high altitude using hypobaric chambers can generate detailed characterization of these neurological effects that may unveil the mechanism underlying these reported cognitive deficits. Because U-2 pilots pre-breathe 100% oxygen and are provided oxygen supplementation during flight, we also assessed the effects of repeated exposures to 100% oxygen on neuronal function. This research is part of a larger study led by the U.S. Air Force School of Medicine being conducted at the 59th Clinical Research Division, Wilford Hall Ambulatory Surgical Center at Lackland Air Force Base. **METHODS:** We used a swine model to investigate effects of hypobaria and hyperoxemia on the brain. Swine brains are gyrencephalic and are believed to better represent the human brain. Animals were either repeatedly exposed to 5,000 ft (control), sea level with 100% oxygen (hyperoxemic) or simulated 30,000 ft (hypobaric). Following exposures, swine brains were quickly harvested and hippocampal slices prepared while maintaining neuronal viability by constant perfusion with oxygenated artificial cerebrospinal fluid. We were able to obtain signals from a majority of intact slices, and recordings were made using a microelectrode array system. We measured spontaneous spiking data, input/output relationship plots, and short-term plasticity assessments using paired pulse stimulation protocol. The study was approved by the WPAFB IACUC. **RESULTS:** We found that there were no statistically significant differences in the overall size of synaptic response as assessed using electrical stimulation of varying sizes from animals repeatedly exposed to control, hyperoxemic or hypobaric conditions. However, there were small but statistically significant differences in paired pulse facilitation as well as spontaneous firing frequency resulting from high oxygen and high-altitude exposures. **DISCUSSION:** Further studies would be needed to confirm that these changes are indeed results of hyperoxemia and/or hypobaria and evaluate the significance of these changes as to whether they are reversible, persistent or progressive, and how they can potentially manifest into cognitive deficits.

Learning Objectives:

1. To generate an electrophysiological profile characterizing the effects of hypobaria and hyperoxemia on brain function using a swine model.

[262] FEASIBLE CONFIGURATIONS FOR AN ISS CREW SHORT ARM CENTRIFUGE

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(ORIGINAL RESEARCH)

INTRODUCTION: Short arm human centrifuge has been proposed since the early years of human space flight. There was even a compact plan within Space Shuttle mid-deck locker. Many experiments possible on the ground have been completed. Due to the discovery of new adverse effects in long duration flight, i.e., ocular problems, medical operations community takes a new look at centrifuge countermeasures. **METHODS:** What should be verified on the International Space Station (ISS) initially are: 1) if short arm centrifuge operation is acceptable by astronauts; and 2) if session repetition interval and G load combination effects are similar to those on the ground. In 2012, an international proposal 'AGREE', to install a short-arm centrifuge combined with ergometer using the ISS module 'PMM', was turned down due to vibration analysis. As PMM is filled up now, most promising location on the ISS is a visiting spacecraft. (A) HTV-X cargo ship, an upgrade from HTV operated by JAXA, is most suitable as it is the largest diameter ship with an orbital life of two years. The beauty of a cargo ship option is thorough test on the ground. If NASA agrees the rotor to fill NASA-owned cargo space, no new rocket manifest is necessary. (B) A new expandable module like 'BEAM' could be used, but the rotor mechanism and its sustaining structure should be installed in orbit, which is not only time-consuming, but integrity of its assembly is hard to check onboard. (C) If a visiting spacecraft, including cargo ship, is rotated as a free-flyer, it could act as a centrifuge. However, no such design exists; it would be extremely costly for safety reasons. In addition, subject crew posture

would be hard to be standardized. **RESULTS:** During design work of ISS module 'CAM', they found that if a 2-ton animal centrifuge rotor came to a sudden stop, Common Berthing Mechanism cannot tolerate the torque. The 300+ kg motorized rotor of AGREE had a vibration issue. Thus, light-weight rotor with inherent safety is desired. For HTV-X vehicle, assuming diameter of 3.2 m, rotation rate of 30 rpm, and single or double-rack width, possible rotor design is a human-powered driven rotor with or without counter weights. The energy necessary for acceleration is close to that of riding a bicycle. **DISCUSSION:** Towards the end of ISS in 2024, we need to be creative in flying and testing a new but also long-standing physiological countermeasure of human centrifuge, looking at Mars missions.

Learning Objectives:

1. To understand that human centrifuge could be a new physiological countermeasure for long duration space flight.

[263] AUSTRALIA'S CURRENT SPACE LIFE SCIENCES CAPABILITIES AND FUTURE DIRECTIONS

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(EDUCATION - PROCESS)

MOTIVATION: Australia has a track-record of collaborative biosciences research and already contributes to the field of space medicine. With the announcement and development of Australia's new space agency, now is the time for Australia to cultivate closer ties and collaborative relationships with the rest of the global space industry. This paper summarizes current Australian capabilities in space life sciences and outlines areas of future capability development. **OVERVIEW:** Biomedical sciences are a key element of the future Australian space industry. The Australasian Society of Aerospace Medicine, the Australasian College of Aerospace Medicine and the Australian College of Rural and Remote Medicine educate aerospace and extreme medicine professionals with applicability to training of future astronauts. The Australian Antarctic Division conducts space analogue research and has developed a medical training program that encapsulates the capabilities required by medical doctors venturing into deep space. Australia's universities are undertaking space medicine research in collaboration with international space agencies, in a wide range of specialized disciplines. Other space medicine research domains worthy of future development in Australia have been identified. The Australian medical research sector values close working relationships with industry, and these space life science research and development efforts will have the potential to generate scientific spin-off benefits through improved health care, the development and market deployment of novel technologies by private industry, and stimulation of the academic sector. The advent of an Australian Space Agency will potentially provide a more streamlined organizational framework and point of liaison to foster collaboration, allowing a greater contribution by Australia to international research, development, commercialization and exploration efforts. **SIGNIFICANCE:** Australia's capabilities and strengths position it well to contribute to the field of space medicine and bioastronautics. Australian researchers are developing capabilities and technologies that can be applied to the optimization of human health and performance in spaceflight, with beneficial applications for the community at home. At the dawn of a new age of long-duration space exploration, Australia will be better positioned to contribute its expertise in niche areas of biomedical science to provide support for future missions.

Learning Objectives:

1. Understand Australia's space medicine research capabilities and future directions.
2. Outline the diverse and multidisciplinary nature of Australia's space medicine research.
3. Discuss opportunities for collaboration with Australian research programs in space medicine.

[264] ASSESSMENT OF AN OCULOMOTOR TEST AND THE PROFILE OF MOOD STATES SCALE DURING 36-HOURS OF SLEEP DEPRIVATION USING MODAFINIL

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(ORIGINAL RESEARCH)

INTRODUCTION: Sufficient sleep has been recognized as one of the most important factors that may help to ensure the success of a mission or field operation. Fatigue due to sleep loss has been named a contributing factor in many military aviation mishaps. Prescription alertness aids, such as modafinil, are effective in improving performance, alertness, and mood during extended wakefulness periods in both the laboratory and in operations. Some evidence suggests an oculomotor measure may be useful in determining the fatigued state of an operator. The current analysis investigates the ability of oculomotor changes to indicate a fatigue state which corresponds to subjective reports of mood. **METHODS:** This study is a randomized, double-blind, placebo-controlled within-subject design. Participants received modafinil (200mg) or placebo during each of the data collection periods. Test sessions were completed every 4 hours starting at 1300 on Day 1 with the last one at 1300 on Day 2. Oculomotor measures were obtained with the Fitness Impairment Tester (FIT); subjective overall mood was obtained with the Profile of Mood States (POMS) survey.

RESULTS: Preliminary two-way repeated-measure ANOVAs (drug x test session) were completed for 7 participants. Saccadic velocity, pupil diameter, and pupil-constriction amplitude revealed no significant interactions between test session and drug. Pupil-constriction latency neared a significant interaction ($F(4, 24) = 2.37, p = .08$) with a significant main effect for test session ($F(4, 6) = 3.77, p = .02$). No main effects for drug were apparent for any of the ocular measures. The POMS total score did not show a significant interaction between test session and drug ($F(4, 24) = 1.88, p = 0.15$); however, there was a main effect for test session ($F(4, 6) = 5.74, p < .01$). There was no main effect for drug. **CONCLUSION:** Preliminary evidence indicates that modafinil could affect some oculomotor measurements in the early morning hours. The drop in mood and oculomotor performance during early test sessions indicates that the use of the FIT and POMS could assist military leaders with quick assessments of fatigue state in early morning hours. Additional analyses will be completed as data collection ends.

Learning Objectives:

1. Understand the use of an oculomotor test in determining the fatigued state of an operator and how it may correspond to subjective reports of mood.

[265] COMPUTATIONAL FLUID DYNAMIC SIMULATION OF HUMAN LUNG AIRWAY FLOW

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(ORIGINAL RESEARCH)

INTRODUCTION: Accurate knowledge of airflow and particle deposition in the human airway allows for better understanding of breathing patterns in both healthy and diseased lungs, and predictions of drug delivery in aerosols. *In-vivo* measurements of airflow within the human lung are problematic considering the complex nature of the lung and its large numbers of branches that become progressively smaller and more difficult to analyze in the terminal alveoli using conventional methods; therefore, *in-vitro* analyses using computational fluid dynamics (CFD) may offer a novel approach to investigate air flow over traditional methods. **METHODS:** Patient-specific computerized tomography (CT) scans of the upper airway and a computer generated lower airway geometry that is statistically accurate, in terms of branch diameter, lengths, and angles, are used to generate the CFD mesh to 16 generations of the conducting zone. Validation of the CFD simulations are compared with a whole-body physiology simulation tool (HumMod). To reduce computing resources, one daughter bifurcation is truncated and replaced with boundary conditions that correspond to a non-truncated region of the lung. Known pressure and airflow distributions were compared with the CFD model. Simulations were run on high performance computing using a

commercial software ANSYS FLUENT[®]. **RESULTS:** Good agreement in alveolar pressure and pleural pressure is found between the CFD and HumMod during 5 s of a complete breathing cycle. The total inhaled air volume is 0.515 L over an inhalation time of 2.5 s. The average volumetric flow rate is 0.206 L/s with a maximum flow rate of 0.451 L/s at an inhalation time of 0.2 s and a minimum flow rate of -0.447 L/s at an exhalation time of 2.8 s. **DISCUSSION:** The results of this study suggest that CFD can provide an alternative to modeling the human lung. With appropriate patient-specific boundary conditions in place, the simulation results yielded excellent mass conservation over each breath cycle and an error of less than 0.02% of the maximum inhaled volume. It is observed that pressure distributions are heterogeneous through all the generations of the airway tree, and the turbulent regions in the upper airways can help predict particle deposition. The model offers substantial improvement because the effects of realistic geometries, time-varying flow volumes, local lung volume change and corresponding transpulmonary pressure change with the effect of abnormal lung compliance.

Learning Objectives:

1. Understand the importance of computational simulations to help better understand airflow through the lung airways.
2. Describe differences in pressure between the atmosphere and alveoli cause air to move in and out of the lung.

[266] MEASURING THE PRECISION OF DYNAMIC CEREBROVASCULAR RESPONSES TO SINUSOIDAL LOWER BODY PRESSURE

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(ORIGINAL RESEARCH)

Sinusoidal lower body pressure (SLBP) has been applied to simulate the dynamic orthostatic stress of gravitational shifts in central blood volume. Although SLBP elicits the fluctuation of systemic hemodynamic variables including arterial pressure, venous pressure, and arterial CO₂, the measuring precision of gain from these variables to cerebral blood flow has not been known. In 12 young adult males, we measured the middle cerebral artery blood flow velocity (MCAv), mean arterial pressure (MAP), thoracic impedance (Z_t), and end-tidal CO₂ (P_{ET}CO₂) during SLBP under differing static central blood volume shift and thermal conditions. Two SLBP frequencies (0.011-Hz and 0.056-Hz) were examined in positive (0 ~ +40 mmHg) and negative (-40 ~ 0 mmHg) pressure fluctuations before and after whole-body heating. We estimated the precision of gain from the SLBP to systemic hemodynamic variables (SLBP connection: Gain-MAP/SLBP, Gain-Z_t/SLBP, and Gain-P_{ET}CO₂/SLBP) and that of gain from systemic hemodynamic variables to MCAv (MCAv connection: Gain-MCAv/MAP, Gain-MCAv/Z_t, and Gain-MCAv/P_{ET}CO₂). We calculated the precision of gain using the signal (gain) to noise (confidence interval of gain) (S/N) ratio in dB. Despite the difference in the static central blood volume shift and thermal conditions, the precision of gains in the 0.056-Hz condition was significantly higher than that in 0.011-Hz ($p < 0.001$), and the precision in the SLBP connection was significantly higher than that in the MCAv connection ($p < 0.001$). All of the precision of gains in the SLBP connection in 0.056-Hz were >34 dB (S/N ratio = 50:1), indicating that the fluctuations of hemodynamic variables in 0.056-Hz were linearly related to the SLBP. For the MCAv connection in 0.056-Hz, the precision of Gain-MCAv/MAP was 37.2 dB, whereas the precision values of Gain-MCAv/Z_t and Gain-MCAv/P_{ET}CO₂ were <20 dB (S/N ratio = 10:1). Our findings indicate that the fast fluctuation of brain blood flow is affected mainly by arterial pressure fluctuation and not by venous pressure or arterial CO₂.

Learning Objectives:

1. The participant will be able to see the linear relationship between brain blood flow and systemic hemodynamic variables.

[267] STAYING SANE AND SUCCESSFUL IN SPACE: A REVIEW OF PSYCHOSOCIAL AND HABITABILITY CHALLENGES IN LONG-DURATION SPACE EXPLORATION

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(EDUCATION - PROCESS)

MOTIVATION: NASA has yet to produce validated mitigation strategies for preventing and treating adverse behavioral events that may occur during long-duration space explorations (LDSE), including manned missions to Mars. The Bellagio II Summit reviewed the current literature regarding psychosocial and habitability stressors/stresses and possible adverse behavioral events associated with LDSE missions and evaluated existing and potential countermeasures for efficacy with possible terrestrial applications. **OVERVIEW:** Behavioral/psychosocial challenges are considered a major "show-stopper" for LDSE missions. Some of the greatest potential challenges include the unexpected development of psychological disturbances such as depression, anxiety, and adjustment disorders in otherwise healthy individuals. Isolation can predispose individuals to mood disturbances, and confined conditions and lack of privacy can lead to interpersonal friction within the team dynamic. Additionally, the increased autonomy crews face as they leave low-Earth orbit can cause tension and displaced anger toward mission control. Countermeasures against psychological disturbances in LDSE include selecting crewmembers without a history of psychiatric pathologies, incorporating resiliency training, and offering appropriate counseling services. There is limited evidence supporting a cohesive algorithm for selecting individuals and teams, so further countermeasures include establishing optimal combinations of personalities and deep-level values, rigorously educating crewmembers in cultural competence, implementing preflight training regimens with mission control, monitoring in-flight behavioral interactions, and leveraging the ICE environment to enhance group interactions. This entails designing spacecraft and habitats that are appropriately aesthetic, hygienic, functional, ergonomic, and supportive of adequate privacy and social interactions.

SIGNIFICANCE: Management of potential spaceflight behavioral health challenges is critical for LDSE mission success, and their countermeasures require further study. Terrestrial applications of spaceflight behavioral health research include improvements in military training programs, better-informed selection of individuals working in stressful environments, developing more sanitary operating room workflows, and establishing guidelines for selecting ICE environment personnel.

Learning Objectives:

1. Develop an understanding of the major behavioral health challenges regarding mood, teamwork, and habitability during long-duration space exploration (LDSE).
2. Develop an understanding of psychosocial countermeasures for LDSE.
3. Develop an understanding of potential terrestrial applications of these psychosocial countermeasures.

[268] VALIDATION AND NORMS OF COGNITION AND SPACEFLIGHT ASSESSMENTS WITH SENIOR MILITARY LEADERS

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(ORIGINAL RESEARCH)

INTRODUCTION: WinSCAT is used as a neurocognitive screening tool to monitor the status of astronauts during spaceflight. The Cognition Battery was recently developed by UPENN researchers to assess astronaut cognition as a behavioral health and performance component of the NASA Standard Measures. While it has been extensively tested, direct comparisons of its psychometric properties in comparison to the WinSCAT battery are not available. There is need for a validation study to compare WinSCAT to Cognition to independently validate the psychometric properties of both measures and develop norms using a population with high demands similar to those experienced by astronauts (deployments, isolation, extreme environments). **METHODS:** 51 students attending a senior service college participated in 2 data collection times with a 90-day lag. All participants passed medical screenings, wore the Zephyr bioharness system during testing, and completed the NASA Task Load Index after testing. Those individuals attending senior service colleges are among the

most elite of leaders and serve as a valuable surrogate for astronauts (13 of 20 recent astronauts selected were military officers). **RESULTS:** Our independent validation study rigorously compared the measures by collecting normative data and examined intercorrelations within and between the assessments. Cognition and WinSCAT accuracy scores were stable across the 90-day lag, some subtasks may be influenced by practice effects, and high consistency across administrations for other subtasks may allow performance tracking over time in real-world conditions. **DISCUSSION:** This validation provides operational personnel with an understanding of the cognition assessment tools within the context of (1) reliable and valid normative data; and offer the use of these data to (2) develop intra-individual variability norms of mental effort. This will ensure reliable information is available to help guide the interpretations of intra-individual variability in cognition testing for space- and ground-based personnel. Our validation establishes the groundwork for and validity of each assessment tool with a population experienced in real-world situations involving extreme environments and isolation, commensurate to astronauts.

Learning Objectives:

1. Establish the validity for each of these 2 assessment tools (WinSCAT, Cognition Battery) with a population experienced in a variety of real-world situations involving extreme environments and isolation.

[269] ACCURACY OF FLIGHT EXPERIENCE ESTIMATED BY AIRCREW

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(ORIGINAL RESEARCH)

INTRODUCTION: Aircrew are commonly asked to report their 'flying hours' as a basic demographic element of aircrew-related experimental or survey research. Studies may request total flying experience, hours on particular aircraft types, hours flown in the last 30 days (or other period), and hours flown with NVGs or other helmet-mounted devices. Some studies request that aircrew report the actual number of logged flight hours; other studies simply ask aircrew to estimate their flying experience. No study has explored the extent to which aircrew estimates of their flying experience accurately reflect their actual logged flying experience. **METHODS:** Aircrew attending selected aerospace physiology refresher training courses at the RAAF Institute of Aviation Medicine were asked to estimate their total flying experience, hours on their current platform, hours flown in the last 30 days, and hours flown with NVGs. The following day, they were asked to record the actual flying experience as documented in their log books. 122 aircrew participated in this study, with 107 providing paired data for analysis. **RESULTS:** Estimated total flying hours were highly correlated to actual logged flying hours (Pearson correlation 0.999, $p < 0.001$). This was equally-high for pilots and non-pilot aircrew. The mean absolute error between estimated and logged total flying hours was 63.5 hours. When individual errors were expressed as a percentage of the logged total flying hours, the mean error was only 2.3% of logged flying hours. Estimated and logged 'hours on type' were highly correlated (Pearson correlation of 0.999, $p < 0.001$), with an absolute mean error of 64 hours, representing only 7.5% of actual logged hours. Hours flown in the last 30 days was also highly correlated (Pearson correlation 0.927, $p < 0.001$), with an absolute mean error of 4 hours. NVG hours were also highly correlated (Pearson correlation 0.859, $p < 0.001$), with a mean absolute error of 16 hours. Aircrew with greater flying experience tended to report greater errors and rounding effects, but not to an extent that that would be aeromedically or clinically significant. **CONCLUSION:** Estimated flying hours are highly correlated with actual logged flight hours, and may be used with confidence to capture flight-related demographic data for aeromedical research. The magnitude of errors and rounding practices are too small to be aeromedically or clinically significant.

Learning Objectives:

1. Estimated flying hours are highly correlated with actual logged flight hours, and may be used with confidence to capture flight-related demographic data for aeromedical research.

[270] EFFECTS OF ACUTE HYPOXIA ON VISUAL PERFORMANCE AND RETINAL BLOOD OXYGEN SATURATION

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(ORIGINAL RESEARCH)

INTRODUCTION: Acute hypoxia could hamper the visual performance during the aviation, such as the contrast sensitivity and the color vision, which is largely due to the decline of blood oxygen saturation. However, the detailed changes of the retinal blood oxygen saturation have not been clearly illustrated during acute hypoxia. In the study, we aimed to investigate the effects of acute hypoxia on the contrast sensitivity, the color vision and the retinal blood oxygen saturation. **METHODS:** Twelve healthy young volunteers were selected to test the contrast sensitivity (CS), the color contrast sensitivity (CCS), and the retinal arterial oxygen saturation at altitude of 300m, 3000m and 4500m by using the hypobaric cabin to stimulate acute hypoxia (3000m = mild hypoxia; 4500m = moderate hypoxia). All data were collected after the heart rate and the blood oxygen saturation became stable, and were analyzed by the paired student t test. **RESULTS:** At the altitude of 3000m, the CS at the spatial frequency of 1.5cpd was significantly affected ($P < 0.05$). The CS of 1.5 and 3.0cpd elevated with statistical differences when being at the altitude of 4500m ($P < 0.05$), while the CS of high spatial frequency did not change. The overall retinal CCS tend to increase with degree of acute hypoxia, and a statistical difference came out at the altitude of 4500m ($P < 0.05$), with the CCS of the temporal superior and inferior quadrants significant affected, while the CCS of the other quadrants of retina were slightly increased, but not significantly. As the altitude increased, the arterial blood oxygen saturation of the overall retinal region declined significantly at the altitude of 4500m, with the arterial blood oxygen saturation of the nasal superior at and inferior quadrants significantly reduced at 4500 m ($P < 0.01$). **DISCUSSION:** Mild and moderate acute hypoxia tend to affect the CS in the low spatial frequency. Color contrast sensitivity deteriorates with the increased degree of acute hypoxia; the temporal quadrant were more likely to be affected, which might due to the decreased of retinal blood oxygen of the nasal quadrant retina, and implied the use of the nasal visual field to search for colored objects.

Learning Objectives:

1. This study would help to understand the effect of acute hypoxia on visual performance, such as contrast sensitivity, color vision, the retinal arterial blood oxygen saturation, and the different sensitivities among the retinal quadrants.

[271] A NUMERICAL ALGORITHM TO ESTIMATE AN ACHIEVABILITY LIMIT FOR CREWED PLANETARY LANDING

E. Davis, C. Pinedo and T.K. Clark

Aerospace Engineering Sciences, University of Colorado at Boulder, Boulder, CO

(ORIGINAL RESEARCH)

INTRODUCTION: The planetary landing process can be complex and demand a high pilot workload as noted by the six Apollo crewed moon landings which, although successful, all included "close calls" with respect to fuel remaining at touchdown or proximity to hazards. To assist with this process, the concept of providing "achievability limit" information to the pilot has been proposed. However, an approach to accurately estimate the achievability limit in a complex three-dimensional planetary landing task has yet to be developed. **METHODS:** The generalized algorithm developed to estimate the achievability limit, consists of three components: 1) vehicle and environmental dynamics, 2) guidance algorithms, and 3) a standard "crossover" pilot model. An enclosed zone of the achievable landing region is then created by combining these components. Subjects flew simulated planetary landing test trials to validate the efficacy of the algorithm and determine the impact on human performance. **RESULTS:** The predicted achievable landing point and fuel remaining has been consistent with pilot subject data. Fuel remaining deviations were typically < 30 kg, which corresponded to a 4%

error with respect to the initial mass. Initial test trials indicate an increase in situation awareness and decrease in workload. **DISCUSSION:** The algorithm was reasonably accurate across a range of conditions. Particularly, landings on the edge of achievability limit resulted in near zero fuel remaining. The algorithm could be further improved by modifying the update rate to on-demand (pilot initiates update) or near real time (continuous updates throughout flight). As terrain hazards are identified near the landing area, the pilot may need to select a new landing site. The factors that define landing site achievability often behave non-linearly and may interact in a non-intuitive manner such that even experienced pilots may struggle to accurately estimate the achievable limits. Providing the astronaut pilot the achievability limit in near real-time, we hypothesize will improve landing success and pilot performance, reduce pilot workload, and improve situation awareness. The vehicle and environmental dynamics are currently specified for a lunar landing; however, the algorithm is generalized such that it could be applied to any future planetary lander or "hopper" vehicle or to entirely autonomous landings by replacing the model of the pilot with a model of the autonomous control system.

Learning Objectives:

1. Characterize the effects of the Achievability Limit Algorithm and Display on human performance.
2. Validate the Achievability Limit Algorithm.

[272] RECENT SPACE-DRIVEN INNOVATION IN MEDICAL TECHNOLOGY. A REVIEW STUDY

*L. Cinelli*¹ and *L. Brown*²

¹*Biomedical Engineering, NUIG, Galway, Ireland;* ²*Surgery, University of Auckland, Auckland, New Zealand*

(EDUCATION - PROCESS)

MOTIVATION: The Bellagio Summit II sought to identify evidence-based information and mature data with significant clinical implications for Terrestrial populations, by reviewing and analyzing peer-reviewed internationally published literature and NASA technical resources (from 2012 to 2017). In this process, consideration was given to advances in medical technology developed specifically for assistance and monitoring of Astronauts' health and safety. Major clinical studies often include the development or optimization of available engineering resources. A considerable number of medical devices, originally born for Space applications only, are now commercialized and accessible to terrestrial patients and customers. **OVERVIEW:** Technology innovation is usually driven by progress and needs of large populations. However, despite that Astronauts are a small population with specific vital needs, innovation in Space medical technology is shown to well stand on its own. Because novelty in developing medical devices arise from both (i) adaptation of current and emerging Terrestrial technology towards Space applications, and (ii) biomedical research on Astronauts' physiology and health issues during and after Space flight, we discuss and analyze medical technology's evolution with: highlighting key advantages of using Space technology for medical assistance on Earth whether in hospitals, remote locations, or areas affected by natural disasters, and identifying the medical needs for such technology in the foreseeable Future of human Outer Space exploratory missions.

SIGNIFICANCE: Commercialization of medical devices and tools, born within the space medicine field, is a remarkable evidence of the benefits of space research for Terrestrial applications and the space-driven innovation in medical care.

Learning Objectives:

1. Innovation in medical technology is driven by space medicine.
2. Space medical technology has terrestrial applications.
3. Identifying the medical needs during interplanetary missions to boost innovation in technology.

[273] A NOVEL TECHNIQUE TO MEASURE ACTIN'S CRITICAL CONCENTRATION IN MICROGRAVITY DURING PARABOLIC FLIGHT

A. Kozminski^{1,2}

¹*Medical School / Dept. of Mechanical Engineering, University of Michigan, Ann Arbor, MI;* ²*Biochemistry, Northwestern University, Evanston, IL*

(ORIGINAL RESEARCH)

INTRODUCTION: Basic molecular science in orbit is logistically complicated. Sending samples back to Earth can be destructive to some biopolymers. Parabolic flight provides a useful environment for short exposures to microgravity. Narrowing an experiment's exposure to microgravity in parabolic flight can be done using various techniques. When working with actin polymers, using capping protein allows for polymerization to occur only in the microgravity portions of the flight profile. **METHODS:** Actin elongation was performed aboard a Zero-G Boeing 727 out of Ellington Field as a part of the 2014 NASA Reduced Gravity Education Flight Program. Monomeric actin was prepared pre-flight and distributed into 135 1-mL syringes at concentrations of 2.5, 5, and 10 μM . Each syringe was dispensed into 96-well plate wells containing "seed" F-actin upon entering microgravity in each parabola. Alexa-488-Phalloidin was injected into 1/3 of the wells after 10, 15 and 20 seconds to cap the polymers. Rate of elongation versus [G-actin] gives critical concentration of elongation. Controls were in 1G.

RESULTS: Prior to the flights, samples from ground trials were successfully imaged, using confocal fluorescence microscopy, and measured using Image J (total length - length of seed = growth). Test trials were done at 10 and 18 seconds at 2.5, 5 and 10 μM G-actin. Direct, visible differences were seen amongst concentrations at both times. Statistical analysis was not performed on test trials. Upon imaging the samples from flight, ice crystals were found in all, too invasive to take measurements (most likely formed during shipping across the country). **DISCUSSION:** Without images from the flight data, the value of this experiment lies within this novel approach towards isolating effects of microgravity on biopolymer chemistry during parabolic flight. This technique was developed for actin biopolymers but can be used for other cytoskeleton proteins. The aim of this particular biopolymer investigation was to help answer questions like how the human body detects gravity on a cellular level. The implications of being able to identify how protein dynamics change with gravity go beyond medicine for healthy astronauts. This will impact our understanding of the commercial spaceflight passenger with inherent protein-based pathology. Further work aims at validating this experimental design and then using it to investigate protein dynamics in various pathologies in microgravity.

Learning Objectives:

1. Cytoskeleton proteins act differently in microgravity.
2. Actin is a protein that can affect every tissue of the body.
3. Biopolymer chemistry is difficult to perform in an environment that exposes the polymers to a wide range of forces.

Wednesday, May 09
Ballroom D

10:30 AM

S-058: SLIDE: IMPACT OF STRESS ON PERFORMANCE

Chair: John Charles
Houston, TX

Chair: Casey Pruett
Cologne, NRW, Germany

10:30 AM

[274] PERSONALITY TRAITS AND SLEEP-RELATED PROBLEMS IN CREWMEMBERS OF THE HAWAII SPACE EXPLORATION ANALOG AND SIMULATION (HI-SEAS)

N.L. Shattuck and *P. Matsangas*

Operations Research, Naval Postgraduate School, Monterey, CA

(ORIGINAL RESEARCH)

INTRODUCTION: Personality is an important variable when assessing team performance and cohesion, especially in small teams performing in isolated, confined, extreme environments such as space exploration. The Hawaii Space Exploration Analog and Simulation (HI-SEAS) project consists of a series of simulated Mars missions whose purpose is to study the psychosocial impact of isolated and confined

living conditions, and to assess space-flight crew dynamics and behaviors. Our study investigated the association between personality traits and sleep characteristics during the 8-month long Mission V. **METHODS:** Participants (N=6 – the entire crew, 26 to 29 years of age, four males) completed a questionnaire two weeks before the study commenced, on the day they entered the habitat, and every month thereafter. The questionnaire included four standardized tools (Epworth Sleepiness Scale – ESS, Insomnia Severity Index – ISI, Pittsburgh Sleep Quality Index – PSQI, Profile of Mood States – POMS). Personality traits were assessed with the NEO Five-Factor Inventory (NEO-FFI). To further assess differences in sleep characteristics, we calculated a single metric, a Figure of Merit (FOM), as the linear combination of ESS, ISI, PSQI, and POMS Total Mood Disturbance (TMD) scores. Higher FOM scores indicated better sleep. **RESULTS:** Two crewmembers (P3012 and P3014; one male) showed subthreshold insomnia for ~40% of the mission. P3014 was identified early as a poor sleeper and showed a gradual deterioration in mood until the third month of the mission when the mood of the crewmember stabilized. P3012/ P3014 showed increased variability in their responses on the PSQI, ISI (P3012), and ESS scores compared to other crewmembers. Compared to the other crewmembers, P3012 and P3014 scored higher in neuroticism (average severity), lower in extraversion (average severity), and lower in agreeableness (average severity). P3012 and P3014 had lower FOM scores than the other crewmembers (p=0.018). **DISCUSSION:** Our results provide evidence that personality traits are associated with sleep characteristics when small teams live for extended periods of time in confined and isolated environments. Specifically, higher neuroticism scores combined with lower in extraversion/agreeableness scores were associated with sleep-related problems. Follow-up analysis will focus on the association between subjective scores and objective sleep attributes obtained with actigraphy.

Learning Objectives:

1. To identify whether sleep-related attributes are associated with the personality traits of members of small teams living for extended periods of time in confined and isolated environments.
2. To describe the association between personality traits and sleep-related attributes in members of small teams living for extended periods of time in confined and isolated environments.
3. To recognize the importance of individual differences in terms of sleep-associated attributes in small teams.

10:45 AM

[275] P300 ASSESSMENT OF COGNITIVE CAPACITY DURING THE CONTROL OF AN OBJECT WITH SIX DEGREES OF FREEDOM

B.W. Johannes¹, A.W. Gaillard², S.V. Bronnikov³, Y.A. Bubeev⁴, T.I. Kotrovskaya⁴ and J. Rittweger⁵

¹Institute of Aerospace Medicine, German Aerospace Center (DLR), Cologne, Germany; ²Psychology, Tilburg University, Tilburg, Netherlands; ³Ergonomics, Russian Space Corporation, Moscow, Russian Federation; ⁴Psychology - Psychophysiology, Institute of Biomedical Problems, Moscow, Russian Federation; ⁵Muscle and Bones, Institute of Aerospace Medicine, Cologne, Germany

(ORIGINAL RESEARCH)

INTRODUCTION: In a ground based study a method was tested and verified foreseen for the investigation of cognitive capacity during the spacecraft docking training onboard the space station (experiment PILOT-T). Eighteen subjects participated. The P300 component of evoked EEG potentials in response to acoustic stimuli as secondary task was examined. **METHODS:** The subjects passed successfully a self-sufficient educational program ("6df") in individual time spans (16 to 32 sessions). In a familiarization session the complete experiment was run once, using the standard 6df-tasks. EEG was registered continuously using the space equipment foreseen for the application on the ISS. Acoustic stimuli of similar physical properties but different frequencies were applied as secondary task. Subjects had to count the rare tone to complete a monitoring task (switching power supply among several active solar panels). In the experimental session after three standard tasks the subjects were confronted with two untrained more difficult tasks (rotating object to dock on). **RESULTS:** There were significant negative correlations found between the docking quality, given task difficulty, and

subjectively perceived difficulty. The performance in the secondary tasks was unrelated to these factors. The magnitude of the P300 component was, as expected, more expressed during the standard tasks than in the difficult tasks; the latency was prolonged. There was a certain range of individual P300 changes. Using a series of R-based significance calculations for individual's data a decision matrix was tested for possible proficiency classification of the subjects by means of exploratory cluster analyses. **DISCUSSION:** The results confirm the assumption that P300 might be a useful tool to investigate the operator's cognitive capacity during a mission relevant operation as the hand controlled docking of a spacecraft on a space station. A decreased P300 magnitude could be an indicator of reduced free cognitive capacity, needed for unexpected changes or events.

Learning Objectives:

1. applied P300 research.
2. hand controlled docking maneuver.
3. cognitive capacity.

11:00 AM

[276] INSIGHT AND TASK PERFORMANCE IN SIMULATED SUBORBITAL SPACEFLIGHT: IMPLICATIONS FOR INFORMED CONSENT

E. Stratton³, R.S. Blue⁴, J. Vardiman⁴, C. Mathers⁵, T. Castleberry^{4,6}, F. Bonato¹, A. Bubka¹, K. Seaton² and J. Vanderploeg^{4,6}

¹St. Peter's University, Jersey City, NJ; ²UTMB/KBRwyle, Houston, TX; ³SUNY Upstate Medical University, Cicero, NY; ⁴Preventive Medicine & Community Health, UTMB, Galveston, TX; ⁵Clinical Preventive Medicine, UTMB Health, Galveston, TX; ⁶Center for Space Medicine, Baylor College of Medicine, Houston, TX

(ORIGINAL RESEARCH)

INTRODUCTION: Commercial spaceflight participants (SFPs) will likely have little specialized knowledge in the aerospace field. Imparting sufficient knowledge for SFPs to understand the risks associated with spaceflight may be difficult and, in part, will require that individuals recognize their own roles and responsibilities as vehicle occupants and the potential risks imparted by themselves and those around them. We sought to understand how minimally trained laypersons would perform during a simulated emergency during centrifuge-simulated suborbital spaceflight. We evaluated participant insight regarding their own performance and their perceptions of the efficacy of the training they received. **METHODS:** 148 individuals participated in one of four centrifuge training programs of varied complexity and duration, culminating in two simulated suborbital spaceflights. At most, subjects underwent seven centrifuge runs over 2d, including two +Gz runs (peak +3.5Gz, Run 2) and two +Gx runs (peak +6.0Gx, Run 4) followed by three runs approximating suborbital spaceflight profiles (combined +Gx and +Gz, peak +6.0Gx and +4.0Gz). 137 subjects further participated in a simulated emergency scenario and were evaluated on task performance and queried on their awareness of their own performance. **RESULTS:** Subjects made numerous mistakes during simulated emergency scenarios. Further, most subjects demonstrated poor awareness of their own performance. Only around half of perfect scorers believed that they completed the emergency scenario without error, and a third of subjects believed that they had performed flawlessly despite significant errors during the emergency scenario. **DISCUSSION:** Results suggest that SFPs have difficulty performing tasks in stressful scenarios and retrospectively demonstrate poor understanding of their performance. This may highlight an opportunity to better educate future SFPs on risks imparted by vehicle occupants, personal responsibility, and similar factors that may significantly alter the risk profile of commercial spaceflight. Improved awareness of these issues may better allow SFPs to fully participate in the informed consent process before choosing to accept the risks inherent to commercial spaceflight.

Learning Objectives:

1. Discuss the roll of spaceflight participant performance in risk characterization.
2. Discuss how insight can affect a spaceflight participant's ability to take part in the informed consent process.
3. Discuss layperson performance in emergency scenarios during simulated suborbital spaceflight.

11:15 AM
[277] A HIGH PERFORMANCE FIGHTER PILOT WITH
OBSESSIVE-COMPULSIVE DISORDER

T. McBride

USAFSAM, Wright-Patterson AFB, OH

(EDUCATION - CASE STUDY CLINICAL)

PROBLEM STATEMENT: This case report describes a highly capable U.S. Air Force fighter pilot who developed obsessive-compulsive disorder (OCD). **BACKGROUND / LITERATURE REVIEW:** Many of the emotional and behavioral manifestations of OCD can significantly interfere with flying safety and mission completion. Obsessive thoughts, urges, or impulses coupled with compulsive, repetitive behaviors can critically impair an aviator's ability to focus on and manage the complexities of flying operations. **CASE PRESENTATION:** The subject pilot was a 34-yr-old male F-15 senior pilot and Weapons School graduate assigned as a test pilot to Joint Base Triple Checking. With a relatively slow onset occurring over more than 2 yr, the pilot developed acute symptoms following a 4-mo combat deployment. He developed a broad range of obsessions, including those related to failing to complete flight checklists and certain safety-related tasks. Compulsions also developed to relieve his obsessions, requiring not only confession to his superiors but to his spiritual leaders as well. Eventually, his symptoms progressed to such an extent requiring mission cancellation, and he self-referred for mental health treatment. The combination of high motivation and effective treatment resulted in a return to baseline functioning. He was referred to the U.S. Air Force Aeromedical Consultation Service for evaluation to determine whether he was safe to return to flying operations. **OPERATIONAL / CLINICAL RELEVANCE:** This case highlights how OCD can develop and impair the life of capable aviators. It also highlights the essential ingredients of successful treatment and the process of returning to full flying status.

Learning Objectives:

1. Understand the insidious nature of OCD and the detrimental consequences it can have on safety of flight and mission completion.
2. Understand key ingredients to effective treatment outcomes.

11:30 AM
[278] WAIVING FLYERS WITH OBSESSIVE-COMPULSIVE
DISORDER: THE U.S. AIR FORCE EXPERIENCE

R. Peirson^{1,2}

¹Aeromedical Consultation Service - Neuropsychiatry, USAFSAM, Wright-Patterson AFB, OH; ²Psychiatry, Wright State University School of Medicine, Dayton, OH

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: Obsessive-compulsive disorder (OCD) is classically a pervasive, debilitating illness. Although amenable to treatment, it can be very difficult to achieve remission. Also, it can be difficult to quantify recurrence risk in stressful environments. As such, the U.S. Air Force (USAF) has a limited history of approving waivers for flyers with disqualifying OCD. **TOPIC:** The presentation will be based on a discussion of the 30 aviators who have sought waivers for flying duties who have been diagnosed with medically disqualifying OCD, based on data available in the Aeromedical Information Management Waiver Tracking System. The incidence of waiver requests based on flying class, crew position, and disposition will be discussed. Only four aviators have been granted renewals, and the USAF experience with taking the calculated risk in limited circumstances will be explored. **APPLICATIONS:** The waiver trends observed in USAF aviators and analysis of limited cases will be of most interest to military audiences, but with OCD's point prevalence of 2.4% in the United States (and similar incidence estimated outside the United States), the aeromedical risk factors, as discussed, have parallels in commercial and general aviation.

Learning Objectives:

1. The participant will learn the major medical outcomes of aviators recommended for waiver.
2. The participant will learn guideline recommendations for duration and modality of treatment for OCD.
3. The participant will learn areas of concern where obsessive-compulsive symptoms may intersect with the demands of the aerospace environment.

11:45 AM
[279] MILD NORMOBARIC HYPOXIA EXPOSURE DECREASES
SKILL-BASED TASK PERFORMANCE OF OPERATORS WHEN
TASK SWITCHING

C.L. Stephens¹, K.D. Kennedy¹, N.J. Napoli¹, M. Demas², B. Crook⁴, R. Williams⁴ and P. Schutte³

¹Crew Systems & Aviation Operations, NASA Langley Research Center, Hampton, VA; ²University of Virginia, Charlottesville, VA; ³U.S. Army, Ft. East's, VA; ⁴Analytical Mechanics Associates Inc., Hampton, VA

(ORIGINAL RESEARCH)

INTRODUCTION: The present experiment was designed to investigate the impact of normobaric hypoxia induction, as a method to induce mild cognitive impairment, on operator performance. The study required operators to perform multi-tasking during non-hypoxic and hypoxic exposures to examine the impact of hypoxia on task switching behavior. **METHODS:** Professional pilots were test subjects (n=57, 49 males) in the study involving simulated altitudes of sea level (21% O₂) and 15,000 feet (11.2% O₂) induced by an Environics, Inc. Reduced Oxygen Breathing Device. Each subject experienced both non-hypoxic and hypoxic (SPO₂ ≤ 95%) exposures and performed three 10-minute tasks, one of which was the NASA Multi-Attribute Task Battery application (MATB-II). The dependent measure included in this report is the MATB-II Tracking task Figure of Merit (FOM) score. Difference scores were calculated between two instances of FOM score, specifically the ten seconds after the MATB-II Communication task onset ("During") and the ten seconds after the simultaneously occurring Comm task air traffic controller message ended ("After"). Also, Tracking task FOM difference scores were calculated between the ten seconds prior to the onset of a simultaneously occurring Comm task ("Before") and the ten seconds after the Comm task onset ("During"). Test subject experienced 10 Ownship ATC messages requiring input during the 10-minute task. **RESULTS:** No significant difference was found between the non-hypoxic and hypoxic runs in the "During" and "After" segments for FOM score, p > 0.05. A statistically significant difference was observed between the non-hypoxic and hypoxic runs in the "Before" and "During" segments for FOM score, t(384) = 1.960, p < 0.05. **DISCUSSION:** These results indicate that mild normobaric hypoxia affects the skill-based MATB-II Tracking task performance when an operator is required to task switch to the rule-based MATB-II Comm task. An implication of this finding is that task switching between tasks requiring different skills can result in deteriorated performance of tasks when an operator is in a compromised mental state such as that induced by hypoxia. The impact of cognitive impairment due to hypoxia on multi-tasking, will be presented and discussed.

Learning Objectives:

1. Discover how mild hypoxia exposure can impact operator multi-tasking performance.

Wednesday, May 09

10:30 AM

Ballroom E

S-059: PANEL: REFINING CARDIOVASCULAR RISK
IN AIRCREW - NATO AVIATION CARDIOLOGY
WORKING GROUP AND EACTS AVIATION
MEDICAL COMMITTEE

Chair: Eddie Davenport

Wright-Patterson AFB, OH

Chair: Ed Nicol

Hitchin, Bedfordshire, United Kingdom

PANEL OVERVIEW: This session will introduce a new multi-dimensional risk paradigm (extending beyond the 1% rule) for cardiovascular risk assessment in all aircrew, outline the role of advanced imaging technologies such as cardiovascular MRI and CT and demonstrate the use of these risk assessment tools across a range of cardiovascular conditions (coronary, structural, electrical, heart muscle and congenital heart disease).

[280] IS A 3 D MATRIX SUFFICIENT TO ASSESS THE AEROMEDICAL RISK? THE PREMATURE VENTRICULAR BEAT EXAMPLE

O. Manen^{5,10}, J. d'Arcy⁹, N.J. Guettler⁶, T. Syburra⁷, D. Bron¹, R. Rienks³, G. Gray², E.D. Davenport⁸ and E. Nicol⁴

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Putten, Netherlands; ⁴Clinical Aviation Medicine Service, Centre of

Aviation Medicine, Hitchin, United Kingdom; ⁵French Military Health

Service Academy, Paris, France; ⁶Internal Medicine, German Air Force

Center for Aerospace Medicine, Fuerstenfeldbruck, Germany; ⁷Cardiac

Surgery, Luzerner Kantonsspital, Luzern, Switzerland; ⁸USAFSAM, U.S.

Air Force, Wright-Patterson AFB, OH; ⁹Aviation Medicine Clinical Ser-

vice, Royal Air Force, Abingdon, United Kingdom; ¹⁰Aviation Medicine

Clinical Service, Percy AEMC, Clamart, France

(EDUCATION - CASE STUDY CLINICAL)

BACKGROUND: Heart diseases are initially disqualifying in aircrews as far as they may suddenly impact flight safety because of various symptoms. Ideally, in the case of cardiac findings, the aeromedical decision should take into account the likelihood that a clinical event will occur, the possible consequences of this event on the mission and flight safety, and also the precise function of the aircrew on board. The Royal Canadian Air Force has designed an aeromedical risk matrix which may allow better occupation decision making. **METHODS:** Premature ventricular beats (PVB) are a common finding in aviation medicine and yet the assessment of the real risk(s) remains a challenge. This presentation will develop different aircrew case-reports with a medical history of PVB who were examined and assessed in Percy Military Hospital (Paris, France). Each of them will be submitted to the matrix to see if the whole risk can be so well calculated. **RESULTS:** The following sub-groups of aircrew will be discussed: « benign » PVB with all reassuring criteria (echocardiography, 24h-ECG, exercise test, late potentials); PVB with a short episode of non-sustained ventricular tachycardia during exercise but no cardiopathy; arrhythmia with a high PVB burden during 24h-ECG; PVB whose origin is compatible with a myocardial scar on cardiac MRI (myocarditis or necrosis); PVB considered as « benign » during years until a diagnosis of arrhythmogenic right ventricular cardiomyopathy; symptomatic PVB which required radiofrequency ablation and demonstrated strange myocardial findings; and ablated PVB but in a context of multiple ablations for arrhythmias. **DISCUSSION:** This matrix is a useful addition to model the decision making-process with the representation of the factors to take into consideration. However, a precise estimation remains difficult, particularly for complex situations or with cumulative risks. Finally, it does not include the possible aggravating or triggering role of the flight itself, specially the arrhythmogenic effect of +Gz accelerations.

Learning Objectives:

1. To know the interest and limits of a 3 D aeromedical risk matrix applied in cardiology.
2. To be aware of the many possible situations in case of premature ventricular beats in aircrew before taking a decision.

[281] EXPANDING AEROMEDICAL RISK ASSESSMENT BEYOND THE 1% RULE- A 3 D RISK MATRIX APPROACH

G. Gray², D. Bron¹, E.D. Davenport⁹, J. d'Arcy⁸, N.J. Guettler⁶, O. Manen⁵, R. Rienks³, T. Syburra⁷ and E. Nicol⁴

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tal, Luzern, Switzerland; ⁸Aviation Medicine Clinical Service, Royal Air

Force, Abingdon, United Kingdom; ⁹USAFSAM, U.S. Air Force, Wright-

Patterson AFB, OH

(EDUCATION - TUTORIAL)

INTRODUCTION: The notion of formal risk assessment in aviation cardiology was introduced at the First United Kingdom Workshop in Aviation Cardiology in 1984, at which the concept of linking aeromedical

risk to accepted targets for aircraft accident rates resulted in the 1% rule. This was based on a series of assumptions relating to commercial aircraft operations with a target of less than one accident per 1000 million (10^{-9}) flying hours due to an incapacitating cardiovascular event. Over the subsequent 30+ years, risk management has evolved into a formal discipline practiced in multiple diverse sectors, with risk assessment forming an integral tool. Risk assessment now involves assessing not only the probability of an event, but also the likely consequences. Additionally, the operational role of the particular aircrew influences the likely impact of a cardiovascular event on aviation safety and mission. **METHODS:** The widely utilized process of risk assessment using risk matrices has been extended to the assessment of aeromedical cardiovascular risk. A risk matrix is a table with probabilities of events in rows, and consequences of events in columns. To include aircrew roles, a series of risk matrices are stacked to reflect the probable impact of a cardiovascular event in differing aircrew. **DISCUSSION:** This paper will present the concept of utilizing risk matrices to assess aeromedical cardiovascular risk, and present an illustrative case. **CONCLUSION:** The 1% rule established a target for an acceptable probability of an incapacitating cardiovascular event in aviation. Aeromedical risk assessment has evolved beyond utilizing simple event probability to include defining likely consequences of an event and the impact of the operational role of aircrew on aviation safety.

Learning Objectives:

1. To better understand the process of risk assessment in an aeromedical context.
2. To understand the concept of risk matrices in quantifying risk.
3. To understand the concept of 3D risk matrices in assessing aeromedical risk. This approach integrates of risk the probability and consequences of an event, along with type of aircrew role in assessing aeromedical risk.

[282] THE ROLE OF CARDIAC MRI (CMR) IN REFINING AIRCREW RISK ASSESSMENT

J. d'Arcy⁷, E.D. Davenport⁸, G. Gray⁵, O. Manen⁶, E. Nicol², R. Rienks¹, T. Syburra⁴ and N.J. Guettler³

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Wright-Patterson AFB, OH

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: Risk assessment in aircrew poses challenges discrete from standard clinical decision making. The definitive confirmation or exclusion of disease, or detection of mild phenotypes, will often require a multi-parametric approach in aircrew. An understanding of how cardiac magnetic resonance (CMR) techniques can be used in this area will assist flight surgeons when considering an individual's safety for flight. **TOPIC:** The ability to definitively distinguish between diagnoses may be the difference between unrestricted flight privileges, restriction or even grounding. In other pathologies accurate assessment of severity may assist with risk stratification, helping the flight surgeon to more clearly determine an individual's safety for flight. The use of CMR to assess aircrew has much to offer in this area. It provides the ability to assess anatomy, function, and flow of the chambers and valves, as well as anatomy of the great vessels. The use of gadolinium contrast agents also provides the ability to look for fibrosis and infarction. Distinguishing between myocarditis and myocardial infarction, which may both present with similar clinical pictures, is a key example of its utility in this area. Presentations of hypertrophic cardiomyopathy, hypertensive heart disease, and athletic heart can also be very similar, but CMR can be of use in clarifying the diagnosis in such cases. In addition to optimizing diagnosis, findings on CMR may have prognostic significance. This may help the flight surgeon in distinguishing those with a higher risk of adverse events, from those

who can be considered low risk and thus continue flying. **APPLICATIONS:** The use of CMR in aircrew with cardiac disease should be considered as part of optimizing assessment and risk stratification. It has significant utility as part of a multi-parametric approach to diagnosis and prognostication in a broad spectrum of cardiac conditions. An awareness of its utility will help the flight surgeon to optimize investigation in the aviation population.

Learning Objectives:

1. The participant will understand the utility of cardiac MRI in the risk assessment of aircrew.

[283] AEROMEDICAL RISK ASSESSMENT IN CARDIOLOGY – CASE STUDIES USING A THREE-DIMENSIONAL RISK MATRIX

N.J. Guettler¹, R. Rienks², O. Manen³, J. d'Arcy⁴, T. Syburra⁵, G. Gray⁶, E.D. Davenport⁷ and E. Nicol⁸

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(EDUCATION - CASE STUDY CLINICAL)

BACKGROUND: Cardiovascular diseases can impair aircrew performance to a variable extent, from distraction to sudden incapacitation in flight. They are the most frequent reasons for aeromedical disqualification. Therefore, risk assessment is crucial, but challenging in many cases. Modern aeromedical risk assessment has to consider probability and consequences of medical events as well as the occupational role of aircrew. While the risk has to be estimated by the aeromedical examiner, the acceptable level of risk has to be defined by the certification agency. **METHODS:** As a tool for aeromedical risk assessment a three-dimensional risk matrix is demonstrated, which was developed by the Royal Canadian Air Force and has been adapted by the NATO Aviation Cardiology Working Group. Cases of coronary artery disease (CAD), valvular heart disease, and atrial fibrillation (AF) are discussed using the matrix. Risk assessment focuses on the probability and severity of adverse events, but also on the variability of acceptable risk levels for different crew positions. **RESULTS:** Individuals with CAD have to be asymptomatic to be assessed fit for flying. Acute coronary syndrome is mostly caused by atherosclerotic plaque rupture. The risk of such a plaque rupture depends on several conditions including number and severity of stenoses. The Aeromedical Consultation Service of the U.S. Air Force proposed risk assessment using the aggregate of lesions at the time of index coronary angiography, which is the arithmetic sum of all graded lesions. This model has been adapted into the risk matrix by the NATO Aviation Cardiology Working Group based on consensus recommendations by the group. As an example, for valvular heart disease a case of aortic regurgitation is discussed. There is a certain risk of an asymptomatic individual to develop symptoms, left ventricular dysfunction, or even sudden cardiac death. Finally, individual risk assessment in some cases of AF is demonstrated. The risk of individuals with one single episode versus recurrent episodes, and asymptomatic AF versus highly symptomatic AF is compared, as well as the risk reduction by catheter ablation. **DISCUSSION:** Aeromedical risk assessment of several cardiological diseases is demonstrated using a three-dimensional risk matrix. But even with such risk matrices, risk has to be calculated individually. It can be very variable in different situations, even if it affects the same disease.

Learning Objectives:

1. Learn principles of aeromedical risk assessment in cardiology based on probability and consequences of medical events as well as the occupational role of aircrew.
2. Get to know a three-dimensional risk matrix as an example for a risk assessment tool.
3. Learn individual cardiological risk assessment using the examples of different cardiological diseases.

[284] SITUATIONAL AWARENESS AMONG CARDIAC SURGEONS: WHAT DO WE KNOW ABOUT AVIATION MEDICINE?

T. Syburra^{1,7}, G. Gray⁸, N.J. Guettler⁹, D. Bron¹, O. Manen⁴, R. Rienks², J. d'Arcy⁵, E.D. Davenport⁶ and E. Nicol³

¹Swiss Air Force, Aeromedical Centre, Duebendorf, Switzerland; ²Cardiology, Central Military Hospital, Putten, Netherlands; ³Clinical Aviation Medicine Service, Centre of Aviation Medicine, Hitchin, United Kingdom; ⁴Aeromedical Expertise, French Military Health Service Academy, Clamart, France; ⁵Aviation Medicine Clinical Service, Royal Air Force, Abingdon, United Kingdom; ⁶USAFSAM, U.S. Air Force, Wright-Patterson AFB, OH; ⁷Swiss Airforce, Aeromedical Centre, Duebendorf, Switzerland; ⁸CAF- CFEME, Toronto, ON, Canada; ⁹Internal Medicine, German Air Force Center for Aerospace Medicine, Fuerstenfeldbruck, Germany; ¹⁰Cardiac Surgery, Luzerner Kantonsspital, Luzern, Switzerland

(ORIGINAL RESEARCH)

INTRODUCTION: Situational awareness in aviation medicine among cardiac surgeons is unknown and has not been studied yet. A first study was completed 2017 within the European Association for Cardio-Thoracic Surgery (EACTS). Cardiovascular diseases accounts for 50% of all pilot licenses withdrawn for medical reasons and is the most common cause of sudden incapacitation in flight. As aircrew retirement age is increasing, the burden of potentially significant cardiac disease leading to surgical treatment increases. To fly as a pilot after cardiac surgery is possible; however, special attention to perioperative planning is mandatory. Choice of procedure is crucial for license renewal. The cardiac surgeon should always liaise and communicate with the pilot's aviation medicine examiner (AME) prior to and following cardiac surgery. **METHODS:** The Aviation Medicine and Cardiac Surgery (AMCS) working group was created 2013 within EACTS to promote the knowledge transfer between surgeons and aviation specialists. From October 2016 to October 2017, AMCS sent a questionnaire with 25 questions through repeated email bursts to the EACTS affiliated surgeons, 88 questionnaires were returned completed to the online platform (1.76% reply rate). **RESULTS:** 9% of the answering cardiac surgeons are holders of a pilot license. 9% are also an AME or a flight surgeon. 30% have performed cardiac surgery on a pilot, 50% have not, and 20% did not know if the patient was a pilot. 25% did liaise with an AME prior surgery. 8% of the valve replacements in pilots were done with mechanical prostheses. All coronary artery bypass grafting (CABG) achieved full revascularization. No stenosis <50% luminal narrowing was grafted. 54% of the operated pilots fly again, 13% do not, in 33% the surgeon has no information regarding the postoperative flight status of the operated pilot. **DISCUSSION:** Despite the consequences on flight crew licensing, pilots still get mechanical valves implanted. Regarding the stenosis thresholds for CABG indication, as competitive flow in low grade stenosis negatively affects graft patency, the discrepancies between flight crew licensing regulations and evidence based surgical guidelines need to be addressed. A majority of pilots fly again after cardiac surgery. Communication between cardiac surgeons and the aviation community is paramount. The situational awareness of cardiac surgeons in the aviation environment needs to be improved and increased knowledge transfer is needed.

Learning Objectives:

1. To assess the level of awareness in aviation medicine among cardiac surgeons.
2. To match best medical evidence and surgical guidelines with flight crew licensing regulations.
3. To avoid unnecessary grounding of flight crew by promoting knowledge transfer among specialists.

Wednesday, May 09

10:30 AM

Wedgewood

S-060: PANEL: BELLAGIO II AEROSPACE MEDICINE SUMMIT: TERRESTRIAL APPLICATIONS FOR HUMAN HEALTH PERFORMANCE AND LONGEVITY – 2

Chair: Smith Johnston
Houston, TX

Chair: Marian Sides
Grayslake, IL

PANEL OVERVIEW: The Bellagio II summit sought to identify mature data in the literature and published NASA technical resources with significant clinical implications for terrestrial populations. During the development of areas and topics of interest, significant cross-domain correlations were noted that shaped the final product. Members from the Bellagio II summit were assigned to five teams, including genetics, environmental hazards, nutrition, physiological fitness, and behavioral health. Each team reviewed current NASA standards and available literature for mature clinical topics with potential translational benefits within terrestrial medical applications. Following summation of literature reviews, teams analyzed interdisciplinary findings and identified the most significant and mature evidence-based topics ready for knowledge transfer. This panel will present space medicine findings and countermeasures with highest probability for future terrestrial application to promote human health, performance and longevity. We will present the data learned from the isolated spacecraft environment, as well as how certain pathologies, including musculoskeletal concerns, nephrolithiasis and space nutrition have resulted in new understandings and technologies with direct terrestrial application.

[285] THE SPACEFLIGHT HABITABLE ENVIRONMENT--TERRESTRIAL IMPLICATIONS

E. Antonsen², M.A. dos Santos⁶, A. Epstein⁸, E. Flynn-Evans⁴, S. Lockley⁹, A. Macovei⁵, V.E. Martindale¹, J. Saary^{10,11}, K. Shimada³ and A. Sirek⁷
¹Army Research Office, APO, AE; ²Medicine, Baylor/NASA, Houston, TX; ³Flight Research Unit, JAXA, Mitaka, Japan; ⁴NASA Ames Research Center, Moffett Field, CA; ⁵National Institute of Aerospace Medicine, Bucharest, Romania; ⁶Pharmacy, PUCRS, Porto Alegre, Brazil; ⁷Schulich School of Medicine & Dentistry, Western University, Windsor, ON, Canada; ⁸Chicago College of Osteopathic Medicine, Midwestern University, Downers Grove, IL; ⁹Division of Sleep and Circadian Disorders, Brigham and Women's Hospital, Boston, MA; ¹⁰University of Toronto, Toronto, ON, Canada; ¹¹Canadian Space Agency, Toronto, ON, Canada

(ORIGINAL RESEARCH)

INTRODUCTION: Space vehicles represent complex, closed, but modifiable environments. Substantial constraints in such an environment require detailed consideration and management of factors easily taken for granted terrestrially that can directly affect human physiology and performance in space. We sought to identify methods of managing spaceflight environmental issues that may have application to improve terrestrial health, if this knowledge were more widely available. **METHODS:** Available peer-reviewed literature, and current NASA practices regarding environmental control and life support systems, was reviewed to identify environmental lessons learned with mature applicability to either general or closed terrestrial environments. **RESULTS:** Numerous environmental issues were identified; not all had immediately translatable terrestrial actions. Those with substantial relevance to the spaceflight habitable environment included noise; air quality including CO₂, VOC levels, particulate filtration and control; water quality, microbiome and micro-organism control; resource (re)utilization; lighting as an underserved design consideration; and radiation issues including biodosimetry, individual susceptibility, biomarkers of exposure, and impact on pharmaceuticals, e.g., pharmacodynamics and radioprotectants. While many of these factors represent persistent challenges, those with mature terrestrially translatable applications included the use of controlled lighting to influence circadian and operational schedules, and microbiological factors such as a microbiome composition, biofilm, antibiotic resistance, and immunological alteration. **DISCUSSION:** There are significant data regarding the use of advanced, modulated wavelength illumination for influencing circadian synchrony, cognitive performance, and alertness which has direct terrestrial application, including implementation of lighting modulation for shiftwork and travel adaptation. Practical application findings also relate to the alteration of the human microbiome and the environmental microbiome, with implications for management of biota load and control of environmental contamination. Studying various environmental factors in isolation however does not enable understanding of possible interactions. Such interactions were identified as emerging and confounding but non-translatable issues, suggesting that ISS

research might benefit from the availability of more detailed environmental monitoring.

Learning Objectives:

1. Recognize the environmental elements of the ISS which have direct terrestrial applications.
2. Recognize areas of environmental research on ISS with implications for future research to benefit the terrestrial population.

[286] TERRESTRIAL APPLICATIONS OF MUSCULOSKELETAL COUNTERMEASURES DEVELOPED FOR MAINTAINING ASTRONAUT HEALTH & PERFORMANCE

J. Hayes⁴, L. Kaye⁵, M. Gallagher¹, A. Hanson³ and M. Shelhamer²
¹Alberta Health Services, Edmonton, AB, Canada; ²School of Medicine, Johns Hopkins University, Baltimore, MD; ³Human Health & Performance, NASA JSC, Houston, TX; ⁴Biomedical Research and Environmental Sciences Division, NASA, Houston, TX; ⁵Yale School of Medicine, New Haven, CT

(EDUCATION - TUTORIAL)

INTRODUCTION: Prolonged exposure to microgravity induces physiologic changes that result in astronaut deconditioning. This adaptation may have important implications to musculoskeletal health as mission durations lengthen thus, in relative terms, the physical demands associated with occupational astronaut tasks are higher. The Bellagio II Summit assembled experts to evaluate NASA practice in sustaining musculoskeletal health and identify application to terrestrial populations. To do so, we reviewed space countermeasures for skeletal muscle and bone maintenance through aerobic and resistive/anaerobic exercise during spaceflight. Further, we sought an understanding of custom exercise prescriptions as it relates to terrestrial applications. **METHODS:** We reviewed current NASA standards and available literature for the assessment and maintenance of musculoskeletal health before, during, and after spaceflight. Studies evaluated potential optimization of ISS exercise countermeasures through diet and pharmaceuticals. Astronauts were grouped as Mir (N=35) v. ISS (n=44) and Advanced Resistance Exercise (ARED) v. Interim Resistance Exercise (IRED) v. ARED + bisphosphonates. Outcomes were assessed pre- and postflight via use of retrospective data using DXA, isokinetic exercise, and bone markers. **RESULTS:** A combination of customized exercise: aerobic, anaerobic and resistive exercise has demonstrated benefits for muscle and bone health. Furthermore, dietary and pharmacological supplements have shown additional value. Studies show that high intensity resistance exercise coupled with diet, supplements, and bisphosphonates improved astronaut strength, markers of bone health, and bone mineral density (BMD). The ARED showed significant improvements over IRED in percent change in pelvis BMD (7%) and muscle strength knee flexion and extension (6.2%, 6.6%, respectively). ARED + bisphosphonates v. IRED-only showed increases in femoral neck BMD (6.5%). **DISCUSSION:** These techniques for the maintenance of musculoskeletal health may have applications in the terrestrial setting. The practice of diet and high intensity resistance exercise plus antiresorptive drugs are useful for protecting musculoskeletal health during long-duration spaceflight. The utility of a personalized medicine approach using exercise, diet, and pharmacologic prescriptions may translate to occupational health and performance in terrestrial populations with specific physical tasks and environmental conditions.

Learning Objectives:

1. Understand the countermeasures used to mitigate musculoskeletal changes in astronauts associated with spaceflight.
2. Understand the differences in exercise countermeasure effectiveness.
3. Understand the treatments that may translate to terrestrial applications for occupational populations with high physical demands.

[287] APPLICATION OF NASA RESEARCH, SURVEILLANCE AND COUNTERMEASURES FOR NEPHROLITHIASIS TO THE GENERAL POPULATION

D. Reyes⁵, J. Locke⁵, A.E. Sargsyan⁴, K. Garcia⁶, S.L. Johnston⁵, A. Sirek², M. Shelhamer³ and E. Antonsen¹
¹Medicine, Baylor/NASA, Houston, TX; ²Schulich School of Medicine & Dentistry, Western University, Windsor, ON, Canada; ³School of Medicine, Johns Hopkins University, Baltimore, MD; ⁴Flight and Medical Operations, KBRwyle, Houston, TX; ⁵NASA JSC, Houston, TX; ⁶KBRwyle, Houston, TX

(ORIGINAL RESEARCH)

INTRODUCTION: The Bellagio II Summit reviewed NASA efforts for the mitigation of renal stones in astronauts to identify technology that can be applied to terrestrial populations. We evaluated the research, clinical practice, monitoring and interventional technologies developed for spaceflight. Renal stones have the potential for major operational risk; similarly, nephrolithiasis causes significant morbidity in the terrestrial population. Thus, knowledge transfer from space medicine to the general population can be beneficial. **METHODS:** The current literature as well as NASA standards, clinical practice guidelines, and research efforts for the management of nephrolithiasis were reviewed for relevance to the general population. **RESULTS:** Complex physiological changes in calcium homeostasis, acid/base balance and urine chemistry occur during spaceflight, which may increase the risk of renal stones. As of 2016, 37 renal stone events have occurred in 23 U.S. astronauts, out of all astronauts who have ever flown. Most occurred at more than one year post flight, and after retirement from NASA. No stone event has occurred during spaceflight in U.S. crew. NASA mitigates the risk of nephrolithiasis via a comprehensive screening program based on a detailed ultrasound methodology. Dietary and pharmacologic interventions can be started before flight in persons at increased risk which may attenuate the physiological changes caused by microgravity. Ongoing research into biochemical modeling to predict renal stone formation, and development of new ultrasound technology to push and potentially break up stones *in vivo* has also been funded by NASA. **DISCUSSION:** The physiological perturbations caused by microgravity have led to the development of novel modelling, monitoring, and mitigation strategies to reduce the risk of nephrolithiasis in astronauts. The results of NASA's extensive work can be useful to the terrestrial medical community. This work has direct applications in clinic and the emergency department for patients presenting with stones that can: improve early detection and prediction of stone risk, reduce radiation exposure by use of a detailed ultrasound methodology, and speed time to relief of symptoms by direct manipulation of stones. NASA's renal stone management efforts can be used to reduce morbidity and cost to the general population from this common medical condition.

Learning Objectives:

1. Understand how physiology is altered in space in a manner that may impact the formation of renal stones.
2. Understand how NASA mitigates the risk of renal stone formation in astronauts.

[288] APPLICATION OF OCULAR-ALIGNMENT MEASUREMENT DEVELOPED FOR OTOLITH ASSESSMENT IN SPACEFLIGHT TO VESTIBULAR ASSESSMENT ON EARTH

M. Shelhamer and M. Schubert

School of Medicine, Johns Hopkins University, Baltimore, MD

(ORIGINAL RESEARCH)

INTRODUCTION: The Bellagio II Summit reviewed approaches used by NASA for the assessment of neurovestibular problems during and after long-duration spaceflight, and approaches to their mitigation. From these efforts, those with particular application to terrestrial health were identified. While a variety of spaceflight-oriented concepts have influenced terrestrial medicine to different degrees, one specific set of apparatus and procedures was found to be currently in active use for the evaluation of blast injury in military populations. **METHODS:** The current literature as well as NASA standards, clinical practice guidelines, and research efforts for neurovestibular problems were reviewed for relevance to the general population. **RESULTS:** One fundamental aspect of spaceflight is altered gravito-inertial force ("weightlessness" or "0g"). Previous studies showed that asymmetries in otolith mass between the right and left vestibular labyrinths, normally centrally compensated in 1g on Earth, can manifest as torsional binocular misalignments in space. We further demonstrated that vertical misalignments can occur in the altered g levels of parabolic flight (an analog of spaceflight). A simple, inexpensive, portable apparatus to quantify these misalignments was developed with NASA support for eventual use in spaceflight. This

apparatus does not require the measurement of eye position *per se*, but instead relies on perceptual nulling to assess misalignment. Ongoing studies show the usefulness of this approach in evaluating patients with unilateral hypofunction, and in military service members with uncompensated injuries. Military personnel with multi-sensory impairment (MSI) due to blast or impact, and patients with unilateral vestibular deficit (UVD), exhibit larger torsional misalignments than normal subjects, when upright. The difference in misalignment between upright and supine positions is also greatest in MSI, based on initial studies. **DISCUSSION:** The desire to monitor the neurovestibular perturbations caused by the altered gravity of space flight led to the development of spaceflight-compatible instrumentation. This instrumentation is now being used in clinical applications where it is desired to assess vestibular dysfunction through its impact on ocular alignment, but where specialized facilities are not available. Initial findings, especially in military populations, suggest that more widespread adoption of this methodology might occur in the near future.

Learning Objectives:

1. Understand how altered gravity levels can produce changes in ocular alignment.

[289] TERRESTRIAL APPLICATION OF NASA NUTRITIONAL GUIDELINES

S.M. Smith², S. Zwart¹, G. Douglas², P. Buys³, M. Sides⁴ and S.L. Johnston²

¹UTMB, Galveston, TX; ²NASA JSC, Houston, TX; ³Royal Caribbean Cruise Lines, Miami, FL; ⁴University of Chicago, Chicago, IL

(ORIGINAL RESEARCH)

INTRODUCTION: The Bellagio II summit sought to evaluate current NASA practice in nutrition and dietary supplementation to identify applications for the general public. Terrestrial populations often seek guidance from physicians regarding optimal diet. However, widely variable information, often without supporting evidence, can result in negative health outcomes. We sought to highlight the elements set out by NASA nutrition guidelines that are planned for exploration class missions. These could easily be applied to terrestrial populations. **METHODS:** We reviewed current NASA standards and available literature for diet and nutrition in support of crew health before, during, and after spaceflight. **RESULTS:** NASA has developed comprehensive nutritional guidelines for health and performance for astronauts on exploration missions. Specific guidelines include: Maintain energy intake, body mass; 2-3 servings fish/week (n6:n3 ratio <3.4); >6 servings fruits and vegetables/day; >5 servings lycopene-rich foods/wk; >2 flavonoid-rich foods/day; Maintain protein at 1.2-1.7 g/kg BW; Maintain potassium intake at 3500 mg/d; Maintain calcium at 1000-1200 mg/d; Sodium intake near or below 2300 mg/d; Iron intake close to 10 mg/d or lower; Vitamin D3 800 IU/d. These guidelines highlight the importance of balanced energy intake and the critical need for nutritionally stable processed food sources. Supplementation is typically not required with the exception of vitamin D. Ideally, the food system for exploration class missions will include adequate vitamin D from dietary sources. The management of macronutrients and micronutrients in the diet are highlighted and distilled into relevant and approachable values for the general clinician. **DISCUSSION:** NASA provides comprehensive dietary recommendations to develop and maintain the fitness and physiological status of astronauts. Validation of the effectiveness of these dietary recommendations during flight is still required. Nonetheless, these guidelines can be used by the terrestrial population, and these highlight the importance of whole-food based sources of nutrients. Food (and thus nutrition) is the one countermeasure that is guaranteed to fly on exploration missions. Maximizing the benefit of nutrition will be critical for mission success and the long-term health of the crew.

Learning Objectives:

1. Understand the role of food and nutrition in astronaut health.
2. Describe several targeted nutrients and their potential areas of effect on crew health.
3. Understand the role and limitations of supplementation.

Wednesday, May 09
Ballroom B

10:30 AM

S-061: PANEL: PRECLINICAL RESEARCH ON THE IMPACT OF AEROMEDICAL EVACUATION RELEVANT HYPOBARIA AND HYPEROXIA ON DISTAL ORGAN INJURY IN TRAUMA PATIENTS

Chair: Tamara Averett-Brauer
Wright-Patterson AFB, OH

Chair: Catriona Miller
Baltimore, MD

Chair: Lee Payne
Scott AFB, IL

PANEL OVERVIEW: Precipitous aeromedical evacuation (AE) of combat casualties to definitive care in the CONUS has been current practice during OEF and OIF, because of the assumption that transport via aeromedical evacuation to a state-side hospital as soon as possible leads to better patient outcomes. However, both anecdotal evidence and pre-clinical research has raised concerns that the transport of patients at altitudes typically utilized during aeromedical evacuation (AE) contributes to worse patient outcome due to tissue oxygenation abnormalities. In this panel, we investigated the relationship between aeromedical evacuation and possible deleterious influences on patient outcome in a realistic combat casualty care, evacuation and definitive care 14-day survival study in small animal and swine models of acute lung injury, sepsis, and polytrauma.

[290] RECOVERY IS SLOWED AFTER SIMULATED AEROMEDICAL EVACUATION FROM BATTLEFIELD TO CONUS IN SWINE WITH TRAUMATIC BRAIN INJURY

A.H. Scultetus

NeuroTrauma Department, Naval Medical Research Center, Silver Spring, MD

(ORIGINAL RESEARCH)

INTRODUCTION: During recent military conflicts, it has been presumed that transport via aeromedical evacuation to a state-side hospital as soon as possible leads to better patient outcomes. However, there are concerns that the transport of patients at altitudes typically utilized during aeromedical evacuation (AE) contributes to worse patient outcome due to tissue oxygenation abnormalities. In this study, we investigated the relationship between aeromedical evacuation and possible influences on patient outcome in a realistic combat casualty care, evacuation and definitive care 14-day survival study in swine. **METHODS:** Animals received fluid percussion TBI on Day 1. A simulated AE flight in a hypobaric chamber with atmospheric pressure equivalent to an altitude of 8000 ft. (HYPO) was performed on Days 3 (6 hour flight) and Day 6 (9 hour flight). Animals received daily health and behavior checks to include attitude, gait, gastrointestinal and pulmonary assessment with 0=no problems to 2=obvious specific issues. They were euthanized on Day 14. Control animals (NORMO) did not undergo simulated AE. Data were analyzed with 2-Way ANOVA $p < 0.05$ was considered significant. **RESULTS:** Average daily scores were significantly worse for HYPO animals compared to NORMO on Day 7 (after the second flight) and remained worse for the remainder of the 14 day observation period ($p < 0.05$) except for Day 13. These differences in scores were due to gait and pulmonary issues. **DISCUSSION:** In this study, prolonged hypobaric after TBI resulted in slowed recovery compared to animals that did not undergo simulated AE. These findings suggest that hypobaric conditions may have potentially detrimental effects on recovery in trauma patients. Further studies are indicated to simulate other en route care scenarios to include timing of evacuation, and possibly re-evaluate casualty evacuation guidelines.

Learning Objectives:

1. Investigate the relationship between aeromedical evacuation and possible influences on patient outcome in a realistic combat casualty care, evacuation and definitive care 14-day survival study in swine.
2. Identify the ways in which hypobaric conditions may have potentially detrimental effects on recovery in trauma patients.
3. What further studies are indicated to simulate other en route care scenarios to include timing of evacuation, and possibly re-evaluate casualty evacuation guidelines.

[291] MRI AND NEUROPHYSIOLOGIC MEASUREMENTS DURING EXPOSURE TO HYPOBARIA AFTER EXPERIMENTAL TRAUMATIC BRAIN INJURY

G. Fiskum, R. Gullapalli and A. Puche

University of Maryland School of Medicine, Baltimore, MD

(ORIGINAL RESEARCH)

BACKGROUND: Previous research demonstrated that exposure of rats to 6 hours of aeromedical evacuation-relevant hypobaria (8000 ft. altitude) within several days after experimentally-induced mild to moderate traumatic brain injury (TBI), worsens neurologic and neuropathologic outcomes compared to those in rats that do not experience hypobaria. We also found that exposure of rats to 100% O₂ during hypobaria initiated at 24 hr post-injury resulted in even greater injury in comparison to rats exposed to 28% O₂ during hypobaria. Measurements performed on the brain tissue of rats following TBI and hypobaria suggest that vascular damage, inflammation, neuronal axonal damage, and oxidative stress contribute to neuronal death and neurobehavioral alterations. Our findings have been restricted to one terminal time after the initial TBI for each animal. We now propose to utilize multiple, clinically relevant and translational measurements on rats before, during, and after exposure to hypobaria. **METHODS:** We have developed a unique plan for monitoring intracranial pressure (ICP), brain tissue O₂ (PbO₂), brain electrical activity (EEG), cerebral blood flow (MRI), neurochemical alterations (MRS), and a variety of other MRI-quantifiable brain outcome measures during hypobaria after TBI. **RESULTS:** Experiments are in progress to determine if MRI/MRS measurements performed on rats during or after exposure to hypobaria following TBI indicate that hypobaria reduces CBF, alters brain microstructure, increases lactate and decreases glutathione. We are also determining if changes in EEG recordings indicative of either hypo-activity or subclinical seizure activity occur during or after exposure to AE-relevant hypobaria. Finally, we are conducting experiments to determine if intracranial pressure increases and brain O₂ decreases during hypobaria after TBI and if the brain becomes hyperoxic during hypobaria under 100% O₂. **DISCUSSION:** These unprecedented measurements, performed before, during, and after exposure to hypobaria, will provide much needed insight into how post-TBI exposure to hypobaria worsens outcomes. This information will be used to identify targets for both prophylactic and therapeutic interventions against the deleterious effects of flight-relevant hypobaria on TBI victims. Supported by U.S. Air Force FA8650-17-2-6H13.

Learning Objectives:

1. Identify changes that occur in the brains of rats during exposure to aeromedical-evacuation relevant hypobaria following traumatic brain injury.

[292] AIR-EVACUATION-RELEVANT HYPOBARIA FOLLOWING TRAUMATIC BRAIN INJURY PLUS HEMORRHAGIC SHOCK INCREASES LUNG INJURY AND MORTALITY

J. Proctor, J.A. Medina, P. Rangghran, A. Moore, T. Coksaygan and G. Fiskum

University of Maryland School of Medicine, Baltimore, MD

(ORIGINAL RESEARCH)

BACKGROUND: Rats exposed to aeromedical evacuation (AE) relevant hypobaria within 72 hr after isolated traumatic brain injury (TBI) exhibit greater neurologic injury than those maintained under normobaria (PubMed ID: 26593382 and 28452879). This study tested the hypothesis that exposure to hypobaria worsens neurologic outcomes or mortality following polytrauma (PT) consisting of controlled cortical impact (CCI) TBI followed by hemorrhagic shock (HS). **METHODS:** Following CCI, rats were

subjected to HS, (MAP 35-40 mm Hg), for 30 min. Resuscitation utilized Hextend followed by blood re-infusion (Pubmed ID: 26406421). At 24 hr post-surgery, rats were placed in a "flight chamber" and exposed to either normobaria (sea level) or hypobaria (=8000 ft altitude) for 6 hrs under normoxic (21 or 28% O₂) or hyperoxic (100% O₂) conditions. Behavior was tested weekly for 4 weeks. Cortical lesion volumes were determined using stereologic histopathology. Additional animals were tested for lung histopathology and neutrophil infiltration (myeloperoxidase immunostaining). **RESULTS:** Polytrauma injured rats exhibited a mortality rate of 30-35% which increased to 45% when exposed to AE relevant normoxic hypobaria and to 60% when hypobaria was combined with hyperoxia. Histologic evidence indicates that the differences in mortality were associated with differences in sub-acute lung injury and inflammation. There was no difference in cortical neuropathology between the normobaric and hypobaric groups or between the normoxic and hyperoxic sub-groups. While rats in all PT groups exhibited worse neuroscores and greater balance-beam foot-faults at 7 days, there were no effects of hypobaria or hyperoxia. **DISCUSSION:** Exposure of rats after PT to 6 hr of hypobaria or hyperoxia or both results in increased mortality. Based on lung histopathology at 2 days following PT, the cause for this increase in mortality is exacerbation of lung injury. These findings are consistent with clinical studies indicating that critical care complications during AE can be reduced by increasing aircraft cabin pressures to the equivalent of 4000 ft altitude, compared to the commonly employed level of 8000 ft (Pubmed ID: 27026118). Supported by U.S. Air Force FA8650-15-2-6D21.

Learning Objectives:

1. Evaluate previous evidence that exposure of lab rats to aeromedically-relevant hypobaria within several days after traumatic brain injury worsens both neuropathology and behavioral alterations.
2. Compare the differences in mortality between a rat model of isolated traumatic brain injury to a polytrauma model consisting of traumatic brain injury followed by hemorrhagic shock.
3. Identify mechanisms by which hypobaria and hyperoxia can worsen mortality following polytrauma.

[293] EFFECT OF AEROMEDICAL EVACUATION-RELEVANT HYPOBARIA AND HYPEROXIA DURING SEPSIS ON SURVIVAL AND SYSTEMIC INFLAMMATION IN RATS

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(ORIGINAL RESEARCH)

BACKGROUND: We hypothesized that exposure to "in-flight" hypobaria and/or hyperoxia within 24 hr after the onset of sepsis accelerates the development and/or severity of sepsis and neurologic injury in survivors. **METHODS:** Rats were used in a cecal ligation puncture (CLP) model of sepsis. In addition to Sham rats that underwent surgery without CLP, on the day after CLP, rats were randomized to 4 groups: a) normoxia (21%), normobaria; b) hyperoxia (100%), normobaria; c) normoxia (28%), hypobaria; and d) hyperoxia (100%), hypobaria. On day 2, blood was drawn for cytokine levels and mitochondria were isolated from the heart and forebrain. Other sets of animals from these groups were followed for mortality and neurologic morbidity over 14 days. **RESULTS:** Seventy-four rats underwent CLP: 52 were followed for up to 14 days and 22 rats were euthanized at 2 days for mitochondrial (mito) preparations. Nineteen rats underwent sham operations with two euthanized for mito prep. All rats that underwent had moderate to severe peritonitis. Mortality was 19% (10/52) with 6/30 (20%) undergoing hypobaria vs. 4/22 (18%) mortality for those exposed to normobaria. Three of 23 rats (13%) exposed to hyperoxia died vs. 7/29 (24%) exposed to normoxia. At day 2 post-CLP, there were minimal to no cytokine levels among sham-treated rats in all groups and no evidence for aberrant respiration by isolated brain or heart mitochondria. In contrast, while there were minimal cytokine responses among rats with NB/21% O₂, among the other 3 groups there were increases in IL-6, IL-10, IL-12, IL-17A and the chemokine, GRO/KC, with no differences among the 3 groups. Composite neurologic scores were lower for CLP rats compared to shams but were not affected by hypobaria or hyperoxia. **DISCUSSION:** There was no difference in mortality between rats undergoing hypobaria vs. normobaria. Rats exposed to hyperoxia had only half the mortality vs those with normoxia, despite the

finding that hyperoxia exposure increased inflammatory serum cytokines. Further studies are warranted to determine the effect of different levels of hypobaria and hyperoxia on survival and long-term outcomes from intra-abdominal infection during "in-flight" evacuation. Supported by U.S. Air Force FA8650-15-2-6D27.

Learning Objectives:

1. Distinguish the differences in cytokines and mortality for septic rats exposed to normobaria and hypobaria under normoxic and hyperoxic conditions.

[294] LUNG & KIDNEY INJURY IS EXACERBATED AFTER SIMULATED AEROMEDICAL EVACUATION IN SWINE WITH & WITHOUT ACUTE LUNG INJURY

D. Malone^{1,2} and A.H. Scultetus¹

¹NeuroTrauma Department, Naval Medical Research Center, Silver Spring, MD; ²Surgery, Uniformed Services University, Bethesda, MD

(ORIGINAL RESEARCH)

INTRODUCTION: Precipitous aeromedical evacuation (AE) of combat casualties to definitive care at CONUS is current practice. However, there is a dearth of knowledge about the effects of hypobaria during flight on trauma patients. We investigated possible effects of hypobaria during AE on organ damage in a swine model with and without acute lung injury (ALI). **METHODS:** Lung injury was induced in anesthetized swine via oleic acid infusion, followed by injury-specific care over two hours. Sham animal received no injury. Once the animal was stable, a 4 hour AE was simulated in a hypobaric chamber with atmospheric pressure equivalent to an altitude of 8,000 ft. (HYPO, n=6). Control animals were kept at normobaric conditions (NORMO, n=6). Sham animals received no ALI ± AE (n = 6 each set). At 4 hours, animals were euthanized and histopathological analysis of lung, kidney and brain tissues after staining with H&E was performed. **RESULTS:** Physiological and neurological parameters were similar between the groups over time. Organ damage was assessed by combined scores for hemorrhage, inflammation, edema, necrosis and microatelectasis (lungs only), and was significantly worse in HYPO animals compared to NORMO in lungs (p<0.0001) and kidneys (p=0.0439) in ALI animals. There were no differences between groups in brain, pancreas, liver and adrenal glands. In sham animal, there was also a significant increase of pulmonary pathology in HYPO animals compared to NORMO. **DISCUSSION:** In this study, a simulated 4 h aeromedical evacuation at a cabin pressure of 8,000 ft. caused significant histopathological damage to lungs and kidneys in both animals with and without ALI. This may have implications on combat casualty transport. These findings also indicate that healthy passengers may be affected by prolonged hypobaria. This relationship should be investigated further in other AE scenarios.

Learning Objectives:

1. Investigate possible effects of hypobaria during AE on organ damage in a swine model with and without acute lung injury (ALI).
2. Identify how organ damage was assessed.
3. Identify levels of AE relevant hypobaria.

Wednesday, May 09

10:30 AM

Topaz

S-062: SLIDE: AIRCREW MENTAL HEALTH

Chair: Eilis Boudreau
Portland, OR

Chair: Chris Front
Washington, DC

10:30 AM

[295] OCCUPATIONAL STRESS IMPACTS AMONG USAF MAINTENANCE PERSONNEL

L. Prince^{3,2}, T. Goodman¹, W. Chappelle² and K.M. Zuccarelli⁴

¹Neurostat Analytical Solutions, LLC, San Antonio, TX; ²Aeromedical Operational Psychology, USAFSAM, Wright-Patterson AFB, OH;

³Prince Research & Analytic Services LLC, Birmingham, AL; ⁴SGOP, 4th Medical Group, Seymour Johnson, NC

(ORIGINAL RESEARCH)

INTRODUCTION: The U.S. Air Force (USAF) maintenance community is tasked with sustaining the mission effectiveness of an array of aircraft. Faced with the demand of providing immediate response and 100% accuracy, occupational stress among maintainers has been anecdotally reported, but never formally assessed. This study identifies the primary sources of stress among USAF maintainers and the prevalence of role challenges and negative psychological outcomes associated with executing this critical mission. **METHODS:** In total, 207 Air Combat Command (ACC) and 441 Air Force Special Operations Command (AFSOC) aircraft maintainers completed a web-based assessment with standardized and qualitative health items. Statistical analyses were conducted to identify sources of stress and examine the prevalence of role conflict, overload, emotional exhaustion, psychological distress, social role and interpersonal relationship distress, and post-traumatic stress disorder (PTSD) symptomology. **RESULTS:** Operational stressors affecting ACC and AFSOC maintainers were identified as manning; long work hours; organizational, leadership, and management issues; nature of work; shift schedule; and excess admin duties. ACC maintainers reported role conflict (31%) at almost twice the rate of AFSOC (18%). A similar difference in role overload existed between ACC (28%) and AFSOC (13%). Emotional exhaustion for ACC (42%) was more than twice that of AFSOC (18%), as was psychological distress for ACC (22%) and AFSOC (11%). Social role distress among ACC maintainers (44%) was notably higher than AFSOC (29%), as was interpersonal relationship distress for ACC (25%) and AFSOC (15%). Only when examining PTSD symptom criteria was the ACC rate (5%) lower than AFSOC (10%). **DISCUSSION:** Study results suggest ACC maintainers experience more frequent negative outcomes associated with stress than do their AFSOC counterparts. Differences in culture and availability of resilience-oriented resources (i.e., operationally oriented medical and mental health providers) likely play a role in the reported major command differences. Only PTSD emerged more prevalent within AFSOC. Differences in nature of duties and operational environment may contribute to this distinction. While further study is necessary to fully understand dynamics in the USAF maintenance community, preliminary findings offer a basis for line and medical efforts to reduce the risk of negative health outcomes within this critical career field.

Learning Objectives:

1. Identify the Operational Factors that affect all surveyed USAF Maintenance Personnel: Low Manning; Long Work Hours; Organizational/Leadership/Management Issues; Nature of Work; Shift Schedule; Excessive Administrative Duties.
2. Rates of Role Conflict and Role Overload among surveyed USAF Maintenance Personnel: (a) ACC Maintainers: Role Conflict (31%) / Role Overload (28%); (b) AFSOC Maintainers: Role Conflict (18%) / Role Overload (13%).
3. Rates of Emotional Exhaustion, Psychological Distress and PTSD Symptomology among surveyed USAF Maintenance Personnel: (a) ACC Maintainers: Emotional Exhaustion (42%) / Psych Distress (22%) / PTSD Symptomology (5%); (b) AFSOC Maintainers: Emotional Exhaustion (18%) / Psych Distress (11%) / PTSD Symptomology (10%).

10:45 AM**[296] ARMY AVIATION PREVALENCE AND RETURN TO DUTY EXPERIENCE WITH COMMON MENTAL DISORDERS**T.W. Britt¹, J.S. McGhee² and M. Quattlebaum³¹Psychology, Clemson University, Clemson, SC; ²Injury Biomechanics Division, U.S. Army Aeromedical Research Laboratory, Enterprise, AL;³U.S. Army Aeromedical Activity, Fort Rucker, AL**(ORIGINAL RESEARCH)**

INTRODUCTION: Aviation medicine occupies an important niche in the U.S. Army's flight safety program. It exists to conserve the tremendous investment each crewmember represents while insuring that medical disorders do not constitute an unacceptable threat to crew, materiel, and mission. Behavioral health disorders are common in the general population and not surprisingly in the Army. This paper recounts the U.S. Army experience with common behavioral health disorders (PTSD, Other Anxiety Disorders, Depressive Disorders, and Adjustment Disorders) in terms of prevalence, disorder interactions, and return to duty (waiver). **METHODS:** The Aeromedical Electronic

Resource Office (AERO) database contains a synopsis of medical records for all aircrew in the U.S. Army. This system was queried for the period 2010 – 2015. An anonymized subset of unique individuals carrying at least one of the diagnoses of concern was analyzed. Subjects were either pilots, air traffic controllers (ATCs), or unmanned aerial system (UAS) operators. Descriptive statistics were used to define the prevalence and likelihood of waiver for the stratified groups. **RESULTS:** There were 1115 cases identified as having at least one of the diagnoses studied yielding an overall 5-year prevalence of 3.6%. Of the cases identified, 78.2% had a single diagnosis and 21.8% carried more than one diagnosis. Adjustment Disorder was the most frequent diagnosis (38.0%) followed by PTSD (21.5%), Other Anxiety Disorders (20.0%), and Depressive Disorders (15.8%). Pilots (3.1%) were less likely to be diagnosed with one or more of the disorders than either ATCs (5.0%) or UAS operators (5.4%). Females were more likely to be diagnosed (5.9%) than males (3.4%). Waivers were granted for 55.3% of the population identified (44.7% were suspended). Pilots were most likely to receive a waiver (64.7%), followed by UAS operators (54.8%), and ATCs (45.8%). **DISCUSSION:** Within groups of aircrew population, variations exist regarding prevalence of behavioral health diagnoses and waiver rates among the populations studied. Pilots have fewer severe behavioral health issues and are granted waivers more often than ATC or UAS operators. Pilots undergo a more rigorous selection and training processes; though more research is required to determine the reasons for these variations.

Learning Objectives:

1. The objective of this presentation is to impart insight into the magnitude of the behavioral health issues found in the U.S. Army aviator population in terms of prevalence and return to duty rates.

11:00 AM**[297] COMPUTER-BASED MENTAL HEALTH RESOURCES IN ISOLATED CONFINED ENVIRONMENTS**A. Anderson², D. Cowan¹, S.H. Mupparaju³, A. Fellows¹ and J. Buckley¹¹Geisel School of Medicine, Dartmouth College, Lebanon, NH;²Smead Department of Aerospace Engineering Sciences, University of Colorado at Boulder, Boulder, CO; ³Dartmouth College, Hanover, NH**(ORIGINAL RESEARCH)**

INTRODUCTION: Computer-based psychological countermeasures provide confidential, autonomous ways to treat mental health in isolated, confined environments (ICEs). Virtual Space Station (VSS) is a suite of programs for conflict, stress, and depression. Natural scene Virtual Reality (VR), based on attention restoration theory, is also promising support tool in ICEs. We investigated the VSS and VR in two ICEs: the Canada Forces Station – Alert (CFS Alert) in the Arctic and the HI-SEAS Mars simulation during missions III, IV, and V. This talk is a comprehensive summary of our research findings from these deployments. **METHODS:** All protocols were approved by the NASA, Dartmouth, and Defence Research Development Canada Institutional Review Boards. Thirty-one subjects (29 male, 2 female) were studied at CFS Alert. Data were collected in two deployments from December 2015 to April 2016. In each HI-SEAS mission, six participants (10 male, 8 female) spent 8-12 months in the group-isolation. Acceptability and usability were assessed with questionnaires, and perceived value was assessed using semi-structured interviews (14 Alert, 18 HI-SEAS). Transcripts of interviews were coded to identify impressions of the content. **RESULTS:** CFS Alert and HI-SEAS IV cohorts indicated conflict, stress, and depression were relevant issues in these analogs. Acceptability for conflict management content was high at both locations, and interviews indicated particularly high usage in the HI-SEAS IV and V crews. Impressions of depression content varied between Alert and HI-SEAS, and was most positively viewed in HI-SEAS IV and V. HI-SEAS participants (87.5% positive VR codes prevalence) felt very positively about natural scene VR as well as dynamic and urban scenes, particularly those with elements of familiarity. Both cohorts cited lack of time for use (50% of those interviewed at Alert, and 57.1% at HI-SEAS) as a significant problem limiting use. **DISCUSSION:** Overall, participants at both HI-SEAS and Alert found the VSS and VR acceptable and usable. Interview results indicated marked individual differences in preferences and use content, highlighting the importance of offering a range of content in different

formats. Differences between HI-SEAS and Alert results may stem from the level of resources available on-site, populations, and degree of isolation. These tools are viable for improving mental well-being in ICEs.

Learning Objectives:

1. Participants will understand the utility and acceptability of the Virtual Space Station and natural-scene virtual reality computer-based resources for behavioral health issues in isolated confined environments.

11:15 AM

[298] ADDRESSING MENTAL HEALTH IN FLIGHT CREWS: HOW JUST CULTURE MAY HELP

D. De Rooy and S. Mulder

Psychiatry, Leiden University Medical Center, Leiden, Netherlands

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: Mental health problems are highly stigmatized, especially in aviation. Just Culture principles are widely accepted in the aviation industry. We will discuss how Just Culture may be helpful to create an understanding, respectful and non-punitive environment for discussing mental health problems. **TOPIC:** Just Culture was originally developed to be used in safety and accident investigations, to make safe reporting on incidents and accidents possible. In general, in a Just Culture people are not punished unless they were dishonest, grossly negligent or performed willful misconduct. Just Culture does not aim to identify a single truth, but presumes that several accounts of a single event are possible. Just Culture primarily looks forward, and it aims to meet the needs of all involved. On a fundamental level, Just Culture is well compatible with the ethical basis of medicine and some features of a Just Culture could, in our view, be useful to deal with mental and other health problems. Then, Just Culture is about balancing the rights and duties of all involved. The pilot-patient has a right to good care, and a right not to be punished by job- or income loss because of mental disease. At the same time the pilot-patient has a duty to provide safe operations, which means that he or she should be cooperative with mental health examinations and seek treatment when necessary. The industry has a duty to support a pilot with mental illness, which means that adequate insurance for disability should be provided. The main challenge to applying Just Culture principles in the practice of aerospace medicine, are legal issues relating to social security laws, insurance and liability. We will show how many of these can be overcome by specific regulations or collective labor agreements. **APPLICATIONS:** As Just Culture is highly appreciated in most branches of aviation, Just Culture principles may be helpful to discuss mental health complaints in flight crews in a safe and respectful manner. In that way, Just Culture can help to reduce the stigma of mental disorders.

Learning Objectives:

1. As Just Culture is highly appreciated in most branches of aviation, Just Culture principles may be helpful to discuss mental health complaints in flight crews in a safe and respectful manner.
2. On a fundamental level, Just Culture is well compatible with the ethical basis of medicine.
3. When dealing with mental and other health problems, Just Culture is about balancing the rights and duties of all involved.

11:30 AM

[299] SUBTYPES AND PREDICTORS OF MEDICALLY SIGNIFICANT PSYCHOLOGICAL DISTRESS AMONG USAF REMOTE WARRIORS

W. Chappelle¹, C.J. Bryan², T. Goodman³, L. Prince⁴ and W. Thompson³
¹*Aeromedical Operational Psychology, USAFSAM, Wright-Patterson AFB, OH;* ²*National Center for Veterans Studies, The University of Utah, Salt Lake City, UT;* ³*Neurostat Analytical Solutions, LLC, Alexandria, VA;* ⁴*Prince Research and Analytic Solutions, LLC, Birmingham, AL*

(ORIGINAL RESEARCH)

INTRODUCTION: The community of U.S. Air Force remote warriors include a range of military personnel composed of remotely piloted aircraft aircrew, intelligence, as well as cyber warfare operators. The critical, 24/7 around-the-clock job duties in these professions entail long

work hours, rotating shifts, and daily engagement in combat operations. Although research has identified a number of factors correlated with elevated burnout and emotional distress in this population, little is known about the unique needs of discrete subgroups of personnel with medically significant psychological distress. **METHODS:** A total of 7,550 U.S. Air Force remote warriors from multiple locations within the continental United States and across the globe volunteered to participate in an anonymous, web-based, comprehensive demographic and psychological health assessment administered by the Aeromedical Operational Psychology program at the USAF School of Aerospace Medicine. The present study aimed to identify and describe different subgroups of personnel reporting elevated levels of medically significant psychological distress. **RESULTS:** Results of statistical regression procedures and latent class analyses yielded four distinct highly psychologically distressed groups of USAF remote warriors. Each group was delineated by specific demographic (i.e., gender, age, marital status) and developmental career stage (i.e., early career, mid-career, and late career; operationally experienced vs. inexperienced; supervisor vs. non-supervisor duties, etc.) predictors, as well as functional impact of distress. **DISCUSSION:** The results of the study provide profiles, predictors, and characteristics of different groups of remote warriors at risk for differing levels of psychological distress based on demographic and developmental career stage. Integrated operational medicine support recommendations tailored to each subtype are provided to improve capabilities with regard to early assessment and intervention rather than relying upon universal, "one size fits all" strategies.

Learning Objectives:

1. The participant will be able to describe the unique attributes of the four groups of highly psychologically distressed individuals in the study.

11:45 AM

[300] MORAL DISTRESS IN THE CRITICAL CARE AIR TRANSPORT NURSE: A PHENOMENOLOGICAL EXAMINATION

K.N. Eaton and M.A. Wilson

USAFSAM, U.S. Air Force, Wright-Patterson AFB, OH

(ORIGINAL RESEARCH)

INTRODUCTION: Critical Care Air Transport (CCAT) nurses provide world-class patient care in austere environments. These environments can leave them vulnerable to multiple physical and psychological stressors, such as fatigue, multiple traumas, lack of resources, and ethical dilemmas. These stressors put the providers at risk for developing anxiety, depression, and post-traumatic stress disorder. Moral distress occurs when a nurse knows the right action to take but, due to an external or internal barrier, is unable to act in a way that is consistent with his/her belief. The phenomenon of moral distress has been explored in previous research in the civilian sector, but few studies have been completed within the military population. This study aims to explore moral distress in the CCAT nurse population by describing the lived experience of moral distress in CCAT nurses and by identifying the themes described by CCAT nurses during moral distress situations. **METHODS:** Data collection was accomplished through in-person interviews conducted by the study principal investigator. Being a registered nurse and having completed one or more deployments were inclusion criteria for participation. Following an interpretive phenomenological analysis study design, four team members completed data analysis of all transcribed interviews. Data analysis began once the first interviews were completed. Each member completed an individual analysis of the data, then the team met collectively to discuss the findings and establish meaning from the interviews. Emerging themes developed, highlighting the lived experience of moral distress in CCAT nurses. **RESULTS:** Currently 12 interviews have been completed and are in various stages of data analysis. Data collection will remain open for additional interviews until 30 Sep. 2017. At that time, data collection will be complete and final data analysis will begin. All data analysis will be completed prior to presentation. **DISCUSSION:** This study will guide the research trajectory for developing interventions to mediate the response of CCAT nurses to moral distress, potentially reducing negative psychological symptoms such as anxiety, depression, and post-traumatic stress disorder. Future work will also include expanding research to establish the presence of moral distress in other military health provider populations.

Learning Objectives:

1. Define moral distress.
2. Identify the themes of moral distress in Critical Care Air Transport Nurses.
3. Discuss potential ways forward to address moral distress in Critical Care Air Transport Nurses.

Wednesday, May 09
Sapphire

10:30 AM

S-063: PANEL: U.S. NAVY AEROMEDICAL DISPOSITION – CHALLENGING CASES FROM NAVAL AEROSPACE MEDICAL INSTITUTE (NAMI): PANEL # 2

Chair: Kai Yan Cheng
Pensacola, FL

Chair: Joseph LaVan
Pensacola, FL

PANEL OVERVIEW: This panel represents selected challenging cases from the Naval Aerospace Medical Institute (NAMI). NAMI is the center of excellence for U.S. Navy (USN) and Marine Corps (USMC) aerospace medicine and is staffed by flight surgeons, aerospace clinical specialists, and support personnel. All USN and USMC aerospace medicine dispositions are made at NAMI. Annually, NAMI receives approximately 50,000 flight physicals from fleet flight surgeons throughout the world and conducts more than 5,500 clinical encounters in Pensacola, Florida. This multi-disciplinary panel will highlight four challenging cases dispositioned by NAMI in the past year. Case 1 leads a discussion on neurocognitive testing for physiologic episodes, case 2 highlights a pilot with reduced visual acuity from CSR, case 3 is a case of a naval aircrew with neurosyphilis, and case 4 concerns a flight instructor with vertigo. Disclaimer: The views expressed in this panel are those of the authors and do not necessarily reflect the official position of the Department of the Navy, Department of Defense, nor the U.S. government.

[301] NEUROCOGNITIVE EVALUATION SHOWED PILOT'S RECOVERY FROM A PHYSIOLOGIC EPISODE

S. Chee

Psychiatry, Naval Aerospace Medical Institute, Pensacola, FL

(EDUCATION - CASE STUDY CLINICAL)

PROBLEM STATEMENT: Subtle neurocognitive changes after Physiologic Episodes (PEs) can be missed through gross medical examination. A situation where an illness or injury has an adverse impact on cognitive functioning is where neurocognitive assessment is indicated. Neurocognitive evaluation data has provided both general and specific information about current levels of cognitive performance and can indicate level of recovery or further treatment recommendations.

BACKGROUND / LITERATURE REVIEW: The Department of the Navy is currently in the process of conducting research to determine cause and potential future ramifications of Physiologic Episodes (PEs) such as hypoxia and decompression sickness (DCS) with military pilots in high performance aircraft. In order to return to flight following a PE, a pilot must be asymptomatic from all physical, neurologic and neurocognitive symptoms. One way to assess cognitive recovery from DCS is comprehensive neurocognitive testing. **CASE PRESENTATION:** The subject was a 33-year-old male pilot with a history of two episodes of suspected DCS while flying a high performance aircraft. Formal comprehensive neurocognitive testing showed cognitive impairment that resulted in the recommendation for grounding. Repeat neurocognitive testing after a period of rest and recovery showed improvement and subsequent return to flight recommendation. The clinical testing data will be reviewed and discussed in terms of making the recommendation to ground and return to flight.

OPERATIONAL / CLINICAL RELEVANCE: Neurocognitive testing has been shown to be sensitive and specific for subtle cognitive changes in pilots after a physiologic episode. Utilizing comprehensive neurocognitive

evaluation ultimately revealed deficits that otherwise may not have been recognized in a pilot who was otherwise reportedly asymptomatic. Neurocognitive testing can be a key component to determining when a pilot who suffered a PE is safe to return to flying.

Learning Objectives:

1. The participants will be able to identify how neurocognitive data can be used in an aeromedical evaluation.
2. The participants will understand what data neurocognitive testing can reveal about an individual's level of cognitive functioning.

[302] REDUCED MONOCULAR VISUAL ACUITY IN AN AVIATOR AFTER RETINAL DISEASE: RETURN TO FLIGHT CONSIDERATIONS

M. Rings

Ophthalmology, NAMI, Pensacola, FL

(EDUCATION - CASE STUDY CLINICAL)

BACKGROUND / LITERATURE REVIEW: Excellent binocular vision (20/20 acuity in each eye) is the basis for military aviation physical standards. Ocular disease can reduce vision in one eye which is considered disqualifying for flight. Literature review has shown that military pilots with reduced vision in one eye have been allowed to continue flying with no demonstrable performance issues. **CASE PRESENTATION:** A case involving a military pilot with a mild reduction of visual acuity in one eye who was ultimately allowed to continue flying will be discussed. This Naval Aviator suffered from central serous chorioretinopathy (CSCR) in both eyes, and underwent a long period of evaluations, including focal laser spot treatments to resolve his CSCR. A waiver was considered for this highly-trained combat-seasoned aviator. Upon examination, he had retinal damage in both eyes: best-corrected visual acuity of 20/30 OD, and 20/15 OS. Retinal damage also caused an acquired monocular color vision deficiency of the red and green cones. A 10 degree visual field test showed a small central scotomata in the right eye. Ocular Coherence Tomography demonstrated no fluid under the retinas. The aviator passed extensive visual flight simulator testing with high grades for shore and carrier landings, air-to-air refueling, air-to-ground and air-to-air combat simulations with bogey and missile tallies at greater than 10 NM.

OPERATIONAL / CLINICAL RELEVANCE: A reduction of best-corrected vision can lead to the loss of a highly-trained military pilot. CSCR is not an uncommon disease in pilots, and frequently leads to recurrent episodes with cumulative retinal damage leading to a loss of visual acuity, which is disqualifying for flight duty. This particular case highlights the medical and practical testing processes for evaluating and retaining a military pilot with loss of best-corrected vision in one eye.

Learning Objectives:

1. Reduced vision in one eye does not necessarily reduce binocular visual acuity, as the visual center typically gives attention to the better eye for visual processing. Reduced vision in one eye while the other eye remains 20/20 or better may allow experienced pilots to continue flying, based upon research and the historical record of famous civilian and military aviators with reduced or no vision in one eye.

[303] OPTIC NEURITIS AS TERTIARY SYPHILIS PRESENTATION AND CHALLENGES OF STIS DURING DEPLOYMENTS IN MILITARY POPULATION

M. Mathew and A.L. Solis

NAMI, Pensacola, FL

(EDUCATION - CASE STUDY CLINICAL)

INTRODUCTION: According to a recent study Sexually Transmitted Infections (STIs) are increasing. Following is a case of ocular syphilis and neuro-syphilis in an active duty service member acquired during deployment. 24-year-old male air crew member developed acute onset of visual "floaters". He had significant history of heterosexual unsafe sex practices the year prior during deployment to Africa, during deployment he was on malaria prophylaxis with doxycycline. He reported painless left-neck lymphadenopathy. He denied penile discharge, body/genital rash including palms/soles of feet, chancre or patchy alopecia. Denied neurologic symptoms, memory or hearing issues. Ophthalmologic evaluation revealed optic neuritis, retinitis, and papillitis. Screening test was positive syphilis. A final diagnosis of optic neuritis, neurosyphilis and

tertiary syphilis was made. **Laboratory findings** High titer RPR (titers 1:256), positive VDRL, positive FTA. CSF studies consistent with neurosyphilis. Positive for chlamydia. **Treatment** 2-week course of Penicillin G 24 million units/ 24 h and 1 gram of Azithromycin. treatment well tolerated with no residual neurologic/ ophthalmological deficits. **Aeromedical disposition:** Neuro-syphilis, ocular syphilis and optic neuritis are considered disqualifying (CD). Waiver was granted by NAMI with annual infectious Disease and ophthalmology evaluation. At annual follow up RPR titer (1: 64) and was retreated with PCN. **DISCUSSION:** Ocular involvement in syphilis may be silent or present with a myriad of unspecific manifestations. The case described as atypical showing mottled appearance of the RPE and scattered hemorrhages at the macula. A major contributor to the uptrend in STI prevalence is the rise high risk sexual practices, including multiple sexual partners, encounters with commercial sex workers, unprotected sex, and meeting anonymous partners on the internet. Subclinical, atypical clinical presentation of syphilis, as in this case, can lead to misdiagnosis and subsequently to the evolution of the disease process, delay of treatment and complications. Structural interventions should be implemented education regarding safe sex practices as well as screening when these behaviors are identified. STI reduction interventions within all U.S. military population especially pre- and post-deployment period should emphasize implementing the USTPF recommendations for obtaining a routine sexual history and screening on high risk populations.

Learning Objectives:

1. Structural interventions should be implemented education regarding safe sex practices as well as screening when these behaviors are identified.
2. STI reduction interventions within all U.S. military population especially pre- and post-deployment period should emphasize implementing the USTPF recommendations for obtaining a routine sexual history and screening on high risk populations.

[304] VERTIGO IN AN INSTRUCTOR PILOT FOLLOWING SCUBA AND FLIGHT ENVIRONMENT EXPOSURES

C.A. Reese

Otolaryngology, NAMI, Pensacola, FL

(EDUCATION - CASE STUDY CLINICAL)

PROBLEM STATEMENT: A Challenging case seen at the Naval Aerospace Medical Institute recently was a USAF pilot serving as a Flight Instructor with the Navy who experienced a prolonged episode of vertigo following two training flights that were below 8,000' AGL. These flights occurred two days after two uneventful SCUBA diving evolutions down to approximately 100'. **BACKGROUND / LITERATURE REVIEW:** There is a well-documented increased risk of decompression sickness (DCS) in individuals who fly immediately following significant exposure to a hyperbaric environment. For this reason, there are specific guidelines for how long individuals should remain at site level following SCUBA diving before engaging in flight operations. The onset of vertigo following exposure to hypo- or hyper-baric environments could possibly represent Type II DCS. It could also be a manifestation of inner ear barotrauma or some other unrelated entity. **CASE PRESENTATION:** A 32 year old active duty USAF pilot went spearfishing down to 100' with 2 uneventful dives following all appropriate SCUBA diving protocols. Two days later he had two aviation training missions that were below 8000' AGL. Approximately 90 minutes after the last flight he experienced significant vertigo. Evaluation by an Undersea Medical Officer identified gait instability, a positive Romberg and spontaneous left beating nystagmus. He was treated with a Treatment Table 6 course of hyperbaric oxygen. There was minimal improvement and no further hyperbaric treatments were performed. Meclizine provided some relief and symptoms diminished, but persisted. ENT evaluation was consistent with right peripheral vestibulopathy. Vestibular evaluation identified a 59% reduced vestibular response on the left. Further treatment consisted of an aggressive course of prednisone and his symptoms resolved in approximately 30 days. **OPERATIONAL / CLINICAL RELEVANCE:** Disequilibrium and vertigo significantly degrade performance and constitute a very real threat to safe flight operations. Regardless of cause, individuals with a history of protracted or persistent vertigo should be grounded until an etiology can be determined and they must be symptom free for an appropriate length of time before resuming flight duties. This presentation will discuss

appropriate tests/clinical tools for evaluating vertiginous patients in the acute phase and then following recovery, what is required to establish a timeline for safely returning to flight duties.

Learning Objectives:

1. To be able to incorporate a series of physical examination techniques that will enhance the clinical evaluation of the vertiginous patient.
2. Develop a plan of action for evaluating a vertiginous aviator and know when it is appropriate to return that individual to flight duties.

Wednesday, May 09
Chantilly East

10:30 AM

S-064: PANEL: RESIDENT GRAND ROUNDS II

*Sponsored by The American Society of Aerospace
Medicine Specialists*

Chair: Richard Allnutt
Beavercreek, OH

Chair: Mark Coakwell
Beavercreek, OH

PANEL OVERVIEW: This panel will consist of pairs of Aerospace Medicine residents presenting clinical cases of aeromedical interest or significance. During their residency practicum years, residents conduct evaluations of patients with diverse medical problems. Residents prepare and present a case report based on a patient encounter undertaken during their practicum experience. One resident from each pair presents the history of the presented problem. The other resident presents the physical findings and a discussion of the aeromedical policies associated with the condition. Learning Aerospace Medicine at the specialist level involves understanding the impact of medical conditions on aircrew health and mission accomplishment. The cases presented will not only be of academic interest but will also illustrate aeromedical decision making in the operational environment.

Wednesday, May 09
Ballroom D

2:00 PM

**S-065: PANEL: RETURN TO SPACE: THE 1998
SHUTTLE FLIGHT OF JOHN GLENN**

Chair: Mark Campbell
Paris, TX

Chair: John Charles
Houston, TX

PANEL OVERVIEW: Twenty years ago (October 1995), John Glenn launched onboard the Shuttle Discovery (STS-95) to return to orbital space flight. He was 77 years old, the oldest person to fly in space. This was 35 years after he was proclaimed an American hero for becoming the first U.S. astronaut to orbit the Earth. This will be the results of that flight from the perspective of another crewmember and his crew medical officer, his flight surgeon, and the project scientist.

[305] JOHN GLENN: AN AMERICAN HERO

M. Campbell

Private practice, Paris, TX

(EDUCATION - TUTORIAL)

John Glenn was the first American to orbit the Earth in 1962 on Friendship 7 during the Mercury Program. He was a unique individual who had already accomplished much in military aviation. Following his Mercury flight, he was widely celebrated as an American hero. In 1998 he returned to space on the Shuttle Discovery as the oldest human to experience space flight. This remarkable achievement expanded our knowledge of human space physiology and space medicine.

Learning Objectives:

1. To understand what was unique about John Glenn's personality and physical condition that enabled both of his space flights.
2. To understand what motivated John Glenn to return to space.
3. To understand the differences physiologically between a Mercury flight and a Shuttle flight.

[306] JOHN GLENN'S RETURN TO FLIGHT: FLIGHT SURGEON'S PERSPECTIVEP.C. Stepaniak*Medical Operations SD311, NASA Johnson Space Center, Houston, TX**(EDUCATION - TUTORIAL)*

John Glenn's return to flight in 1998 onboard the Shuttle Discovery (STS-95) was a pioneering event in that he was the oldest person to fly in space. This required constructing new pathways into medical certification for flight, in-flight medical care, and post-flight landing procedures. Details of lessons learned from this unique experience will be highlighted.

Learning Objectives:

1. To understand the medical certification procedures to qualify John Glenn safely for spaceflight.
2. To understand the unique pre, in and post-flight medical problems that were anticipated and encountered for a 77 year old astronaut.
3. To understand the post-landing experience of John Glenn and differences from nominal (younger) astronauts.

[307] JOHN GLENN'S RETURN TO FLIGHT: ASTRONAUT CREW MEDICAL OFFICER PERSPECTIVES. Parazyński*Fluidity Technologies, Houston, TX**(EDUCATION - TUTORIAL)*

John Glenn's return to spaceflight at age 77 onboard the Shuttle Discovery (STS-95) was a pioneering medical event, in that he became the oldest person to fly in space by a large margin. The astronaut crew medical officer (author) was a close and continuous observer of his pre-flight preparation, in-flight performance and medical condition through successful return to earth following this 9-day mission. Details of lessons learned from this unique experience will be highlighted.

Learning Objectives:

1. To understand the individual and special preparations for providing medical care to John Glenn's spaceflight.
2. To understand the unique in-flight medical problems that were anticipated and encountered for the 77 year old astronaut.
3. To understand the subtle differences in John's in-flight adaptation during spaceflight as well as post-flight recovery, compared with his younger astronaut crewmates.

[308] JOHN GLENN'S RETURN TO FLIGHT: PERSPECTIVE OF PROJECT SCIENTISTJ.B. Charles*NASA Human Research Program, Houston, TX**(EDUCATION - CASE STUDY CLINICAL)*

John Glenn's return to flight in 1998 onboard the Shuttle Discovery (STS-95) was a pioneering event in that he was the oldest person to fly in space. Even though this scientific program would result in a data set with an N of only one, the opportunity to collect data on an astronaut well beyond the age of any previous astronaut was the main rationale behind flying John Glenn on this mission. Details of lessons learned from this unique research experience will be highlighted.

Learning Objectives:

1. To understand the details of the research program for John Glenn's space flight.
2. To understand the unique research problems that were anticipated and encountered for the 77-year-old astronaut.
3. To understand the results from the data collected during John Glenn's space flight and post-flight and the differences from nominal (younger) astronauts.

Wednesday, May 09**2:00 PM****Ballroom E****S-066: PANEL: IN-FLIGHT CARDIAC ARREST IN COMMERCIAL AVIATION. TIME TO REVISIT GUIDELINES?***Sponsored by Air Transport Medicine Committee***Chair: Paulo Alves***Tempe, AZ***Chair: Eduard Ricaurte***Edmond, OK*

PANEL OVERVIEW: In-flight cardiac arrests (IFCA) are relatively rare event, given the volume of commercial passenger traffic. However, it is certainly one of the most stressful situations an airline crewmember may face in his/her entire career. Moreover, IFCA's are usually followed by aircraft diversion with impact in safety and costs for the airlines. A critical analysis of the content of the Emergency Medical Kits and crew training is warranted to verify if current procedures and resources are aligned with current scientific evidence. The problem need to be addressed from multiple angles including ethical and legal considerations besides addressing special aspects such as compassionate cases for terminally ill passengers as well as cases affecting children.

[309] EPIDEMIOLOGY OF IN-FLIGHT CARDIAC ARRESTSP.M. Alves*MedAire Inc., Tempe, AZ**(ORIGINAL RESEARCH)*

INTRODUCTION: In-flight cardiac arrests (IFCA's) occurring in commercial flights are relatively rare events given the number of passengers flown. The advent of automated external defibrillators (AEDs) not only provided a most important tool to treat IFCA's but also has enabled researchers to have a better understanding of the prognostic factors associated with IFCA's. The objective of this study is to review the epidemiology of IFCA's. **METHODS:** MedAire's case database was reviewed for IFCA's in the period of January to July 2017. Passenger demographic and operational details were collected for every case. As much as possible, additional information about the specifics of the event was collected (witnessed versus non-witnessed collapse, location of collapse). **RESULTS:** A total of 73 cases were available for analysis. Male cases predominate (60.3%). Age median was 70 years (20-93). Age didn't vary according to gender. In 22% of the cases a shockable rhythm was detected by the AED. Only 18.4% of the cases were witnessed. In no case where a victim was found in their seat a shockable rhythm was present. In the few cases in which the location of the collapse was reported, 25% of the cases where the collapse occurred in the aisle where shockable and no case found on their seats where shockable. Return of spontaneous circulation (ROSC) occurred in 11.8% of all cases and only happened in shockable cases. A medical diversion occurred in 63% of shockable cases and 79% of non-shockable ones. Most cases (42.3%) occurred in flights of greater than 6,000 km of distance, however IFCA occurred also in shorter flights. **DISCUSSION:** Cases of IFCA found in their seats carry a poor prognosis. ROSC only occurred in cases where a shockable rhythm occurred. The in-flight environment presents unique challenges which need to be considered while planning crew training and medical equipment on board. The decision to divert and aircraft should take into account the presence of a shockable rhythm.

Learning Objectives:

1. Recognize the prognostic importance of shockable rhythms in cases of in-flight cardiac arrests.
2. Recognize the limitations of flight diversion in cases of non-shockable cardiac arrests.
3. Discuss the importance of where the victim was found in regards to prognosis.

[310] OUT OF HOSPITAL CARDIAC ARREST: PROGNOSIS AND CLINICAL MANAGEMENTK.J. Ruskin*Anesthesia & Critical Care, University of Chicago, Chicago, IL**(EDUCATION - TUTORIAL)*

PROBLEM STATEMENT: Resuscitation of out of hospital cardiac arrest (OHCA) is one of the most challenging areas of pre-hospital emergency medical care. Management of in-flight cardiac arrest involves members of the cabin crew, ground-based telemedicine services, and possibly passenger volunteers. Understanding the natural history and prognosis after OHCA is critical to developing guidelines for in-flight cardiac arrest. **TOPIC:** Nearly 321,000 patients in the United States experience an OHCA each year, most of which are caused by a cardiac event, and approximately 60% are treated by emergency medical services. The aggregate survival rate after OHCA is between 6.7% and 8.4%, and survival has not significantly improved over the past three decades, despite significant amounts of funding, extensive research, and the development of novel drugs and devices. In general, the chances of survival from OHCA are greater when ventricular fibrillation (VF) is seen as the initial rhythm or if there is return of spontaneous circulation (ROSC). The chances of survival are highest when the interval from collapse to initial shock is less than three minutes. Intravenous and endotracheal administration of medications may not be helpful in the initial management of OHCA. ACLS training includes airway management in mask ventilation and advanced techniques such as endotracheal intubation, but at least one major study emphasizes the value of emphasizing CPR continuity, but cautions against the generalization of their findings to all patients.

APPLICATIONS: This presentation will review outcomes after OHCA and the efficacy of resuscitation in the setting of shockable *versus* non-shockable rhythms.

Learning Objectives:

1. Discuss the prognosis associated with shockable vs. non-shockable cardiac rhythms in out of hospital cardiac arrests.
2. Make an appropriate choice regarding the use of intravenous drugs and advanced airway management in patients who have experienced an out of hospital cardiac arrest.
3. Maximize the possibility of successful resuscitation in patients who suffer an out of hospital cardiac arrest.

[311] IN-FLIGHT CARDIOPULMONARY RESUSCITATION: THE GERMAN PERSPECTIVEJ. Hinkelbein*University Hospital of Cologne, Cologne, Germany**(EDUCATION - TUTORIAL)*

BACKGROUND: From approximately 3 billion people travelling by airplane worldwide each year, 1 out of 14,000 to 1 out of 50,000 passengers will experience acute medical problems during passenger transport. Cardiac arrest accounts for 0.3% of all in-flight medical emergencies and has, therefore, an estimated incidence of 1 out of 4.7 mio. to 16.7 mio. At least theoretically, the can be up to 500-700 in-flight cardiopulmonary resuscitation events (IF-CPR) worldwide per year when using these numbers for calculation. **MATERIAL AND METHODS:** A task force from the German Society of Aerospace Medicine (DGLRM) was composed to develop a specific guideline for in-flight cardiac arrest (IFCA) based on clinical and investigational expertise in this area. By using a systematic literature search including the GRADE, RAND, and DELPHI methods, specific recommendations for the treatment of IFCA have been created. **RESULTS AND CONCLUSIONS:** 28 different main specific treatment recommendations have been developed: emergency equipment location as well as content should be mentioned in the pre-flight safety announcement; ECG should be available for patients with cardiac arrest, it is very important to request help by an on-board announcement after identification of a patient with cardiac arrest; two-person CPR is considered optimum and should be performed if possible; the crew should be trained regularly in basic life support – ideally with a focus on CPR in aircraft; a diversion should immediately be performed if the patient has a return of spontaneous circulation. Besides the more general guideline on CPR from the European

Resuscitation Council (ERC), the DGLRM guideline for IFCA is the sole and only specific one to address IF-CPR and gives specific treatment recommendations.

Learning Objectives:

1. Treatment recommendations during in-flight cardiac arrest.

[312] THE ETHICS OF IN-FLIGHT CARDIAC RESUSCITATIONM.F. O'Connor*Anesthesia & Critical Care, University of Chicago, Chicago, IL**(EDUCATION - TUTORIAL)*

The modern era of the management of cardiac arrest began with the advent of and widespread employment of chest compressions and mouth-to-mouth resuscitation in victims of cardiac arrest. Subsequent improvements, including defibrillation, airway management, and the administration of medications, such as epinephrine, atropine, and lidocaine, were also quickly and widely adapted. Even at that time, randomized controlled trials were widely recognized as the most effective way to assess the benefit and risk of new therapeutic interventions, but the practical consideration that the patient (and thus subject of the study) was dead precluded obtaining informed consent in any manner. In fact, ethical considerations have made the study of resuscitation difficult in all settings, but especially in out-of-hospital settings. This has in turn frustrated our ability to evaluate and improve upon the therapies. Much of the study of cardiac arrest has thus taken place outside the USA, where a more permissive regulatory environment and tacit acknowledgement of necessity has facilitated such studies. The results of these have been surprising, and will likely continue to be.

Learning Objectives:

1. To describe the difficulties studying cardiac arrest.
2. To describe the pitfalls of applying techniques from other domains to In-flight cardiac arrest.
3. Discuss the ethics of terminating or not starting resuscitation on a commercial flight.

Wednesday, May 09**2:00 PM****Wedgewood****S-067: PANEL: BELLAGIO II AEROSPACE MEDICINE SUMMIT: TERRESTRIAL APPLICATIONS FOR HUMAN HEALTH PERFORMANCE AND LONGEVITY – 3****Chair: Smith Johnston***Houston, TX***Chair: Marian Sides***Grayslake, IL*

PANEL OVERVIEW: The Bellagio II summit sought to identify mature data in the literature and published NASA technical resources with significant clinical implications for terrestrial populations. During the development of areas and topics of interest, significant cross-domain correlations were noted that shaped the final product. Members from the Bellagio II summit were assigned to five teams, including genetics, environmental hazards, nutrition, physiological fitness, and behavioral health. Each team reviewed current NASA standards and available literature for mature clinical topics with potential translational benefits within terrestrial medical applications. Following summation of literature reviews, teams analyzed inter-disciplinary findings and identified the most significant and mature evidence-based topics ready for knowledge transfer. This panel will present space medicine findings and countermeasures with highest probability for future terrestrial application to promote human health, performance and longevity. We will present the data learned from spaceflight behavioral health and countermeasures, including sleep/fatigue mitigation, cognitive testing, and circadian rhythm synchrony, as well as a discussion of the role of genetics and ethical considerations.

[313] OBJECTIVE ASSESSMENT TOOLS FOR COGNITIVE PERFORMANCE IN SPACE AND ON EARTHM. Basner¹, E. Flynn-Evans², S. Lockley³ and D. Dinges¹¹Department of Psychiatry, University of Pennsylvania School of Medicine, Philadelphia, PA; ²NASA Ames Research Center, Moffett Field, CA; ³Medicine and Neurology, Brigham & Women's Hospital, Boston, MA**(ORIGINAL RESEARCH)**

INTRODUCTION: Astronauts are required to live in isolated, confined, and extreme environments for prolonged periods during low Earth orbit and exploration-type missions. Numerous spaceflight stressors can affect cognitive performance and thus mission success. As humans are notoriously bad at self-assessing cognitive performance, especially in chronic exposure situations, brief, sensitive and valid tools are needed for objective performance assessment in space. These tools need to reflect that astronauts are highly motivated and likely outperform the general population. **METHODS:** Two software tools for objective performance assessments were recently developed and validated in spaceflight. (1) The "Reaction Self-Test" (RST) consists of a 3-minute Psychomotor Vigilance Test (PVT) that is highly sensitive to the effects of sleep loss and circadian misalignment. The PVT is preceded by questions on sleep duration and quality, workload, tiredness, stress, medication use, and caffeine consumption. (2) The Cognition test battery consists of 10 brief cognitive tests that cover a range of cognitive domains and were adapted to reflect the high-performing population of astronauts.

RESULTS: Twenty-four astronauts performed RST every 4 days in the morning and evening during 6-month International Space Station (ISS) missions. Valuable information on the timing and duration of sleep, on medication and caffeine consumption, and on workload, tiredness, and stress were gathered, showing chronically restricted sleep and PVT performance decrements in some astronauts pre-mission and during the mission. Cognition administration feasibility and astronaut acceptability was tested in astronauts, mission controllers, and astronaut surrogate populations in ground-based control studies, in space analog environments (e.g., HERA, HI-SEAS, Antarctica), and during 6 to 12 month ISS missions. Cognition sensitivity was established in studies on the effects of sleep deprivation, general anesthesia, and elevated levels of CO₂. The relationship between Cognition performance and performance on an operationally docking task was also established. **DISCUSSION:** RST and Cognition represent two software tools that were specifically developed for objective assessments of cognitive performance in high performing astronauts identified during the Bellagio II meeting. These tools will be very valuable for translation to other high performing populations on Earth (e.g., military personnel, physicians).

Learning Objectives:

1. Understand which tools have been used in spaceflight to measure cognitive performance related to sleep loss and circadian misalignment.

[314] A PERSONALIZED SPACE MEDICINE APPROACH TO FATIGUE RISK MANAGEMENT SERVICESS.L. Johnston³, E. Flynn-Evans¹, S. Lockley⁴, R.S. Blue⁵ and M. Basner²¹NASA Ames Research Center, Moffett Field, CA; ²Department of Psychiatry, University of Pennsylvania School of Medicine, Philadelphia, PA; ³Space Medicine, NASA JSC, Houston, TX; ⁴Medicine and Neurology, Brigham and Women's Hospital, Harvard Medical School, Boston, MA; ⁵Aerospace Medicine, The Mayo Clinic, Scottsdale, AZ**(ORIGINAL RESEARCH)**

INTRODUCTION: The Bellagio II summit sought to evaluate current NASA practice in behavioral health and sleep biology to identify mature topics for terrestrial applications. Sleep deficiency is a common terrestrial condition, which has significant cost to healthcare and industry productivity. Our review highlights the critical knowledge translatable from NASA research and practice on sleep and circadian rhythms to the general population. **METHODS:** We reviewed current International Space Station medical standards, clinical practice guidelines and available literature for sleep, circadian rhythms, countermeasures and pharmacologic interventions

developed for crewmembers before, during, and after spaceflight. **RESULTS:** NASA has developed an integrated suite of best practices and countermeasures to help crewmembers improve sleep outcomes on Earth and in space. NASA has established a Fatigue Management Service (FMS), which is a central component in translating sleep and circadian research outcomes into operations. This service provides crewmembers with fatigue risk management training and personalized guidance on the use of circadian shift schedules, which include advice on light exposure, light avoidance, melatonin, caffeine and other pharmacologic hypnotic and alertness countermeasures to optimize the pre, in, and post flight sleep environments. NASA-funded research has identified circadian misalignment as a major cause of sleep deficiency among crewmembers. NASA has developed and tested protocols for providing wavelength-specific light exposure to help crewmembers adapt to new schedules and time zones. These light exposure regimes have been paired with personalized schedules, provided to crewmembers by the FMS, to facilitate the fastest possible adaptation.

CONCLUSION: Sleep of adequate duration and quality is critical for optimal alertness and performance and depends in large part on the circadian timing of sleep. Utilization of personalized approaches to help improve sleep outcomes, particularly during episodes of circadian misalignment, has potential benefits to terrestrial populations including military personnel, shift workers, and travelers.

Learning Objectives:

1. Understand the development of the FMS for NASA and the ISS program.
2. Understand the unique ground testing protocols for medications developed by NASA.
3. Understand the NASA FMS program for terrestrial applications for patients with shift worker, jet lag, and insomnia issues and disorders.

[315] IMPLEMENTATION OF DYNAMIC LIGHTING SYSTEMS TO COMBAT CIRCADIAN DESYNCHRONY IN OPERATIONAL ENVIRONMENTSE. Flynn-Evans¹, S. Lockley³ and S.L. Johnston²¹NASA Ames Research Center, Moffett Field, CA; ²Space Medicine, NASA JSC, Houston, TX; ³Medicine and Neurology, Brigham and Women's Hospital, Harvard Medical School, Boston, MA**(ORIGINAL RESEARCH)**

INTRODUCTION: The Bellagio II summit sought to evaluate current NASA practice in behavioral health and sleep biology to identify mature topics for terrestrial applications. Circadian entrainment occurs for most individuals on Earth through passive exposure to the solar light-dark cycle. Circadian misalignment occurs during spaceflight due to inappropriately timed light-dark cues. Circadian misalignment is a common terrestrial condition experienced by shift workers and military populations who work during the biological night or in situations involving jet lag. NASA has funded research, development, and implementation of a dynamic lighting system to facilitate circadian entrainment, improve sleep, and reduce cognitive impairment arising from circadian misalignment. This technology has potential to improve the health and well-being of individuals on Earth who are required to work non-traditional schedules. **METHODS:** We reviewed the literature associated with the development of light as a countermeasure for sleepiness and circadian misalignment associated with spaceflight. **RESULTS:** NASA-funded research has demonstrated that careful control of the intensity, wavelength, pattern, and timing of light can facilitate circadian entrainment and improve sleep, alertness, and cognitive performance. Light in the blue (460-480 nm) range has the strongest effect on circadian phase shifting and also confers acute alerting effects. The development of tunable LED lights allows for the composition of a visibly white light that contains different amounts of blue light. This technology has been used to create a dynamic lighting system that is being used on the International Space Station. This system produces blue-depleted dimmer lighting before the crew's scheduled bedtime to facilitate sleep and transitions to blue-enriched, higher intensity lighting at the crew's scheduled wake time to facilitate circadian entrainment or when needed to counteract high sleepiness. The successful implementation of this dynamic lighting system makes it a candidate for transition to terrestrial and other spaceflight or habitat applications. **CONCLUSION:** A dynamic lighting system developed to facilitate circadian entrainment and alertness among crewmembers on the International Space Station has the potential to benefit terrestrial populations including military personnel, shift workers, and travelers.

Learning Objectives:

1. Understand the how light influences the circadian pacemaker.
2. Understand how circadian misalignment affects alertness, performance, and sleep outcomes.
3. Understand how dynamic lighting systems can be used to facilitate circadian entrainment and phase shifting for terrestrial applications.

[316] RELEVANCE OF PHARMACOGENOMICS TO INDIVIDUALIZE PHARMACEUTICAL AGENT SELECTION FOR INDIVIDUAL ASTRONAUTS

D. Deyle¹, R.S. Blue⁴, L. Brown², T.M. Bayuse³, V. Daniels³, E. Antonsen⁵, A. Epstein⁸, E. Schenker⁶, M. Studer⁷ and J. Stepanek⁴
¹Clinical Genomics, Mayo Clinic, Rochester, MN; ²Surgery, University of Auckland, Auckland, New Zealand; ³Wyle/JSC Pharmacy, Houston, TX; ⁴Aerospace Medicine Program, Mayo Clinic, Scottsdale, AZ; ⁵Exploration Medical Capability, NASA JSC, Houston, TX; ⁶Aerospace Medicine Program, IAMI, Jerusalem, Israel; ⁷University of Zurich, Zurich, Switzerland; ⁸Midwestern University, Downers Grove, IL

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: Astronauts utilize medications during spaceflight to prevent/treat mission-related medical problems, in addition to common medical conditions with the most frequent indications including space motion sickness, sleep disturbances, infections, pain, and inflammation. The response to many of these drugs depends on an individual's genetic makeup, thus affecting their efficacy. Pharmacogenomics enables tailoring of pharmaceuticals to the individual based on genetically predetermined enzymatic pathways. The astronaut population would be suitable for pharmacogenomic testing given the restraints of the spaceflight environment and could act as a translational model for broader use of pharmacogenomics. **TOPIC:** The Bellagio II team assessed literature regarding the use of pharmacogenomic testing, particularly as related to pharmaceuticals used in spaceflight, with sources such as Medline, PubMed, and Cochrane databases (1946-present). We further reviewed NASA standards and regulatory guidelines and discussed ethical issues of astronaut genetic testing. The practice of genetic testing in current workplace environments was also analyzed. Many pharmaceuticals used regularly on the International Space Station are metabolized by enzymes whose pharmacokinetics can be altered by human variation; e.g., zolpidem, used for sleep, has been shown in clinical studies to have limited efficiency within the astronaut population, suggesting variation in metabolism between individuals. Limited workplaces worldwide currently offer pharmacogenomic testing for employees without prejudice, affording tailored treatment for chronic conditions. NASA does not currently complete routine genetic testing on the astronaut corps.

APPLICATIONS: Genetic testing can identify the variance in enzymes between individuals and thus enable tailoring of the pharmaceutical to the astronaut. This will enable the development of a personalized portion of any spaceflight formulary that can improve mission risk posture by minimizing side effects and optimizing efficacy in choosing medications. Further discussion regarding ethics, guidelines, and future protection will need to be undertaken within NASA prior to broad pharmacogenomic testing. However, if successfully implemented, such practices could serve as a useful precedent for terrestrial testing environments. **RESOURCES:** Stingl, JC, *et al.* Where Failure Is Not an Option—Personalized Medicine in Astronauts. *PLoS One*. 2015 Oct 21;10(10):e0140764.

Learning Objectives:

1. The participant will learn about the importance pharmacogenomics and its potential impact on space medicine.

[317] ETHICAL ASPECTS OF GENOMIC INFORMATION IN ASTRONAUT SELECTION, ASSIGNMENT, AND CARE

R.D. Reed³, A. Epstein⁵, L. Brown⁴, R.S. Blue¹, E. Antonsen^{3,8}, D. Deyle², E. Schenker⁶, M. Studer⁷ and J. Stepanek¹
¹Mayo Clinic, Scottsdale, AZ; ²Clinical Genomics, Mayo Clinic, Rochester, MN; ³Johnson Space Center, NASA, Houston, TX; ⁴Surgery, University of Auckland, Auckland, New Zealand; ⁵Midwestern University, Downers Grove, IL; ⁶Kuhnli Pharmaceutical, Co. Ltd, New York, NY; ⁷University of Zurich, Zurich, Switzerland; ⁸Baylor College of Medicine/NASA, Houston, TX

(ORIGINAL RESEARCH)

INTRODUCTION: As the field of genetics has developed, the ethical challenges of appropriately using genetic information have also expanded. NASA recently began genomic research and analysis to understand the impacts of spaceflight on astronauts. As the field develops, NASA will have the opportunity and the ethical challenge of determining how genetic information can improve clinical care and inform health risk assessment in human spaceflight beyond low Earth orbit. How NASA navigates these challenging issues in the context of the Genetic Information Non-Discrimination Act (GINA) may be of value for other high-stakes terrestrial activities. The Bellagio II summit sought to correlate such aerospace strategies to terrestrial application. **METHODS:** Current NASA approaches regarding genetic testing of astronauts was reviewed. The team examined policy for research and clinical care as well as recent scholarship on GINA including informed consent, individual risk characterization, personalized medicine, and policy regarding use of health data for selection, assignment, personalized countermeasures and care. **RESULTS:** Genetic information has several key areas of potential applicability: selection, individual risk characterization, personalized countermeasure development, personalized medicine and pharmacogenomics, mission assignment, and an improved understanding of the health impacts of spaceflight. Currently, federal law prohibits use of genetic information for employment decisions, which includes selection and assignment. An ethical framework for the use of genomic data must balance the rights of individuals to privacy and freedom from genetic discrimination, against the risks to the individuals and to NASA's missions that could be mitigated using genetic information. In the resource-constrained, high-risk environment of exploration, health status informed by genomics may prove to be a critical aspect of mission risk and success and an important aspect of NASA's ethical obligation to protect the health of astronauts. **DISCUSSION:** NASA efforts provide precedent for the use, compartmentalization, and selective surveillance of specific health concerns. This can be translated to the general public with the collection of health data by workplaces, providing precedence and advice for how this data should be used.

Learning Objectives:

1. Identify the ethical challenges associated with the use of genetic information in the astronaut population.
2. Understand how the Genetic Information Non-Discrimination Act (GINA) guides current approaches to the use of genetic information at NASA.
3. Understand how NASA's use of genetic information could provide a precedent for appropriate collection and use of health data in the terrestrial workforce.

Wednesday, May 09**2:00 PM****Ballroom B****S-068: SLIDE: AE URGENT PRACTICAL CHALLENGES & AN EYE TO THE FUTURE****Chair: Tamara Averett-Brauer***Fairborn, OH***Chair: Thomas Hoffman***Honolulu, HI***2:00 PM****[318] U.S. ARMY PARAMEDICS TASK SATURATION STUDY – UNCONSTRAINED ENVIRONMENT**

K. Barazanji^{1,2}, G. Hildebrandt³, J.A. Jones^{1,3}, J. Wurzbach^{1,4}, S. Conti^{1,4} and R. Kinsler¹

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

²Oak Ridge Institute for Science and Education, Fort Rucker, AL;

³U.S. Army Medical Evacuation Propensity Division, Fort Rucker, AL;

⁴NorthTide Group LLC, Fort Rucker, AL

(ORIGINAL RESEARCH)

INTRODUCTION: A recent en route care validation study conducted by the U.S. Army Aeromedical Research Laboratory defined

the minimum space for a critical care flight paramedic (CCFP) to perform en route care tasks as 28 inches (in.) vertical separation between litter pans. The study did not evaluate the flight paramedic's ability to treat and manage more than one patient at a time. **OBJECTIVE:** Identify the CCFPs' medical procedures failure occurrences while completing medical scenarios on 1 to 3 simulated patients with various injuries in a non-space limiting environment. **METHODS:** Two groups of test participants (TPs) conducted medical procedures on simulated trauma patients (Laerdal Medical SimMan® 3G): A less experienced (n=9) and a more experienced (n=10) groups with less than and more than 24 months experience, respectively, from their National Registry Paramedics course successful completion date. Each medical scenario associated with each manikin was based on typical trauma cases at point of injury. The TP had 360-degree access to each simulated patient placed on a litter with a height of 32 in. from floor. Each TP started with a test configuration of two simulated patients, urgent and priority (C1). The TP had 30 minutes to render care to both simulated patients. If unsuccessful, the TP was presented with test configuration of only one priority patient (C2). If successful, the TP was presented with a test configuration of two urgent patients (C3). Evaluation of each TP's performance was completed by one or two clinician(s) with subject matter expertise in U.S. Army CCFP guidelines and training. **RESULTS AND DISCUSSION:** Only one TP (from the experienced group) was able to successfully complete C1, but the same TP was unable to successfully complete C3. Only 52.6% of the TPs (5 out of 9 for the inexperienced group) and 40% of the TPs (4 out of 10 for the experienced group) successfully completed C2. High failure rates among all TPs and medical scenarios were failures to: start blood products within 13 min of casualty receipt (76%), wrap patient in hypothermia blanket within 10 min (63%), and identify and effectively treat hypovolemic shock (59%). On average, there was no difference in simulated patient physiological end points (i.e. 30th minute) between the experienced and inexperienced groups. The results suggest that proficiency and task saturation may be the largest contributing factors to the high failure rates.

Learning Objectives:

1. The audience will learn findings from a study on the flight paramedics' ability to render critical care for more than one patient aboard a medical evacuation helicopter.
2. The audience will learn flight paramedics' failure rates of specific medical procedures used on one-patient and two-patient configurations.
3. The audience will learn whether flight paramedics experience is a factor on the study findings.

2:15 PM

[319] DEFENSE POW/MIA ACCOUNTING AGENCY (DPAA) UPDATE

T.S. Hoffman

Surgeon Section, Defense POW/MIA Accounting Agency (DPAA), Honolulu, HI

(EDUCATION - PROCESS)

MOTIVATION: Aerospace medical professionals train to support the flight environment. The principles developed and skills acquired to support the ubiquitous nature of the flight environment can be combined with the principles and skills required to support operations in remote and austere environments. This presentation shows how aerospace medicine practices are synergistically combined with other medical disciplines in supporting the search for our missing combatants around the world. **OVERVIEW:** The Defense POW/MIA Accounting Agency (DPAA) mission is to provide the fullest possible accounting for our missing personnel to their families and the nation. DPAA investigates missing personnel records and information from all sources; develops case histories; negotiates with host nations; coordinates with universities, contractors, and NGO's; sends investigation and recovery teams to remote and austere locations around the world; recovers evidence and osseous material; analyzes the recovered evidence; and identifies missing personnel utilizing the most modern forensic techniques available. DPAA operates the largest forensic laboratory in the world. Missions are to some of the most remote locations on earth, including high altitudes in

India and Burma (usually aircraft crashes), ice bergs, remote jungles, mountainsides, and underwater shipwrecks. Personnel train in wilderness and pre-hospital medical care, including Tactical Combat Casualty Care (TCCC) and Prolonged Field Care (PFC) to support missions in remote environments. This presentation shows that aerospace medicine practices combined with other medical disciplines combine synergistically to provide multidisciplinary problem solving for mission accomplishment. **SIGNIFICANCE:** Aerospace, prehospital care, and wilderness medicine practices are applied to all facets of DPAA operations. Practices include medical standards and screening of personnel to ensure fitness for deployment, travel medicine preparation to remote/austere locations, personnel training in TCCC and PFC, aircraft accident and forensic science procedures, medical evacuation from remote locations, fatigue and resiliency of deployers, team dynamics, Agency cultural change, international relations, Humanitarian Assistance, environmental and hazardous exposure factors, and medical equipment and treatment protocols. This presentation exemplifies the 2018 Aerospace Medicine Association theme of the synergy and power of multidisciplinary problem solving.

Learning Objectives:

1. Understand the pre-mission training of DPAA personnel, including Tactical Combat Casualty Care (TCCC) and Prolonged Field Care (PFC).
2. Describe the types of field missions DPAA teams conduct.
3. Understand the general processes involved in DPAA field mission operations.

2:30 PM

[320] EXPERIENCE OF MILITARY AEROMEDICAL EVACUATION IN TAIWAN

K. Chiang¹, C. Liu² and H. Chu³

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(EDUCATION - PROCESS)

MOTIVATION: Military Aeromedical Evacuation in Taiwan had been set up since 1958. After 60 years of development, it is now composed of mainly 2 parts: the Aeromedical Evacuation (AE) squad and the Air Rescue (AR) Group. **OVERVIEW:** The AE squad uses C-130 Hercules and provides support for remote islands AE, for both military and civilian patients. There are now 5 AE teams, each containing 1 flight nurse (FN) and 1 AE technician (AET). The FN in each team is responsible for the coordination of the AE mission. The AR Group is the military Helicopter Emergent Medical Service (HEMS) unit, it uses Sikorsky S-70C and EC-225 Super Puma for search and rescue (SAR) missions. Now, the AR group includes 32 AETs members, of which 2 AETs will be dispatched in each SAR mission. The EC-225 Helicopter is equipped with ICU level flight-powered medical equipment and is capable of AE of critical patient. **SIGNIFICANCE:** Special achievement of the AE squad includes AE of patient on Extracorporeal membrane oxygenation (ECMO) by C-130, urgent AE of a premature baby, disaster AE and some international Humanitarian Assistance and Disaster Relief (HA/DR) operations. Special achievement of the AR group includes AE of ECMO patient, disaster AE and some international HA/DR operations. Future prospective of our military AE includes exchange of international AE experiences, update AE and HEMS facilities, provide professional training of AE crews and participate in international HA/DR operations.

Learning Objectives:

1. The flight nurse in each team is responsible for the coordination of the AE mission.
2. Special achievement of the AE squad includes AE of patient on Extracorporeal membrane oxygenation (ECMO) by C-130, urgent AE of a premature baby, disaster AE and some international Humanitarian Assistance and Disaster Relief (HA/DR) operations. Special achievement of the AR group includes AE of ECMO patient, disaster AE and some international HA/DR operations.
3. Military Aeromedical Evacuation in Taiwan had been set up since 1958.

2:45 PM

[321] CHEST PAIN IN ACTIVE DUTY AEROMEDICAL EVACUATION PATIENT: A CASE REPORT

N.A. Bumbarger and S.E. Chapman

*Flight Medicine, Malcolm Grow Medical Center, Andrews Air Force Base, MD**(EDUCATION - CASE STUDY CLINICAL)*

PROBLEM STATEMENT: This case report describes an active duty male who presented with acute onset chest pain and shortness of breath during an aeromedical evacuation flight from Landstuhl Regional Medical Center (LRMC) to Joint Base Andrews (JBA) who was subsequently found to have coarctation of the aorta and atrial septal defect. **BACKGROUND/LITERATURE REVIEW:** Aeromedical evacuation increases physiologic stress to the patients. The oxygen partial pressure changes, vibration, thermal changes, and barometric pressure changes can be taxing, even for healthy individuals. Those with underlying medical conditions may not be able to mount a compensatory sympathetic response. It is critical to identify and treat patients with cardiovascular impairment prior to evacuation. **CASE PRESENTATION:** The subject was a 20-yr old Army tank driver was deployed to Latvia where he was injured during a live fire exercise. He experienced convulsions, cardiac arrest, and loss of consciousness after a hydraulic line blew. The patient was intubated in the field, stabilized in an Intensive Care Unit, and subsequently transferred by aeromedical evacuation (AE) to LRMC via Critical Care Air Transport Team (CCATT). He was extubated and treated for ventilator associated pneumonia and noted to have type II NSTEMI. He was subsequently discharged on hospital day three and was on an AE transport back to his home station three days later. During the AE flight from LRMC to JBA the patient developed sudden onset of dyspnea and chest discomfort. During his evaluation at JBA, a CT chest revealed coarctation of the aorta and a cardiology referral was placed. The patient was transferred to Walter Reed National Military Medical Center where he underwent percutaneous repair of coarctation of the aorta and atrial septal defect. **OPERATIONAL/CLINICAL RELEVANCE:** This case highlights the increased physiologic demands that aeromedical evacuation patients are exposed to. Previously undiagnosed conditions may present during flight and can be exacerbated by the injuries the patients sustained. It is imperative to keep a broad differential when evaluating these patients. In addition, this case illustrates the need for thorough initial entry screening as well as pre-deployment screening. This patient had a history of hypertension which was previously untreated. Flight surgeons should perform a thorough workup for secondary causes of hypertension in patients younger than thirty with no predisposing factors.

Learning Objectives:

1. To highlight critical pre-flight assessment of patients prior to Aero-medical Evacuation.
2. To increase knowledge and evidenced based reporting of Aeromedical Evacuation and effects of altitude on physiology.

3:00 PM

[322] DEALING WITH ARREST DURING AEROMEDICAL EVACUATIONA.M. Refai^{1,2}*¹FMC-KAEC, Dr. Soleman Fakeeh hospital, Zarka, Jordan; ²Family Medicine, Ex-Royal Medical Services, Amman, Jordan**(EDUCATION - CASE STUDY CLINICAL)*

INTRODUCTION: Arrested patients is highly possible during Aeromedical Evacuation, since patients moved by air mostly are critical patients, although it is a safe, modern, and complex transportation system designed to move patients by air during which needed care is provided from the scene of initial injury or illness till the arrival to definitive care installation. **OBJECTIVE:** Objective is to study the efficacy of procedures done on board when arrest happens to the ICU patient during an International Aeromedical Evacuation from Saudi Arabia to Jordan during which nine critically-ill patients, 2 of them were on respirator. **PATIENTS AND METHODS:** A Jordanian family of 7 members aeromedically evacuated from Saudi Arabia, involved in a

road traffic accident and 5 of them had severe multiple injuries and 2 of them were in respirator, during takeoff a flat rhythm of one of the two patients was seen, i.e., arrest, after which rapid CPR was done with early defibrillation post which he has been recovered from. **RESULTS:** A recovery from cardiac arrest has been achieved after implementing good and high quality CPR from the trained team on board despite difficult situation during flying especially taking off. **RECOMMENDATIONS:** Arrest is to be expected during AE of the patient on board even if he is stable on respirator and to be ready for it.

Learning Objectives:

1. During aeromedical evacuation of patient on board, even if he is stable on respirator arrest is to be expected.

3:15 PM

[323] VICTIMS OF OUR OWN SUCCESS: EN ROUTE CARE, EXPECTATIONS, THREATS, AND HOW WE MIGHT THINK ABOUT THE FUTUREP. Nelson^{1,2}*¹Air University, Maxwell AFB, AL; ²Adjunct Faculty, USAFSAM, Wright-Patterson AFB, OH**(EDUCATION - PROCESS)*

MOTIVATION: In the military combat environment of the future, the operational pre-conditions the Joint Trauma System depends upon may not consistently exist. This scenario would threaten our current concepts of casualty management and operational support. If we do not rethink how we view casualty management now we risk mission failure in future conflicts. **OVERVIEW:** Aerospace Medicine capability and expertise have been critical enablers in support of the Joint Trauma System (JTS). This system of casualty management, refined over the past 15 years, has been so effective that it has produced an expectation by many that America and her allies can fight a war with minimal fatalities. We have nurtured this perspective with stories of remarkable heroics to save one wounded soldier, but have not been as effective at communicating the complexity of the system's requirements to decision makers. The JTS capability, executed with medical, line, joint, and coalition partners, is heavily dependent upon just-in-time logistics, to include manpower, materiel, and airlift support. In a future conflict, especially one with a peer or near peer competitor, these pre-conditions for operational success will not consistently exist which would threaten our current concept of casualty management. Air University has partnered with the Air Force Medical Service and others to explore expectations for casualty management, but also to help define this emerging capability gap thru a series of scholarly papers and analytical wargames. **SIGNIFICANCE:** This presentation will frame the findings of this line of research in terms of realistic assumptions, threats, and possible emerging requirements with a goal of informing both medical and line decision makers, but also the general population.

Learning Objectives:

1. Understand the medical, operational, and geo-political implications of threats from operating in a denied environment on our ability to execute casualty management with our current Joint Trauma System construct.
2. Consider risk mitigation strategies in terms of emerging requirements to successfully execute the Joint Trauma System mission in the future.
3. Understand the emerging research around Medical Support for Combat Operations in a Denied Environment. (MS-CODE).

Wednesday, May 09**Topaz****2:00 PM****S-069: SLIDE: STRESS IN AUS"STEER" ENVIRONMENTS****Chair: Charles DeJohn**
*Oklahoma City, OK***Chair: Brent Haskell**
Georgetown, KY

2:00 PM

[324] EVIDENCE OF DISORIENTATION IN OPERATORS OF REMOTELY PILOTED AIR SYSTEMS (RPAS)T.L. Grimshaw*Human Performance, Qinetiq, Farnborough, United Kingdom**(ORIGINAL RESEARCH)*

INTRODUCTION: Disorientation is often described as a physiological problem arising from the movement of aircraft in flight. However, since 2004 QinetiQ has conducted detailed analyses of military disorientation incidents for the UK Ministry of Defence (MOD) through the Orientation Incident Survey, and the results show that other factors also play a critical role in disorientation. These include misperception of visual cues, distraction, crew communication and high workload. With the increase in the number of military remotely piloted flights, the MOD wanted to understand whether these factors could present a risk to flight safety for these platforms. **METHODS:** An anonymous survey of RPAS operators was conducted, asking them to describe occasions when they either became confused about the attitude, altitude or position of their aircraft or they suddenly became aware that the aircraft attitude, altitude or position was not what they had expected it to be. These descriptions were then analyzed to understand the factors that contributed to the disorientation incident. **RESULTS:** A total of 27 incidents were reported, with 25 of these from the main UK RPAS platform, Reaper. This represents an incident rate of 26% against the number of operators surveyed, which is higher than has been reported for any single platform over the thirteen years that the Orientation Incident Survey has been conducted, and half of those operators stated that their incidents have occurred more than once, with some being a daily occurrence. Ten incidents resulted in errors in the position of the aircraft, including two airspace infringements. Several incidents resulted in unplanned changes to the position of the aircraft, whether height, attitude or geographical location, with associated risks to flight safety for aircraft in the surrounding airspace or for personnel on the ground. Many issues were associated with the layout of displays and the movement of personnel between Ground Control Station (GCS), and several altitude errors were due to difficulty accessing the required information. **DISCUSSION:** The results show that disorientation represents a risk to flight safety for RPAS operations. The use of anonymous reporting and the focus on incidents where operators have become confused about the position of their aircraft means that the survey provides a unique record of disorientation in RPAS operations. The results are being used to inform flight safety through education and training.

Learning Objectives:

1. To understand how RPAS operators might be affected by spatial disorientation.

2:15 PM

[325] IMPACT OF RPA WORK ON FAMILIES: OCCUPATIONAL HEALTH SCREENING OF USAF REMOTELY PILOTED AIRCRAFT OPERATOR SPOUSES

M. Schuster^{1,2}, W. Scott¹, L. Prince³, T. Goodman⁴ and W. Chappelle⁵
¹*U.S. Air Force Academy, Colorado Springs, CO;* ²*German Air Force Centre of Aerospace Medicine, Fürstfeldbruck, Germany;* ³*Prince Research and Analytic Solutions, LLC, Birmingham, AL;* ⁴*Neurostat Analytical Solutions, LLC, Alexandria, VA;* ⁵*Aeromedical Operational Psychology, USAFSAM, Wright-Patterson AFB, OH*

(ORIGINAL RESEARCH)

INTRODUCTION: Multiple psychological health studies of U.S. Air Force (USAF) Predator/Reaper weapon-strike remotely piloted aircraft (RPA) operators reveal self-reported high levels of marital and family-related stress due to difficulties with having to balance warfighting duties with domestic and family-related obligations. This is an initial study to assess the prevalence of psychological distress, marital functioning, and needs of spouses, as well as their main sources of stress with regard to supporting RPA operators. **METHODS:** A total of 250 USAF RPA active duty operator spouses completed a comprehensive, self-report, web-based psychological health assessment composed of standardized and qualitative items. Spouses also participated in follow-up interviews.

Participation in the psychological assessment was coordinated with behavioral scientists from the U.S. Air Force Academy. The main sources of stress affecting spouses' health and family life, sources of family and network support, satisfaction with family roles, and levels of psychological distress were assessed. Qualitative data from write-in feedback items and interviews were also analyzed. **RESULTS:** The prevalence of medically significant psychological distress ranged from 10-27% and was the highest for spouses struggling with balancing their marital support to operators and child-rearing obligations. Additionally, the percentage of spouses reporting significant marital or relational distress ranged from 18-32%. Other significant stressors affecting the RPA spouses included operator shift work and constantly changing work schedules, financial difficulties due to remote geographic location of units, lack of quality time at home with operators, and juggling spouses' own occupational and/or educational commitments. The percentage of spouses reporting perceived unhealthy family functioning ranged from 12-15%. Family-centric events and activities, leadership support, and shift work without rotations were cited as family-friendly aspects of current assignment and improvements in psychological health, but the rates of support efforts varied by location. **DISCUSSION:** Recommendations are provided for line and medical leadership for reducing family distress and therefore optimizing health of RPA operators and their families. More balanced and reliable schedules, transparent strategic vision and professional development, community support, and growth of the RPA community are discussed.

Learning Objectives:

1. The participant will be able to identify significant sources of stress for RPA spouses, and strategies for optimizing health of RPA operators and their families.

2:30 PM

[326] UNEXPLAINED PHYSIOLOGICAL EVENTS VERSES PHYSIOLOGICAL EPISODES - A NAVAL SAFETY CENTER APPROACHL.A. Vitaoe*U.S. Navy, Naval Safety Center, Norfolk, VA**(EDUCATION - PROCESS)*

MOTIVATION: The past 10 years, the USN/USMC have had an alarming increase in the number of unexplained physiological events. Two separate Root Cause Analysis teams have been set up to attempt to get to the root of the problem and reduce the overall number of events. As this is a in depth and often lengthy process, the Naval Safety Center has instituted new policy throughout Naval Aviation in hopes of identifying and reducing these over incidences. **OVERVIEW:** Class A mishaps (most severe category) in the U.S. Naval Aviation demand rigorous investigation to understand the causal factors and to create robust lessons learned to prevent further loss of life and property. As our incidence of unexplained Physiological Episodes has increased, we have extended a miniature version of our standard Class A mishap protocol to attempt to get a root cause and unveiling more of the human factors that we hope will eventually lead to a return of normal incidence of human physiological episodes that are explainable and understandable. **SIGNIFICANCE:** Ultimately, we hope to increase our knowledge of aircrew habits as it relates to aviation life support equipment usage and better understand the human factors that have changed over the last 10 years that have led us to this point in history. Additionally, the number of events with our aircrew that have led to significant loss of work days and in some cases, permanent downing of aircrew, is no longer acceptable.

Learning Objectives:

1. The participant will be able to explain the new policy that the Navy has instituted to reduce unexplained physiological episodes.

2:45 PM

[327] REFINEMENT OF A SHIVERING SUPPRESSION PROTOCOL FOR MINIMALLY INVASIVE PROLONGED COOLING IN HEALTHY INDIVIDUALS

J. Rittenberger^{1,2}, K. Flickinger^{1,2}, A. Weissman^{1,2}, F. Guyette^{1,2}, J. Elmer^{1,2}, S. DiFiore¹, M. Repine^{1,2}, C. Dezfulian^{1,2} and C. Callaway^{1,2}
¹*University of Pittsburgh, Pittsburgh, PA;* ²*Emergency Medicine, Applied Physiology Laboratory, Pittsburgh, PA*

(ORIGINAL RESEARCH)

INTRODUCTION: Hypothermia is a neuroprotective strategy for cardiac arrest and spinal cord injury. These patient populations require invasive techniques and anesthetic levels of sedation to suppress shivering. Hypothermia in healthy individuals is also a potential strategy to decrease metabolic demand in order to facilitate prolonged space travel, but would require non-invasive and safe methods to suppress shivering. Hypothermic sleep might also have psychological benefits during prolonged confinement. **METHODS:** We recruited healthy individuals between 18-49 years of age. All subjects received a bolus followed by a continuous intravenous infusion of dexmedetomidine to suppress shivering. We induced and maintained cooling for up to 3 hours using an initial intravenous bolus of cold saline followed by surface cooling. We observed subjects an additional 2 hours until they were able to ambulate, void and tolerate liquids. We recorded the coldest temperature achieved and any adverse event that occurred during the study period. We explored different timing of drug and saline administration. **RESULTS:** We cooled 13 subjects 20 times. Mean age was 31 (SD 8) years and 8 (62%) were males. Mean weight was 71 (SD 14) kg, height was 168 (SD 9) cm and BMI was 25 (SD 3). The mean lowest temperature achieved was 34.9 (SD 0.7) °C. All subjects experienced asymptomatic bradycardia during the experiment. One subject experienced a sinus pause during concurrent infusion of dexmedetomidine and cold saline. The infusions were stopped and the pause resolved. One subject experienced atrial fibrillation that resolved with rewarming. All subjects could be woken using verbal or physical stimulation and able to follow commands for the duration of the experiment. **DISCUSSION:** Induction of hypothermia is feasible in healthy individuals without long term sequelae. Concurrent administration of bolus cold saline and dexmedetomidine may cause sinus pause. Ongoing and future studies are evaluating longer cooling durations and optimal pharmacological strategies to maintain hypothermic sleep and minimize adverse effects.

Learning Objectives:

1. Understand common side effects encountered during cooling healthy individuals.

3:00 PM**[328] EVALUATION OF A WIRELESS EKG SYSTEM FOR APPLICATIONS IN EXTREME ENVIRONMENTS**

P. Lee

Surgery, The Ohio State University Wexner Medical Center, Columbus, OH

(ORIGINAL RESEARCH)

INTRODUCTION: Continuous EKG monitoring in astronauts and pilots can significantly improve our understanding of the effects of spaceflight and flying on heart rhythm disturbances. However, such monitoring has been hampered by the impracticality of current wired EKG systems. A simple and easy-to-use wireless EKG system could potential address these practical concerns and pave the way to routine continuous monitoring of astronauts, pilots, or individuals in almost any environment. **METHODS:** As a precursor to possible testing in future spaceflight missions and other extreme environments, a novel commercially available wireless EKG system was tested in two unique environments. First, the system was tested in C130 Air Force pilots during routine flights. The quality of the data and the ease of use were determined. Second, the system was field tested by a volunteer during a 1-month Antarctic mission. The ability to acquire accurate continuous data and to transmit these EKG readings to a "base" station in real time was evaluated. **RESULTS:** The wireless EKG system provided continuous EKG readings from the C130 pilots. There were no significant technical issues, and the data was stored and reviewed postflight with ease. The system was also evaluated in Antarctica where the wireless EKG patch was worn continuously for over two weeks. It was found to be easy to use, unobtrusive, and accurate. EKG readings were also able to be transmitted wirelessly via Bluetooth to a local hand-held tablet and then via the internet to a "base" station in the U.S for real-time monitoring. **DISCUSSION:** A wireless EKG system that can transmit data in real-time from anywhere in the world to anywhere in the world can have numerous applica-

tions and can significantly improve our ability to monitor individuals in remote or extreme environments. This system is easy to use, inexpensive, accurate, and versatile. Further investigation into its application in a variety of settings is warranted.

Learning Objectives:

1. To demonstrate the potential use of a wireless EKG system for continuous monitoring in a remote environment.
2. To highlight practical and human factors issues associated with using a wireless EKG monitoring system in flight and in an extreme environment.
3. To explore benefits and limitations of using a wireless EKG system for continuous cardiac monitoring in various environments.

3:15 PM**[329] COMBAT SWIMMING INDUCED PULMONARY EDEMA**J.W. Cromar¹, J.A. Aun¹ and R. Sarlay²¹Internal Medicine, 81 MDOS/U.S. Air Force, Biloxi, MS; ²Aerospace Medicine, HQ Air Force Reserve Command, Robbins Air Force Base, GA**WITHDRAWN****Wednesday, May 09****2:00 PM****Sapphire****S-070: PANEL: DEFENDERS COMPREHENSIVE MEDICAL READINESS PROGRAM FOR FLIGHT SURGEONS****Chair: Charles Clinton**

Xenia, OH

Chair: Douglas Files

Fairborn, OH

Chair: Jameson Voss

Wright Patterson, AFB, OH

PANEL OVERVIEW: BODY: Aerospace medicine professionals need to be defenders ready to fight back against the many threats facing aircrew. Through shop visits, sanitation assessments, or a travelers medicine evaluations, flight surgeons defend aircrew from a myriad of threats. This panel will engage participants with hands-on interactive experiences addressing a single unit's deployment to Africa. After participants complete a travel briefing and identify the appropriate malaria chemoprophylaxis, the scenario will progress to the deployed location where several cases of bloody diarrhea emerge among food workers. Participants will need to investigate the food and the working conditions their aircrew face. As the operational tempo intensifies acute fatigue countermeasures are needed for mission completion. The session format will include updated didactic material addressing each step in the sequence, but attendees will engage directly in the deployment sequence by splitting into groups (as appropriate) and working through each of the four sections using pictorial examples of findings on the inspections and site visits. In order to enhance realism, participants who fail to protect the food and water will be lost to their team and will have to work the remainder of the sequence separately. At the conclusion, attendees will enhance their ability to defend against various contingencies.

[330] DEFENDERS WORKSITE PHYSICAL AND CHEMICAL HAZARDS

D.S. Files, J.D. Voss and A. Gammill
USAFSAM, Wright-Patterson AFB, OH

(EDUCATION - PROCESS)

MOTIVATION: Numerous potential hazards exist around deployed flight line worksites including chemicals, airborne hazards, ergonomic hazards, infectious agents and injury threats. Aerospace medicine professionals play an occupational medicine role with its traditional focus on preventive medicine, showcasing the importance of the worksite visit. **OVERVIEW:** Many industrial hazards occur on a flightline, making it difficult to memorize all hazards and manifestations. However, understanding the appropriate references for investigating causes of physical symptoms and recognizing the way chemical hazards can change at different temperatures provides a general foundation. Additionally, professionals in occupational medicine cannot overlook common threats such as physical hazards, hygienic conditions, airborne dust, and worksite smoking. **SIGNIFICANCE:** Laying eyes and hands on a worksite can link physical manifestations with environmental hazards. Aerospace medicine professionals from multiple disciplines and countries can benefit in obtaining comprehensive medical readiness skills delivered during this session.

Learning Objectives:

1. Performing a shop visit at a worksite, flight and occupational medicine professionals can link physical manifestations with environmental hazards. Participants will benefit in obtaining comprehensive medical readiness skills delivered during this session.

[331] DEFENDERS TRAVEL MEDICINE UPDATE

J.D. Voss, D.S. Files and A. Gammill
USAFSAM, Wright-Patterson AFB, OH

(EDUCATION - PROCESS)

MOTIVATION: Aerospace medicine professionals exercise oversight of airfield operations that potentially affects the safety and health of populations supporting the flying mission. However, airfield operations are not always in the nation of origin, thus flight surgeons and the people they support need to be prepared to deploy worldwide. This presentation will assist aerospace medicine professionals to maintain currency by participating in travel medicine briefings and administrative tasks. **OVERVIEW:** Duties and responsibilities of flight surgeons at airfields include being the medical expert on travel health issues. This task is complicated by the wide variety of locations where airfield operations can occur. Medical travel guidelines are always changing. This program will allow aeromedical professionals to participate in travel medicine briefings and administrative tasks. The sample case provided will focus on malaria prophylaxis for a deployment to sub-Saharan Africa. **SIGNIFICANCE:** Health risks to aircrew have expanded with global travel. The risks are so great that currency in travel medicine must include regular participation in briefings and administrative tasks. While there are numerous venues for flight surgeons to work and keep abreast of immunizations and health risks, they must also learn about planning and presenting briefings on the subject. This program offers international aerospace medicine specialists an opportunity to incorporate some of the latest medical guidelines along with tips and techniques on how to present a briefing of this kind.

Learning Objectives:

1. Health risks to aircrew make regular participation in briefings important for flight medicine personnel. While there are numerous venues for flight surgeons to work and keep abreast of immunizations and health risks, they must also learn about planning and presenting briefings on the subject. This program offers international aerospace medicine specialists an opportunity to incorporate some of the latest medical guidelines along with tips and techniques on how to present a briefing of this kind.

[332] DEFENDERS SANITATION AND FOOD SAFETY

J.A. Lawson, D.S. Files and J.D. Voss
USAFSAM, Wright-Patterson AFB, OH

(EDUCATION - PROCESS)

MOTIVATION: Aerospace medicine professionals oversee public health and preventive medicine operations at their worksites. Performing

sanitation or food/water vulnerability assessments are often assigned tasks. However, some flight surgeons struggle to perform enough assessments. This presentation will assist aerospace medicine professionals to maintain currency by participating in a prototypical virtual food/water vulnerability inspection. **OVERVIEW:** Aerospace medicine professionals take responsibility for the safety, health, and well-being of their populations. Flight medicine experts perform sanitation and food/water vulnerability assessments in order to ensure mission completion and flying safety. However, guidelines change and aerospace medicine professionals can lose currency. This program will update aeromedical and allied professionals on sanitation and food/water vulnerability inspection issues through individuals participating in a virtual inspection regarding a food safety/epidemiology case. **SIGNIFICANCE:** Sanitation and food/water vulnerability inspections should be performed regularly at airfields and other workplaces. Lapses can affect mission completion and flying safety. This session will give preventive medicine and occupational health personnel an opportunity to learn the latest guidelines, tips, and techniques in how to perform these inspections. International professionals will gain insight into United States food standards and how performing these inspections might positively affect airfield safety and health in their own countries. Thus, professionals from all services and all countries will benefit from these sanitation, food, and water inspection cases.

Learning Objectives:

1. This session will give preventive medicine and occupational health personnel an opportunity to learn the latest guidelines, tips, and techniques in how to perform these inspections. International professionals will gain insight into United States food standards and how performing these inspections might positively affect airfield safety and health in their own countries.

[333] DEFENDERS FATIGUE COUNTERMEASURES

R.A. Turner, D.S. Files and J.D. Voss
USAFSAM, Wright-Patterson AFB, OH

(EDUCATION - PROCESS)

MOTIVATION: Aerospace medicine professionals sustain maximal aviator performance. One special interest item in this field involves the use of medication. Flight surgeons prescribe hypnotics to help aviators sleep prior to a sortie and in special circumstances prescribe stimulants to improve performance during critical phases of flight. This presentation will instruct aerospace medicine professionals in the proper usage of performance-enhancing medication for aviators. **OVERVIEW:** Aerospace medicine professionals study the physiologic effects and risks of flight. In order to ensure mission completion, flying safety, and individual health and well-being flight surgeons sometimes prescribe medication for use. At times, hypnotics assist aircrew to sleep prior to a mission while other medications improve pilot alertness during critical phases of flight. Flight surgeon experience with using these medications varies. This program will update flight surgeons on medical and other fatigue countermeasures. **SIGNIFICANCE:** The U. S. Air Force requires annual training regarding the use of performance enhancing medication. Many other services also use performance-enhancing medication. This program will model techniques and will aid all AsMA attendees participating in the session.

Learning Objectives:

1. The U. S. Air Force requires annual training regarding the use of performance enhancing medication. Many other services also use performance-enhancing medication. This program will model techniques and will update all AsMA attendees participating in the session.

Wednesday, May 09
Chantilly East

2:00 PM

S-071: PANEL: RESIDENT GRAND ROUNDS III

*Sponsored by The American Society of Aerospace Medicine
Specialists*

Chair: Richard Allnutt
Beavercreek, OH

Chair: Mark Coakwell
Beavercreek, OH

PANEL OVERVIEW: This panel will consist of pairs of Aerospace Medicine residents presenting clinical cases of aeromedical interest or significance. During their residency practicum years, residents conduct evaluations of patients with diverse medical problems. Residents prepare and present a case report based on a patient encounter undertaken during their practicum experience. One resident from each pair presents the history of the presented problem. The other resident presents the physical findings and a discussion of the aeromedical policies associated with the condition. Learning Aerospace Medicine at the specialist level involves understanding the impact of medical conditions on aircrew health and mission accomplishment. The cases presented will not only be of academic interest but will also illustrate aeromedical decision making in the operational environment.

Wednesday, May 09
Chantilly Foyer

2:00 PM

S-072: POSTER: AEROSPACE ENVIRONMENTAL EFFECTS

Chair: Gordon Landsman
Aurora, CO

Chair: Philippe Souvestre
Vancouver, British Columbia, Canada

[334] ATTENUATION OF THE OPTOKINETIC CERVICAL REFLEX DURING HIGH ALTITUDE FLIGHT

M. Stewart^{1,2}, S. Pingali² and D.G. Newman³

¹University of Melbourne, Melbourne, Australia; ²Griffith University, Nathan, Australia; ³Aviation Medicine Unit, Monash University, Melbourne, Australia

(ORIGINAL RESEARCH)

INTRODUCTION: When an aircraft banks pilots will reflexively tilt their heads in the opposite direction to the bank. This is known as the optokinetic cervical reflex (OKCR), which is thought to be an attempt to keep the moving horizon stable on the pilot's retina, helping to maintain spatial orientation. Previous research has shown that the OKCR is visually based, as it is not apparent during flight under Instrument Meteorological Conditions (IMC). However, nearly all previous studies have been at low altitudes. Our hypothesis was that increasing altitude would reduce the OKCR due to less visual flow of terrain information. **METHODS:** 16 pilots (13 male and 3 female), flew two 15-minute flights using a desktop flight simulator equipped with a large visual display. Head tilt was recorded with a MPU 6050 gyroscope and accelerometer attached to a standard pilot communications headset with a data sampling rate of 100 Hz. Flight data was recorded via a data capturing software program at a capture rate of 8 Hz. The low altitude flight was at an altitude of less than 1,500 feet above ground level (AGL), whilst the high-altitude flight was at least 15,000 feet AGL. This study was approved by Griffith University's Human Research Ethics Committee. **RESULTS:** Aircraft bank caused head tilt in the opposite direction at both high and low altitudes, consistent with the OKCR. 86% of aircraft bank angles from 0 to 90 in either direction had a head tilt that was statistically significantly smaller at high altitude compared to low altitude. The difference in head tilt was greater as the angle of bank angle increased: at over 50 degrees of bank there was around half the head tilt (46% reduction) at high altitude compared to low altitude. **DISCUSSION:** Previous studies have shown that the reflex does not occur during IMC flight. This study further supports the evidence that the OKCR is a visually based reflex. Furthermore, it suggests that it is generally a low altitude phenomenon, with the reflex being significantly attenuated at high altitude. It may be that the visual flow of detailed terrain information at low altitude triggers the OKCR, and that as altitude increases the reduced visual flow of terrain information reduces the reflex. More research is required to better understand this phenomenon across a range of conditions, as well as any practical consequences of OKCR changes on pilot orientation.

Learning Objectives:

1. Understand the effect of high altitude on the optokinetic cervical reflex.

[335] SPATIAL ORIENTATION ABILITIES IN PILOTS DURING DIRECTIONAL JUDGMENTS

P. Verde¹, R. Nori², A. Scagliusi¹, G. Bizzarro¹ and M. Lucertini¹

¹Aerospace Medicine Department, ItAF, Pomezia, Italy; ²Psychology, University of Bologna, Bologna, Italy

(ORIGINAL RESEARCH)

INTRODUCTION: Reading a map requires making judgments about position in a large-scale space from information presented in a small scale representation. Generally, individuals are more accurate and faster in making judgments when the "up" direction on the map is the same as the "forward" direction in the environment; that is when a map is aligned with the perspective of the spatial layout they had learned (alignment effect). The aim of this study is to explore the effect of expertise: we hypothesized that military pilots who have high spatial abilities do not show alignment effect compared with non-pilots. **METHODS:** 20 pilots and 20 non-pilots were recruited. The mean flight hours were 418.75. Non-pilots were without flight experience, matched for age and education with pilots. All participants were asked to learn a map and to perform (10 aligned and 10 counter-aligned) directional judgments to verify whether the alignment effect was present considering absolute angular errors. **RESULTS:** An ANOVA for mixed designs on absolute angular errors revealed a main effect of "group" ($F_{1,38}=57.90, p<.001$): pilots performed better than non-pilots. A main effect of "directional judgments" ($F_{1,38}=55.334, p<.001$): the aligned judgements were easier than counter-aligned ones. ANOVA showed a significant "group x directional judgments" interaction ($F_{1,38}=30.420, p<.001$): post-hoc comparison (Bonferroni correction) showed that counter-aligned are more difficult than aligned judgments for non-pilots ($p<.001$), whereas the pilots were equally accurate in performing both judgments. **DISCUSSION:** The high visuo-spatial abilities as well as the expertise due to the flight experience preserved pilots in having the alignment effect bias. They perform equally well directional judgments apart the changing perspective, suffering less from the increased cognitive load following the changing perspective.

Learning Objectives:

1. Participants will be able to better understand pilots' abilities in performing navigational tasks during an increased cognitive load.

[336] ASSESSMENT OF THE SPATIAL DISORIENTATION DEMO SORTIE AMONG BRITISH ARMY ROTARY WING PILOTS

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(ORIGINAL RESEARCH)

INTRODUCTION: Spatial disorientation (SD) remains a significant risk to flight safety for rotary and fixed-wing pilots. SD training is an essential tool to increase aircrew situational awareness of this risk. In the British Army, aircrew receive a disorientation lecture followed by an in-flight spatial disorientation sortie. During each 30-minute serial, windows are closed in the aircraft to remove any cues offered by change of airflow, particularly during the hover exercises. One student (the subject) obscures their vision by closing their eyes, and lowering the helmet dark visor and visor cover. The other student(s) do not obscure their vision, and compare the actual flight profile with the commentary provided by the subject. This approach enhances the participant's experience and their future ability to recognize SD in themselves and their crew. **METHODS:** From 2015-2017, as part of an overall performance improvement initiative, 107 SD sortie participants were anonymously surveyed and asked to rate their experience as subject or observer for each serial. 63 participants were drawn from initial flight training, and 32 respondents participated in the sortie as refresher training. Survey responses were assessed for overall patterns. **RESULTS:** 84% of all participants noted an improvement in their awareness of the limitations of their orientation senses following the training. **DISCUSSION:** An SD sortie appears to satisfy end-user requirements to enhance their understanding of limitations in terrestrial-based human physiology. By actively demonstrating false perceptions of position and/or motion during the sortie, aircrew develop improved awareness useful in visually degraded environments with a commensurate impact on the overall aviation mishap rate. These basic principles are developed further through unusual attitude demonstrations during instrument training sorties.

Learning Objectives:

1. Estimate the value of a dedicated spatial disorientation sortie among aircrew.

[337] HORIZON AND SPLAY MISPERCEPTIONS MAY PROMOTE THE BLACK HOLE ILLUSION

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INTRODUCTION: A visual effect known as the Black Hole Illusion (BHI) sometimes causes pilots to fly too low during a nighttime landing approach. With good visibility, pilots use several visual cues to maintain a proper glide path, including the aim point, horizon, glare shield, and runway edge lines. At night, the horizon may not be visible, and the solid runway edges are replaced by rows of lights. We examined the possibility that pilots might misperceive the runway edge lines at night and inaccurately judge the location of the horizon. Such misjudgments could cause a pilot to accept an improper sight picture resulting in a low approach. **METHODS:** Participants performed three computer-based tasks, each requiring different angle judgments for various dotted lines simulating runway edge lights at night. The first task required participants to judge where two dotted lines would intersect. This task assessed how well participants judged the vanishing point of two converging lines, simulating how well participants may be able to estimate the horizon's location based on the inferred vanishing point of parallel runway edge lines. The remaining two tasks involved judgments of where a dotted line intersected a straight solid line or a curved solid arc. These tasks assessed how well participants could judge the relative angles of lighted runway edge lights at night. **RESULTS:** Repeated measures ANOVAs revealed that participants tended to underestimate the distance to the convergence point of two dotted lines, especially at shallow convergence angles ($p < 0.001$; $\eta^2_p = 0.47$). Participants also made systematic errors when estimating the angles of the individual dotted lines, perceiving the lines as more horizontal than they actually were. The magnitude of these errors increased as the stimulus lines diverged more from the vertical ($p < 0.001$ for the straight line and curved line tasks, $\eta^2_p = 0.05$ and 0.30 , respectively). **DISCUSSION:** Participants in our study underestimated the convergence point of two dotted lines and the slant of individual lines. These results support the possibility that pilots may misjudge the location of the horizon at night in a manner that causes them to believe it is lower in their visual field than it actually is. This illusion would cause pilots to lower the aircraft's nose, increasing the likelihood of a low approach. Future research will explore these possibilities under more realistic conditions in a flight simulator.

Learning Objectives:

1. The participant will be able to describe hypothesized causal mechanisms that may contribute to the Black Hole Illusion.

[338] MODALITY DIFFERENCES IN SPATIAL TARGET CUEING PERFORMANCE FOR PILOTS WITH NORMAL AND IMPAIRED HEARINGC. Brill¹, B. Lawson³ and A.H. Rupert²¹*Air Force Research Laboratory, Wright-Patterson AFB, OH;*²*U.S. Army Aeromedical Research Laboratory, Ft. Rucker, AL;*³*Naval Submarine Medical Laboratory, Groton, CT***(ORIGINAL RESEARCH)**

INTRODUCTION: Noise-induced hearing loss (NIHL) is a significant problem for military pilots. Long-term noise exposure degrades hearing, compromising performance. Moreover, mild to moderate NIHL can reduce a pilot's ability to effectively use emerging 3-dimensional audio displays. NIHL and noisy environments can impair spatial localization of targets via sound cues. As such, pilots with NIHL may benefit from use of alternative sensory modalities, such as touch (e.g., vibration). Our research evaluated the speed and accuracy with which normal and impaired hearing participants localized non-visual spatial cues. **METHODS:** A 2×3 mixed factorial design was used. Group (normal vs. impaired hearing) was a between-groups variable and modality (auditory, tactile, and audio + tactile) was a between groups variable. The sample included 10 normal

hearing and 17 hearing-impaired volunteers. Egocentric spatial cues (500 ms) were presented in 36 positions (5 times each, random order) across 3 levels of elevation (low, level, high) and 12 positions of azimuth (clock-face). A recording of operationally-relevant helicopter noise was presented continuously at 88 dB. Participants responded using a handheld, motion-tracked laser pointer. Accuracy and response time were recorded. **RESULTS:** Tactile and audiotactile cues yielded significantly better accuracy (by 37%) than 3-D audio alone, regardless of hearing ability ($p < .001$). Responses to audiotactile cues were significantly faster ($M = 1.5$ s) than for tactile or 3-D audio alone ($M = 1.7$ s), but only for participants with normal hearing ($p = .014$).

DISCUSSION: The results suggest tactile spatial cueing offers a viable alternative or supplement to 3-D audio, particularly in noisy environments. Although participants with normal hearing saw a modest increase in response time over those with NIHL, the most significant finding is that tactile cueing, as an alternative or as a supplement, yielded substantially better target localization performance over 3-D audio alone. These results are highly encouraging, as the effectiveness of 3-D audio cockpit displays slated for the cockpit may be improved through integration with redundant or complementary tactile displays. Further, our data suggest pilots with NIHL would reap nearly the same benefits as those with normal hearing. Lastly, the improved accuracy and reliability offered by the addition of vibration to 3-D audio displays may dramatically increase pilot trust in the system.

Learning Objectives:

1. Spatial cue localization accuracy can differ significantly based upon the sensory modality through which information is presented. In this case, a redundant tactile cue greatly improved performance over 3-D audio alone.

[339] SPATIAL DISORIENTATION: THE MAGNITUDE OF THE PROBLEMR.L. Newman² and A.H. Rupert¹¹*AHPD, USAARL, Pensacola, FL;* ²*Crew Systems, Seattle, WA***(ORIGINAL RESEARCH)**

INTRODUCTION: Spatial disorientation (SD) is thought by many to be a general aviation problem. This study examines transport airplane SD accidents and incidents as a subset of loss-of-control (LOC) accidents. There have been many published reports and papers examining LOC accidents -- Wilborn and Foster^[i], Newman^[ii], Belcastro *et al.*^[iii], and SAE-AIR-6237^[iv]. Each used the same approach for data collection, with slight variations in time frames and scope, although all had the emphasis on transport airplanes. **METHODS:** This study examines transport SD accidents and incidents as a subset of LOC accidents and incidents and uses the data from these references. Of the 454 LOC mishaps, 22 had SD as the primary cause and 53 listed SD as a contributing factor. Of these 53 mishaps, 43 were fatal accidents with 2046 fatalities. The pilots flying had a mean flying experience of 7516 hours total with 1546 in type. **RESULTS:** The distribution of mishaps by phase of flight showed that SD had proportionally more mishaps during climb, cruise, and go-around, than did LOC mishaps. A set of likely precursor sequences was identified: Loss of aircraft state awareness on go-around, Improper recovery techniques, and Pitot-static confusion. **DISCUSSION:** In order to reduce SD fatalities in transport aircraft future research efforts should focus on state-awareness during go around especially since there are now several technological solutions to resolve this issue including, Auto-GCAS (Auto- ground collision avoidance system) and integrated multisensory cueing to provide continuous orientation during periods of pilot distraction. **RESOURCES:** [i] J. E. Wilborn and J. V. Foster, *Defining Commercial Transport Loss-of-Control: A Quantitative Approach*, Presented at AIAA Atmospheric Flight Mechanics Conference, Providence, August 2004, AIAA-2004-4811. [ii] R. L. Newman, *Thirty Years of Airline Loss-of-Control Mishaps*, presented at the AIAA Modeling and Simulation Technologies Conference, Minneapolis, August 2012, AIAA 2012-4495. [iii] C. M. Belcastro, L. Groff, R. L. Newman J. V. Foster, D. A. Cryder, and D. H. Klyde, *Preliminary Analysis of Aircraft Loss of Control Accidents: Worst Case Precursor Combinations and Temporal Sequencing*, presented at AIAA Conference, Navigation, and Control Conference, National Harbor, Maryland, January 2014, AIAA 2014-0612. [iv] *Loss-of-Control Mishaps in Revenue Airline Service*, SAE Aerospace Information Report AIR-6237, July 2016.

Learning Objectives:

1. Understand that transport aircraft account for a significant percentage of spatial disorientation mishaps.

[340] DOES AMBIENT NOISE OR HYPOBARIC ATMOSPHERE IN A PASSENGER AIRCRAFT INFLUENCE OLFACTORY AND GUSTATORY FUNCTION?T. Rahne¹, R. Koepcke¹, H. Fischer² and M. Nehring³

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(ORIGINAL RESEARCH)

INTRODUCTION: Hypobaric atmosphere in a passenger cabin has been hypothesized as the main contributing factor for a decreased sense of flavor. In a flying aircraft cabin noise is present additionally to a reduced air pressure. The influence of the noise on flavor and odor in this special environment has not yet been investigated. The objective of the study was to determine for the first time the contributing effects of noise and hypobaric atmosphere to a decreased tasting or smelling. Multidimensional food perception is mainly based on gustatory and olfactory function. Recent research demonstrated that hypobaric pressure impaired subjects' gustatory function and background noise or distracting auditory stimulation impaired the olfactory function for numerous flavors. **METHODS:** Using a hypobaric chamber odor identification, discrimination, and thresholds as well as taste identification and threshold scores were measured in 16 healthy male volunteers under normal and hypobaric conditions (800mbar=6380 ft) using clinically proven tests. In both conditions, background noise was either cancelled out or replaced by white noise presentation (70 dB). White noise and altitude are comparable with conditions in passenger aircrafts. **RESULTS:** Olfactory sensitivity for n-butanol and gustatory sensitivity for 'salty' were impaired in a hypobaric atmosphere. White noise stimulation impaired the sensitivity for 'sour', but not for 'bitter', 'salty', and 'sweet' flavors. All odor test results were not influenced by the noise. **DISCUSSION:** We conclude that hypobaric or noisy environments in an aircraft could impair gustatory and olfactory sensitivity selectively for particular tastants and odorants.

Learning Objectives:

1. Noisy environments can influence odor and taste perception additionally to hypobaric pressure.

[341] AIRCRAFT EXCEEDANCES VARY ACCORDING TO TIME OF DAY AND WORKLOADL. Arsintescu², B.L. Matthews³, M.S. Feary¹, J.L. Nowinski¹, N.C. Oza¹ and E. Flynn-Evans¹

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(ORIGINAL RESEARCH)

INTRODUCTION: The Flight Operational Quality Assurance (FOQA) programs have been implemented in U.S. and Europe to identify anomalous flights based on data recorded on board an aircraft in an effort to improve flight safety. Numerous methods have been developed to support the analysis of FOQA data. However, it is unclear how FOQA data relates to the performance of the pilot. We sought to characterize the frequency and type of flight exceedances extracted from FOQA data during a controlled pilot schedule in order to determine whether patterns of exceedances related to human control of the aircraft would change according to scheduling factors. **METHODS:** Forty-four pilots (mean age 30.8 +/- 7.1 years) from a short-haul airline participated in the study. They flew a roster consisting of a cycle of five days of short duty hours (baseline) followed by four days off, five early duty followed by three days off, five mid-day time starts with many sectors followed by three days off and then five late duties with finishes that generally ended during the night followed by four days off. FOQA data was collected via onboard sensors from 2407 aircrafts (A319 and A320) and was evaluated

through exceedance detection. Exceedances were classified into three levels of severity (low, medium, high) based on predefined parameters.

RESULTS: Eighty-two percent of the flights had at least one exceedance. There were 2,944 exceedances among the flights we examined. The highest number of exceedances were of low severity (85%) followed by medium (12%) and high (3%). Low severity exceedances were higher during flights that started early relative to baseline ($p < .001$). Low severity exceedances were also higher during high workload shifts relative to baseline ($p < .01$). The most common exceedances appeared to be initiated by the pilot as opposed to other causes such as air traffic control requests or aircraft maintenance issues. The highest number of events ($n = 923$) was in the speed category. **DISCUSSION:** We found that more than half of the flights examined had at least one exceedance and speed was the most common category of exceedances related to the performance of the pilot. Additional analyses will be conducted to determine the relationship between pilot performance on standardized cognitive tests and aircraft events.

Learning Objectives:

1. The most common exceedances appeared to be initiated by the pilot as opposed to other causes such as air traffic control requests or aircraft maintenance issues.

[342] CHANGES IN CORRELATIONS OF ENERGY STATUS AMONG CEREBRAL REGIONS AFTER HIGH +GZ ACCELERATIONO. Tokumaru², M. Goto^{4,3}, S. Abe^{4,3}, M. Hiruma³, S. Maruyama¹, T. Kemuriyama⁶, K. Ogata⁵, T. Kitano⁵ and Y. Nishida³

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(ORIGINAL RESEARCH)

INTRODUCTION: Exposure to high +Gz-acceleration (HGA) induces decrease in cerebral blood flow (CBF) resulting in G-induced loss of consciousness (G-LOC). After HGA, the recovery of tissue partial pressure of oxygen (PO₂) delays that of blood flow for several minutes (Sugimoto et al., 2012). We examined the changes in high-energy phosphates in brain tissue exposed to ischemia-reperfusion (IR) injury by HGA.

METHODS: Fourteen C57BL/6NCRSlc mice were used for the experiment. An anesthetized mouse (urethane, i.p.) was placed in a prone position on the centrifuge for small animals (Tomy Seiko, Tokyo, Japan). +8 Gz acceleration was applied to the mouse for 30 s. The brain was *in-situ* frozen by the isopentane-propane freezing mixture (-193°C) at the following time points; before HGA (SHAM, $n = 4$), immediately after the cessation of HGA (IR-1, $n = 5$) and 5-10 min after the cessation of HGA (IR-2, $n = 5$). Coronal slices at the hippocampus level were made with a cryomicrotome and thaw-mounted on indium tin oxide-coated glass slide (Bruker Daltonics). Imaging mass spectrometry was conducted by a matrix-assisted laser desorption ionization time-of-flight mass spectrometer (MALDI TOF/MS) in the negative ionization mode with 9-aminoacridine as the matrix (AXIMA, Shimadzu, Kyoto, Japan). The energy status was evaluated as follows; energy charge (EC) = $([ATP] + 1/2[ADP])/([ATP] + [ADP] + [AMP])$. **RESULTS:** There was no difference in EC between the three groups. However, significant changes in correlations of EC among cerebral regions were observed. In SHAM, correlation coefficient (r) between cornu Ammonis (CA) 3 and dentate gyrus (DG) was 0.87 and those between others were < 0.5 . In IR-1, r between CA1 and cortex was -0.79. In IR-2, r between CA1 and DG, CA1 and cortex, and DG and cortex were -0.97 ($p < 0.05$), 0.85 and -0.73, respectively. Correlations between [ATP] and [ADP] were significant in the cortex and DG ($r = -0.84, -0.78$, respectively), although those in CA1 and CA3 were not ($r = -0.25, -0.10$, respectively). **DISCUSSION:** Rapid recovery of EC immediately after the cessation of HGA was indicated. However, changes in correlation among cerebral regions may imply possible functional alteration in energy status after the recovery of CBF and PO₂.

Learning Objectives:

1. To understand physiological response of energy metabolism in accelerational environment.

[343] AUTONOMIC NERVOUS SYSTEM ACTIVITY DURING SIMULATED FLIGHTE.K. Zawadzka Bartczak¹ and D.A. Bartczak²¹Internal Diseases, Military Institute of Aviation Medicine, Warsaw, Poland; ²Cardinal Stefan Wyszyński University, Warsaw, Poland*(ORIGINAL RESEARCH)*

INTRODUCTION: The effects of stress on human behavior and performance have been well recognized. The pilots are under high task demands also during real and simulated flight. Thus, aircraft piloting requires a high level of the cognitive functioning associated with various stress factors. Such conditions affect activity of the autonomic nervous system (ANS). The purpose of the present study was to analyze the status of sympathovagal balance during simulated flight tasks. **METHODS:** 41 candidates to Polish Air Force Academy were performed simulated flight tasks (SFT) on Hyperion Simulator. The simulator was designed to simulate airplane flights in virtual scenery, in varied field conditions, at different times of the day, and with varying atmospheric conditions. The selection process of candidates for military pilots included a profiled flight reflecting the Bo 105 helicopter flight dynamics. The optical system of the simulator enables for demonstrating both oculomotor stimulus of any shapes and movement parameters, as well as piloting the airplane with the visualization of the flight parameters and external environment. All of them had ECG monitoring in order to evaluate heart rate (HR) and the autonomic activity with frequency domain analysis (heart rate variability - HRV). **RESULTS:** there were significant differences ($p < 0.05$) between resting HR and during SFT- 77.8 vs. 81.9. Furthermore, throughout SFT we noticed significant reduction of parasympathetic activity (high frequency component of HRV - HF) - 384.5 vs 493.0 and also sympathetic activity (low frequency component of HRV - LF) - 859.7 vs. 1713.8. Moreover, SFT did not affect the low frequency to high frequency ratio (LF/HF). **DISCUSSION:** Heart rate variability analysis, therefore, becomes an important tool that provides a window into the activity occurring between the heart and brain. An appropriate level of physiological variability in the regulatory systems reflects an organism's flexibility and ability to coherently adapt to stress and challenges. The autonomic nervous system strives to maintain the dynamic balance between parasympathetic and sympathetic activity for optimal performance of tasks involving cognitive and executive functions.

Learning Objectives:

1. The participant will be able to understand that encounter a new experience or challenge, there can be a mismatch between the input patterns of the new experience and the lack of a familiar reference.

[344] DECOMPRESSION SICKNESS AND ATMOSPHERIC CHANGES. IS THERE AN ASSOCIATION?R.D. Garzon-Ayala, M.A. Corzo Zamora and S.L. Jaimes Gomez
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INTRODUCTION: Decompression Sickness (DCS) is a condition associated to exposure to reduced pressure environments such as experienced in a hypobaric chamber. In 2014, during hypoxia training in the hypobaric chamber at the Aerospace Medical Center (CEMAE) of the Colombian Air Force, only located at 2600 meters over sea level at Bogotá, the highest incidence of DCS was reported (81%, 13 cases) among 16 cases of DCS reported between June of 2010 and December of 2015. The objective of this study was to determine if the high number of solar spots, the high atmospheric temperature registered on 2014, and their influence on temperature and relative humidity inside the hypobaric chamber could be associated with the high incidence of DCS reported at CEMA E.

METHODS: Temperature and relative humidity data for each date of DCS and non DCS events were obtained and analyzed. Weather data in Bogotá was also obtained for these dates. **RESULTS:** It was found that relative humidity was significant higher at 25000 ft and 1800 ft during the days when the DCS cases were reported (76.64 ± 6.28 vs. 71.33 ± 1.03 at 18000 ft and 68.07 ± 2.92 vs. 65.33 ± 1.63). A contrary pattern was found in the temperature values inside the chamber ($16.47^\circ\text{C} \pm 0.65$ vs. $17.33^\circ\text{C} \pm 0.5$ at 25000 ft and $18^\circ\text{C} \pm 1.32$ vs. $19^\circ\text{C} \pm 0$ at 18000 ft). **CONCLUSION:** Considering that in 2014 high temperatures on earth combined with a high

number of solar spots were reported, it was concluded that these events, associated to a high solar electromagnetic activity, could have influenced the nitrogen dynamics of some of the aircrew that were trained in the hypobaric chamber in 2014. Further multi-center research is needed to determine if other training centers experienced the same trend in 2014.

Learning Objectives:

1. Decompression sickness (DCS), is a complex disease resulting from changed barometric pressure, in this paper we review the predisposing causes of DCS and individual predisposing physiologic characteristics such as high atmospheric temperature.

[345] AIRCREW SELF-REPORT OF PHYSIOLOGICAL EPISODES: LESSONS LEARNED AND THE ROAD AHEAD

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(EDUCATION - PROCESS)

Over the past several years, there has been an exponential increase in the number of Physiological Episodes (PHYSEPs) reported during Naval F-18 and T-45 flights. In response, there has been an increase in the number of research efforts dedicated to PHYSEPs. These efforts focus on several facets of the problem including: Enhancing sensor technology for detection (Beer, Shender, Dart, & Evans, 2017; Shender, Litchfield, Hawks, Whitley, Hrebien, Tripp, & Beer, 2017; Rood, Siska, & Harms, 2017); Enhancing and understanding associated training (e.g., Anania, Atkinson, & Tindall, 2017; Cooper, Tindall, & Atkinson, 2017; Atkinson, Tindall, Reeh, Zbrank, Balasubramanian, McEttrick, Immecker, & Scheeler, 2017); Identifying symptom patterns or technologies to reduce specific event types (Morgan, Dart, & Chauvin, 2017; Burch, Golich, Mayes, Harding, & Decker, 2017); and Identify a root cause contamination (e.g., Brown & Braman, 2017; Gordge, 2017; MacIntire & Gordge, 2017). While there are many plausible factors under investigation, there is a growing belief that understanding the influence of human factors will be a major key to unlocking the mystery behind this issue. Aircrew self-reports are potentially one of the richest data sources currently available to understand the multi-faceted human factors contributing to this phenomenon. Degradation in performance and personal symptomology are the indications aircrews are trained to recognize to self-diagnose a physiological episode. Once reported, the affected aircrew provides detailed information regarding their experience pre-, during, and post-flight. In this way, the aircrew self-reports are the catalyst for identifying and classifying a physiological episode. While critical to understanding this issue, aircrew self-reports are not without notable issues. By offering an overview of their perspective and involvement in areas of hypoxia training, data analyses, data collection, and reporting, the panelist will address the challenges involved with collecting, analyzing, and drawing conclusions based on aircrew self-report. The panel will also discuss initiatives and multi-disciplinary efforts to improve fleet self-report data through training and process improvements, to validate the use of self-report data to determine physiological episode severity, and to enhance the standardization of the reporting and data collection process.

Learning Objectives:

1. Understand the challenges and on-going efforts associated with Physiological Episode training and research.

[346] THE EFFECTS OF HYPOXIA AND FATIGUE ON OPERATOR PERFORMANCEC.B. Levin^{1,2}, K. McEwen^{1,2}, G.J. Roush^{1,2}, N. Beasley^{1,2},M.B. VerStraten^{1,2}, L. Drummond^{1,2}, A. Biggs² and M. Funke²¹Henry M. Jackson Foundation for the Advancement of Military Medicine, Dayton, OH; ²Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH*(EDUCATION - CASE STUDY HUMAN PERFORMANCE)*

INTRODUCTION: The onset of fatigue and its symptomology is considered a gradual process, whereas the effects of acute hypoxia are more rapid. Both insults are insidious in nature, however, as any deleterious effects are likely to manifest before any disruption in performance, which limits possible corrective actions. Fatigue and hypoxia have negative influences on similar psychophysiological indices (e.g., visual perception, sustained attention, and reaction time)

despite affecting different physiological mechanisms. These similar symptom profiles make the two sources difficult to dissociate when determining a casual factor for performance impairments. For that reason, it is likely that both fatigue and hypoxia have contributed to several in-flight incidents though reports attributed the incident to only one factor. Thus, it is necessary to examine the effects of each factor independently and to document their interaction. **METHODS:** Twelve participants completed the psychomotor vigilance task (PVT) while being subjected to a 20,000 ft. normobaric hypoxia exposure (9.6% oxygen; Condition A), 23 hours of sustained wakefulness (Condition B), and a combination of the two (Condition C). The PVT was administered during a baseline period at ground-level for 10 min at 0900, at 1600 during Condition A, and at 0500 during Conditions B and C. **RESULTS:** A repeated measures ANOVA revealed a significant main effect between reaction times recorded during baseline and all experimental time periods, and a significant difference between Conditions A and C when compared to Condition B. In addition, an increased number of lapses and slow responses (the slowest 10%) were found in all experimental conditions when compared to baseline. **DISCUSSION:** While all experimental treatments resulted in a significant decrement to PVT performance, the combination of hypoxia and fatigue did not differentially affect response times over that of hypoxia alone. Given this finding, one could assume that hypoxia is the primary cause of the deficit, and that negative performance effects caused by fatigue were negligible in this case. The fact that fatigue alone can elevate the number of lapses and slow responses to similar levels indexed in the other experimental conditions, however, is a statement to its potency in its ability to diminish performance.

Learning Objectives:

1. To understand and appreciate the impact of Hypoxia and Fatigue on operator performance.

[347] BIOENERGETICS AND MOLECULAR FINGERPRINTS OF HYPOXIA IN HUMAN PERIPHERAL BLOOD MONONUCLEAR CELLS

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(ORIGINAL RESEARCH)

Oxygen delivery to the human brain via the bloodstream is vital for cognitive functioning, making recognition of hypoxia critical to optimize pilot performance. There are no reliable, robust markers of hypoxia to provide rapid indications that in-flight emergencies are occurring and causing impaired cognitive function caused by hypoxia. Still-unexplained pilot performance deficits and incapacitation incidents prompted us to design a blood bioenergetics and a biomarker system that could identify whether a hypoxic exposure had occurred during flight. Circulating blood cells can act as predictive biomarkers of mitochondrial function under conditions of metabolic stress, and have been used to monitor various biological adverse effects. Blood was collected from human volunteers before and after exposure to hypoxia in a Reduced Oxygen Breathing Environment (ROBE), a 12x21 ft room capable of simulating altitudes from sea level up to 30,000 ft. Simulated flight profiles consisted of three stages in sequential order: sea level (21% O₂), exposure: altitude (18-25K ft equivalent air mixture for 5-20 min) or placebo (sea level, 21% O₂), and recovery (100% O₂). First, a bioenergetics assessment method using human blood was utilized to give oxidative phosphorylation and glycolytic profiles of peripheral blood mononuclear cells (PBMCs) pre- and post-exposure to hypoxia condition. PBMCs from hypoxic subjects clearly demonstrated decreased mitochondrial function, as evident by low ATP-linked respiration, low reserve capacity, increased proton leak, and high non-mitochondrial respiration. Hypoxic subjects also appear to require higher levels of ATP. Second, proteins and metabolites were isolated from blood for quantitative proteomics and metabolomics. Extracted blood samples were separated and analyzed by liquid chromatography coupled to a QExactive mass spectrometer. Proteomics and metabolomics identified functional pathway families

of novel prognostic markers of hypoxia in PBMCs associated with cellular maintenance/energy metabolism, axon guidance, gene expression, signal transduction, protein folding, adhesion, synaptic transmission, and cell growth. Identifying bioenergetic fingerprints and characteristic cellular pathways of hypoxia could facilitate its earliest detection and aid in determining whether cognitive functioning during flight was impaired due to hypoxia. The ability to detect whether hypoxia likely occurs aids in determining future mitigation strategies.

Learning Objectives:

1. Identify bioenergetic fingerprints and characteristic cellular pathways of hypoxia.

[348] OCCUPATIONAL RISK ASSESSMENT FOR AIRCREW IN FIXED-WING TRANSPORT AIRCRAFTS

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(ORIGINAL RESEARCH)

INTRODUCTION: Long-term exposure to high levels of noise presents potential health risks. Exposure to Volatile Organic Compounds (VOC) is also known to have many health effects. Most researches for occupational risks assessment to aircrew were conducted in airliners. We examined exposures to noise and VOC in military fixed wing transport platforms in the Israeli Air Force. **METHODS:** In this descriptive observational study, measurements were performed in seven types of aircrafts, constituting the fixed-wing transport platforms used by the Israeli Air Force: Beech Super King Air 200 (two configurations – Kukia and Tzufit), Beech A36 Bonanza, Boeing 707, C-130 Hercules, Gulfstream V, and C-130J Super Hercules. In Beech Super King Air 200 and Beech A36 Bonanza the cockpit is not separated from the airplane's body. In these aircrafts, the results measured near the pilots reflect the whole airplane. On the other aircrafts, measurements were held in the airplane's cockpit and body. Body measurements included three points: front, center and back, as well as the entrance to the cockpit in the C-130 and C-130J. The measurements were conducted using validated and calibrated equipment according to the standards required by NIOSH. **RESULTS:** All the measurements of VOC were found significantly lower than the occupational limit levels. Harmful noise levels were measured in the cockpit of Beech Super King Air 200 (Kukia configuration), Beech A36 Bonanza and the C130 Hercules (87.4 dB [A], 94 dB [A] and 88.6 dB [A] respectively) and in the body of Boeing 707, C-130 Hercules, Gulfstream V, and C-130J Super Hercules, especially noting 94.5 dB [A] in the center of the Gulfstream body. **DISCUSSION AND CONCLUSIONS:** No meaningful exposures to VOC are present in all fixed wing transport of the Israeli Air Force. Exceeding occupational noise exposure threshold limits noted in the measurements requires attention, especially for pregnant aircrew with regards to the health of the fetus which cannot be protected from exposure to noise.

Learning Objectives:

1. The participant will learn about noise exposure levels and volatile organic compounds levels in fixed-wing transport aircrafts in the cockpit and body of the airplane.

[349] PREVALENCE OF FATIGUE AND COUNTERMEASURE USE IN FEMALE U.S. ARMY ROTARY-WING PILOTS

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

(ORIGINAL RESEARCH)

INTRODUCTION: The current study examined the perceived prevalence of fatigue and the use of fatigue countermeasures in U.S. Army Aviators. Although previous research has indicated that the majority of Aviators identify fatigue as a significant concern, few studies have reported these findings in relation to the growing population of female aviators. Given that females report different

responses to stressors including fatigue in the civilian population, it is worth examining female perceptions separately from those of males. **METHODS:** This study employed a survey. Participants included (N = 185) U.S. Army Aviators who had performed flight duties within the past six months. The overall survey consisted of questions related to flight hours, fatigue, and nutrition, among other topics. For the purpose of this study, only questions related to fatigue were examined. The female subset (n = 8) makes up around 4% of the study's sample. The mean age of this subset is 26 years with mean flight experience of 206.09 hours (SD = 165.273). Despite being such a small sample, it is reflective of females in the overall Army Aviation population. **RESULTS:** Descriptive statistics were conducted. Pilots reported an average of 7 hours flown per week with flights lasting three hours on average. Respondents reported an average of approximately 8 hours of sleep per night. Respondents revealed that they felt they needed an average of 5.47 hours (SD = 1.445) of sleep a night to feel fully rested. When asked if fatigue was a widespread problem in Army aviation, 50% of respondents agreed. Further, 87.5% of respondents use coffee as a countermeasure to fatigue while 57.1% regularly use energy drinks. **DISCUSSION:** Self-reports of average sleep per night, number of hours required to feel fully rested, use of caffeine, and the perception that fatigue is a prevalent issue across the Army aviation community are moderately contradictory. Further research should be done with larger sample sizes of female aviators to understand these implications.

Learning Objectives:

1. Individuals will gain a better understanding of the stressors faced by U.S. Army aviators.
2. Individuals will gain an understanding of the perceived prevalence of fatigue among female U.S. Army aviators.
3. Individuals will gain an understanding of the use of countermeasures to fatigue among female U.S. Army aviators.

[350] FATIGUE AND ASSOCIATED FACTORS AMONG AIRLINE PILOTS

Y. Choi^{1,2}, H. Kim¹, Y. Yun¹ and Y. Kwon¹

¹Aeromedical Center, Korean Air, Seoul, Republic of Korea; ²Nursing, College of Medicine, Inha University, Incheon, Republic of Korea

(ORIGINAL RESEARCH)

INTRODUCTION: This study aimed to identify the prevalence and associated factors of fatigue in Korean commercial airline pilots. **METHODS:** This was a cross-sectional study in which Korean commercial airline pilots were requested to complete an on-line questionnaire collecting data on person, health, lifestyle and work, and psychological assessment scales for fatigue, sleep, QoL and job stress. The final 1029 samples, which finished the questionnaires completely, were analyzed. The association of the risk factors with fatigue was determined using logistic regression analysis. **RESULTS:** The prevalence of fatigue was 65% (FSS index ≥ 3), disturbed sleep 28% (PSQI ≥ 9), daytime sleepiness 17% (ESS ≥ 10), and sleep apnea (BQ ≥ 2) 11%. The fully adjusted logistic regression showed that quality of life (OR=0.15, 95%, CI 0.10-0.23), sleep quality (OR=1.44, 95%, CI 1.29-1.61), sleep time (OR=1.50, 95%, CI 1.19-1.89), daytime sleepiness (OR=1.20, 95%, CI 1.13-1.29), late start (OR=1.18, 95%, CI 1.01-1.39), high physical activity (OR=0.85, 95%, CI .75-.96) and job stress (OR=1.08, 95%, CI 1.04-1.13) were associated with higher fatigue. **DISCUSSION:** Lower quality of life, disturbed sleep, frequent daytime sleepiness, lack of sleep time, higher job stress, less physical activity and frequent late start were shown to be risk factors for fatigue in airline pilots. These findings should be taken into account in the development of sleep and fatigue countermeasures for airline pilots.

Learning Objectives:

1. Understand the prevalence and risk factors of fatigue in Korean commercial airline pilots.

[351] KC-135 AIRCREW HEAT STRESS AND HUMAN PERFORMANCE

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(ORIGINAL RESEARCH)

INTRODUCTION: The flight safety risk due to heat stress experienced by KC-135 aircrew stationed in warm climates is uncertain. **METHODS:** The Air Force Safety Automated System (AFSAS) was queried for KC-135 mishaps in which the nearest United States Air Force base was Al Udeid Air Base from January 2004 through May 2017. Also, an observational study was completed in spring 2017 to determine if KC-135 aircrew personnel are exposed to a level of heat stress known to cause performance degradation. For this study, the cabin heat index was captured by small sensors worn by six boom operators and eight pilots during operational missions. The performance failure thresholds were those established by Hancock and Vasmatzidis' meta-analysis of thermal stress and task performance. **RESULTS:** Near Al Udeid AB from January 2004 through May 2017, 720 KC-135 mishaps occurred. In the six cooler months, there were 322 (45%) mishaps and, in the six hotter months, there were 398 (55%) mishaps. Two heat stress mishaps caused mission failure. In 2005, a 23-year-old female boom operator vomited for 45 minutes due to heat stress after take-off in a KC-135 leading to mission cancellation. In 2015 a 26-year-old boom operator lost consciousness due to heat syncope in the cargo compartment briefly after take-off. The co-pilots finished the take-off duties then moved to the rear cargo area to assess and help the boom operator who had returned to consciousness. The crew dumped 53klbs of fuel and the mission was aborted. From April 20, 2017 through June 21, 2017 six boom operators and eight pilots wearing temperature sensors flew a total of 155 sorties from Al Udeid AB, Qatar. The mean preflight cabin heat index exceeded the threshold for vigilance and dual task performance (85°F) in 61.2% of the sorties. In 18.1%, 14.8%, and 11.6% of sorties, the threshold was exceeded for tracking performance (96°F), simple mental response (99.3°F), and physiologic function (102°F), respectively. **DISCUSSION:** During spring sorties in the Middle East, KC-135 aircrew are exposed to levels of heat stress associated with decreased cognitive and physiologic function. The degree of heat stress should be better quantified by collecting urine samples during flight to assess end organ damage. To mitigate this flight safety risk, effective air conditioning carts during pre-flight should be utilized, and the KC-135 should be retro-fitted with integrated air conditioning similar to that developed for commercial 707s.

Learning Objectives:

1. The participant will be able to understand that KC-135 aircrew deployed to the Middle East are frequently exposed to heat stress associated with cognitive dysfunction.

[352] VENTILATION DISTRIBUTION ASSESSED BY VC SBW WITH OR WITHOUT POSITIVE PRESSURE BREATHING AT +GZ AND PRESSURIZED ANTI-G SUIT

M. Gronkvist¹, P. Gustafsson² and O. Eiken¹

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(ORIGINAL RESEARCH)

INTRODUCTION: Inflation of an anti-G suit (AGS) has been shown to substantially reduce maximal breath size (vital capacity; VC) and impair ventilation distribution in the lungs, both in normal gravity and at increased headward acceleration (+Gz). The aim was to see if positive pressure breathing (PPB) can mitigate these untoward effects on lung function. **METHODS:** Ten healthy men performed single vital capacity breath washouts of 4% SF₆ at 1 G and +2Gz without AGS inflation and +2, +3, and +4Gz with AGS inflation to 15 kPa with or without 4 kPa PPB. The concentration-normalized SF₆ phase III slopes were used to assess overall ventilation inhomogeneity. **RESULTS:** As expected, +Gz and AGS pressurization reduced VC by 27% at 2 and 3G, and 30% at 4G, and impaired ventilation distribution by 17% at 2G, and 7% at 3 and 4G. PPB did not significantly reduce the VC decrease resulting from +Gz and inflation of the AGS but reduced ventilation distribution inhomogeneity by 15% and 17% (phase III slope) at 2 and 3G, respectively, but did not affect ventilation distribution at 4G. **CONCLUSIONS:** Positive pressure breathing improves overall gas distribution in the ventilated parts of the lungs during exposure to moderate +Gz loads and AGS pressurization, presumably by forcing open some of the partially or totally collapsed basilar lung regions.

Learning Objectives:

1. Lung function during +Gz with inflation of an anti-G suit and applying positive pressure in the airways.

[353] EVALUATION OF STRESS TO THE HYPOBARIC CHAMBER TRAINING IN THE TRAINING STAFFS

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(ORIGINAL RESEARCH)

INTRODUCTION: Staffs of the hypobaric chamber training expose to hypobaric hyperoxia during the training in hypobaric chamber, because they have to inhale 100 % oxygen in this period. They usually complain the fatigue after the training. Nevertheless, the effect of hypobaric hyperoxia on the body of staffs still has been unclear. The purpose of this study is to objectively evaluate the stress to the hypobaric chamber training. **METHODS:** Eight staffs of the Aeromedical Laboratory in JASDF (7 males and 1 female: average age 32.3 ± 12.0 years old) were enrolled. Blood samples were collected before and after the hypobaric chamber training (type II training, maximum altitude 36,000 feet) and also collected 1 h after inhalation of 100 % oxygen under normobaric condition (normobaric hyperoxia) respectively. The levels of plasma cortisol, d-reactive oxygen metabolites (dROMs), biological anti-oxidant potential (BAP), and antibacterial activity of neutrophils that is a novel stress index were measured. Subjective fatigue score was also estimated before and after the hypobaric chamber training and normobaric 100 % oxygen inhalation. **RESULTS:** The subjective fatigue score significantly increased after hypobaric chamber training, although it did not significantly changed after normobaric 100 % oxygen inhalation for 1 h. Notably, antibacterial activity of neutrophils drastically reduced after the hypobaric chamber training. In contrast, there were no significant differences in the plasma cortisol, dROMs or BAP levels between before and after hypobaric chamber training or normobaric 100 % oxygen inhalation. **DISCUSSION:** Hypobaric chamber training gained the subjective fatigue score after the training, although normobaric hyperoxia did not cause subjective fatigue. Interestingly, hypobaric chamber training decreased the antibacterial activity of neutrophils. The decrease in antibacterial activity of the neutrophils may indicate a certain stress caused by hypobaric chamber training. The antibacterial activity of neutrophils may be a more sensitive marker than the plasma cortisol. Neither normobaric hyperoxia nor hypobaric chamber training affected the conventional oxidative stress markers (dROMs and BAP). These results suggest that hypobaric hyperoxia and tasks of staffs under such conditions may cause a certain fatigue in the hypobaric chamber staffs.

Learning Objectives:

1. The effects of stress in training staffs during hypobaric chamber training are introduced.
2. The antibacterial activity of neutrophils as novel stress measurement device is introduced.

[354] THE EFFECTS OF REPEATED EXPOSURE TO MILD HYPOXIA ON PILOT PERFORMANCE IN SUBORBITAL SPACEFLIGHT

J. Thropp¹, J. Scallon² and P. Buzza²

¹Graduate Studies, Embry-Riddle Aeronautical University, Daytona Beach, FL; ²Southern AeroMedical Institute, Melbourne, FL

(ORIGINAL RESEARCH)

INTRODUCTION: A future suborbital spacecraft pilot may be exposed to an 8000-ft. cabin altitude in as many as four 30-min. flights per day. While previous research has generally addressed the effects of mild hypoxia on human performance, the aspect of repeated daily exposures to this altitude presents new considerations. The current study examined the effects of these repeated daily exposures to mild hypoxia upon early stages of the visual attention component of human information processing. **METHODS:** Twenty-four commercial pilots underwent four 30-min. sessions in a hypobaric chamber per day under two different simulated altitude conditions: sea level and 8000 ft. During each session, they completed two computer-based visual attention tasks that assessed the executive function, which is the stage of information processing that directs the allocation of mental resources. The anti-saccade task assesses ability to suppress automatic eye movements toward task-irrelevant stimuli in favor of directing visual attention toward task-relevant stimuli. The

attention network test assesses three types of attention: alerting (achieving and maintaining alertness), orienting (directing attention to task-appropriate aspects of the visual environment), and executive control (resolving conflict among multiple possible responses). **RESULTS:** Two-way within-subjects ANOVAs indicated that there were no significant interactions between altitude condition and flight number for either accuracy or reaction time. In the fourth flight of the day, reaction time on both tasks was shorter for the 8000-ft. condition compared to the sea-level condition. Also in the fourth flight of the day, orienting scores were higher for the 8000-ft. condition than the sea-level condition; this difference was not observed in the earlier three flights of the day. **DISCUSSION:** Performance on the visual attention tasks was not compromised at 8000 ft.; rather, several performance improvements were observed. It is possible that participants were cognizant of the effects of the mild hypoxia and fatigue, and consequently executed a compensatory strategy in which they exerted additional effort to supplement their performance. Generally, the results show that the 8000-ft. cabin altitude, coupled with a time-on-task component, did not significantly impair performance on tasks that assessed the early stages of visual information processing.

Learning Objectives:

1. Performance on tasks that assess early stages of visual information processing did not appear to be adversely impacted by repeated short daily exposures to a simulated 8000-ft. cabin altitude.

Wednesday, May 09

4:00 PM

Ballroom D

S-073: PANEL: ADVANCES IN AEROSPACE MEDICINE IN IBEROAMERICA

Sponsored by Iberoamerican Association of Aerospace Medicine (IAAM)

Chair: Eduard Ricaurte

Edmond, OK

Chair: Lina Sanchez

Bogota, Colombia

PANEL OVERVIEW: In 2018, the panel sponsored by the Iberoamerican Association of Aerospace Medicine (IAAM) celebrates its 21th year of sharing scientific advances in Iberoamerica. Conducted in the Spanish language, it will be chaired by the IAAM president, Dr. Lina Sanchez, of Colombia, and Chaired by Dr. Eduard Ricaurte, of Colombia, the panel will commence with a description of a hypobaric chamber study conducted by Dr. Marcos Moreno, of Argentina. Next, Dr. Rocío Garzón, of Colombia, will present Decompression sickness and atmospheric changes. Dr. Alexandra Mejía, of Colombia, will then discuss Determination of Heat Stress Factors in the Colombian Air Force K-Fir Pilots. The panel will continue with a presentation by Dr. Eliana Rincón, of Colombia, Frequency of Waivers in the Colombian Air Force Pilots. Dr. Diego García, of Colombia, will complement the session by discussing Reports of In-flight Incapacitation in Colombian Civilian Pilots.

[355] PULMONARY THROMBOEMBOLIC DISEASE IN CIVIL AVIATION

M.A. Moreno

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(ORIGINAL RESEARCH)

INTRODUCTION: deep venous thrombosis usually occurs in the lower limbs the displacement of thrombi to pulmonary vessels generates pulmonary thromboembolism, which may be experienced by humans while in an aircraft cabin at altitude. We evaluated these phenomena in the Hypobaric Chamber, reproducing the conditions of hypobaric hypoxia as experienced in an the aircraft cabin 7500 ft and studied the effects of such exposure by means of biological parameters, laboratory tests and Nuclear Medicine Imaging. **METHODS:** Eleven healthy male and female: volunteers participated in the study and were divided into two age groups: 20-40 years (seven) and 40-60 years (four). The subjects were evaluated consecutively, at sea level at altitude, in both rest and exercise conditions. The following

variables were measured: heart rate, blood pressure, oxygen saturation, trombina antitrombina, D-dimer, phlebogram radioisotopes of lower limbs, and pulmonary perfusion via SPECT gamma camera. Statistical analysis included probability of significance $p=0,05$ Student and Chi-square Tests. **RESULTS:** Oxygen saturation values at both stages showed significant differences in both groups ($p=0,001$), mainly when it was correlated to exercising (walking) at altitude. There was no difference in the evaluation of heart rate, blood pressure and D-dimer. Thrombin-antithrombin Time showed differences between the groups ($p=0,002$). The radionuclid phlebography of lower limbs and pulmonary V/Q gammagraphy, showed alterations at altitude (Hypobaric Chamber) in the venous system, in lower limbs and the lung fields, in accordance with the pulmonary thromboembolism images of two volunteers from the 40-60 age group. **CONCLUSION:** The presence of pulmonary thromboembolism in aeronautical activity is of high significance. Its physio pathogeny involves particular conditions of hypobaric hypoxia that enhance predisposing factors of the patient and crew member. Immobility, is an important factor in the increase in chronic venous pressure and a significant determining factor in triggering deep venous thrombosis and pulmonary thromboembolism. This warrants further investigation of the risk factors with updated means of diagnosis.

Learning Objectives:

1. To evaluate biological parameters in hypobaric chamber simulating cabin altitude, conditions of pulmonary thromboembolism.

[356] DECOMPRESSION SICKNESS AND ATMOSPHERIC CHANGES. IS THERE AN ASSOCIATION?

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

²Astronomy, Antonio Nariño University, Bogotá, Colombia

(ORIGINAL RESEARCH)

INTRODUCTION: Decompression Sickness (DCS) is a condition associated to exposure to reduced pressure environments such as experienced in a hypobaric chamber. In 2014, during hypoxia training in the hypobaric chamber at the Aerospace Medical Center (CEMAE) of the Colombian Air Force, only located at 2600 meters over sea level at Bogotá, the highest incidence of DCS was reported (81%, 13 cases) among 16 cases of DCS reported between June of 2010 and December of 2015. The objective of this study was to determine if the high number of solar spots, the high atmospheric temperature registered on 2014, and their influence on temperature and relative humidity inside the hypobaric chamber could be associated with the high incidence of DCS reported at CEMA E.

METHOD: Temperature and relative humidity data for each date of DCS and non DCS events were obtained and analyzed. Weather data in Bogotá was also obtained for these dates. **RESULTS:** It was found that relative humidity was significant higher at 25000 ft and 1800 ft during the days when the DCS cases were reported (76.64 ± 6.28 vs. 71.33 ± 1.03 at 18000 ft and 68.07 ± 2.92 vs. 65.33 ± 1.63). A contrary pattern was found in the temperature values inside the chamber (16.47°C ± 0.65 vs. 17.33°C ± 0.5 at 25000 ft and 18 °C ± 1.32 vs. 19°C ± 0 at 18000 ft). **CONCLUSION:** Considering that in 2014 high temperatures on earth combined with a high number of solar spots were reported, it was concluded that these events, associated to a high solar electromagnetic activity, could have influenced the nitrogen dynamics of some of the aircrew that were trained in the hypobaric chamber in 2014. Further multi-center research is needed to determine if other training centers experienced the same trend in 2014.

Learning Objectives:

1. Decompression sickness (DCS), is a complex disease resulting from changed barometric pressure, in this paper we review the predisposing causes of DCS and individual predisposing physiologic characteristics such as high atmospheric temperature.

[357] DETERMINATION OF HEAT STRESS FACTORS IN PILOTS OF THE K-FIR SQUADRON OF THE COLOMBIAN AIR FORCE

A. Mejia-Delgado

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(ORIGINAL RESEARCH)

INTRODUCTION: The high thermal conditions to which combat plane pilots are exposed may affect their performance and tolerance to gravita-

tional forces and therefore, may have negative effects on aviation safety. The objective of this descriptive study was to determine the environmental factors during flight, and their physiological effects in relation to heat stress in eleven pilots of the K-FIR squadron. **METHOD:** Relative temperature and humidity conditions inside the cockpits of KFIR planes were measured during 3 months, a total of eleven flights were analyzed. The Fighter Index of Thermal Stress (FITS) was calculated in healthy pilots with valid psychophysical aptitude tests. Post-flight urine density or specific gravity was measured. **RESULTS:** A significant occurrence of dehydration in pilots was found. The FITS demonstrated that the relative dew point temperature and dry bulb temperature conditions were in the caution zone for 10 of the 11 flights analyzed, and one of them was in the danger zone. The simultaneous recording of relative dew point temperature and relative humidity in the cockpits during flights showed an average maximum dry bulb Temperature of 39.0 °C and a maximum relative humidity of 74.2%, with a maximum dry bulb temperature of 46.6 °C in the cockpit. There was an average rise in temperature of 9.3 °C inside the cockpits compared to the environmental temperature readings. **CONCLUSION:** Environmental factors contributing to the development of hyperthermia and dehydration in KFIR squadron pilots were found. This situation may be considered as a physiological risk. Key words: dehydration, temperature, relative humidity, FITS, cockpit K-FIR is the aircraft's name

Learning Objectives:

1. Understand the body effects of cockpit high temperatures exposure.

[358] FREQUENCY OF WAIVERS IN COLOMBIAN AIR FORCE

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(ORIGINAL RESEARCH)

INTRODUCTION: Medical boards are the way to decide on medical fitness when a crewmember has an illness or disability. To return to flight activities, the granting or not a waiver is studied. A crewmember with waiver is subject to physical examinations and more frequent procedures and operating restrictions. **METHODS:** The purpose of this study was to identify the frequency of mental and physical fitness with waiver resulting from the medical boards performed in the Colombian Air Force Aerospace Medical Center from January 2004 to September 2016. The aircrew members were classified by the outcome of the decision of fitness, military rank and diagnostic medical specialties. **RESULTS:** The frequency of mental and physical fitness with waiver was 33% (n=159) from 481 medical boards performed in the 13 years period. The rank classification was: officers 56.7% (n= 273), non-commissioned officers (NCOs) 41.7% (n= 201) and ensign 1.4% (n=7); The classification for medical fitness was: apt 60.2% (n= 290), defer 9.9%(n= 48) and unfit 29.7% (n= 143). Diagnoses of waivers in terms of the medical specialties involved were: sport medicine n= 42, orthopedics n= 32, aerospace medicine n= 11, internal medicine n= 10 and otolaryngology n= 12. These 5 medical specialties contained 67.2% (n= 107) of the waivers granted to the crewmembers. The largest numbers of restrictions were granted in the last 4 years 66.6% (n= 106) as follows: 52 in 2016, 25 in 2014, 19 in 2013, and 10 in 2015. **CONCLUSION:** The regulations for the classification of medical fitness are updated periodically in accordance with changing qualifying conditions. This study supports the consideration of including new medical specialties which could increase different activities for monitoring and controlling medical certification waivers related to flight activities; following changes in the epidemiological profile.

Learning Objectives:

1. To evaluate the frequency of waivers in the aircrew members of Colombian Air Force.

[359] REPORTS OF IN-FLIGHT INCAPACITATION IN COLOMBIAN CIVIL PILOTS.

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²Grupo Factores Humanos, Educación y Certificación AeroméDica, UAEAC Aerocivil Colombia, Bogota, Colombia

(ORIGINAL RESEARCH)

INTRODUCTION: The primary purpose of aeromedical certification is to mitigate the risk of aircrew in-flight incapacitation. International Civil Aviation Organization (ICAO) and local civil aviation authorities go beyond

periodical aeromedical certification screening by requiring pilots to not exercise the privileges of their license if they are aware of any physical or mental condition that might reduce their readiness for flight duties. However, common and minor illness may escalate to flight safety threatening situations. Few studies have addressed this issue from a report-based perspective, thus making the prevalence of sudden in-flight incapacitation difficult to determine. Gastrointestinal symptoms are considered the main cause of diminished capacity while at the controls, followed by otalgia and faintness. The purpose of this study is to describe the frequency and characteristics of in-flight incapacitation in Colombia. **METHODS:** Mandatory reports of commercial operators were collected for 2015 and 2016. These reports were cross-referenced with monthly crew illness reports from operators to the Colombian Civil Aviation Authority. Also, information about departures and number of operations were analyzed. Variables included age, gender, role, aircraft, degree of incapacitation, diagnoses, and risk to flight safety. Descriptive statistical analysis was performed. **RESULTS:** During the two-year period a total of 23 reports were retrieved (13 for 2015 and 10 for 2016), involving: Captains (30%) and first officers (70%). Average age was 33 years (SD \pm 9.8). Airbus 320 and Jetstream 32 crewmembers were the most affected (39% and 30% respectively). Most of the occurrences (74%) were related to dysbarisms. The incapacitation rates were 1.4 per and 1.1 per 100,000 in 2015 and 2016 respectively. None of the reported events posed a hazard to flight safety. **DISCUSSION:** In-flight medical incapacitation are rare events. In this study, the most common condition was dysbarism, often associated with upper respiratory infection. Unlike previous reports, cardiovascular, mental health-related or gastrointestinal episodes were not prevalent. It is noteworthy that incapacitation was most common among first officers than in captains. Although underreporting might have played a role, these overall results show similar rates than previous studies.

Learning Objectives:

1. To acquire further knowledge about in-flight medical incapacitation rates and characteristics in Colombian Civil Pilots.

Wednesday, May 09
Wedgewood

4:00 PM

S-074: PANEL: PSYCHOLOGICAL COUNTERMEASURES FOR OPTIMUM HUMAN PERFORMANCE: TOWARDS TRANSLATION FROM NASA DATA AND ANALOG SPACE RESEARCH

Chair: Jane Klingenberger
Williamsburg, VA

Chair: Karen Ong
New York, NY

PANEL OVERVIEW: Optimizing human performance becomes increasingly more complex as long-duration space missions are considered and undertaken. Novel challenges/experiences/threats in space, as in high-consequence terrestrial environments, require an optimum level of heightened awareness, focus and psychological response. Yet, when does the ideal stress response transition from resiliency and adaptation to an actual decrement in performance? In aviation parlance, how do we maximize the psychological "positive lift over the negative drag" – our "L/D Max"? In this panel, we examine how the psychological countermeasures developed for space exploration can translate to terrestrial clinical settings, high-consequence special-duty operational missions, and commercial space travel. How are corollaries of expected stressors in space best derived, examined, and preemptively mitigated in terrestrial and commercial space settings? Moreover, what is the ideal balance of workload, physiologic, and psychological stress for space explorers - and how can that knowledge translate into other terrestrially-based clinical, commercial space, and operational settings? Spaceflight and space analog research provides critical knowledge that, when viewed through the NASA and National Center for Advancing Translational Science/National Institutes of Health (NCATS/NIH) Translational Science Models, can guide the translation of analog space countermeasures to performance, clinical response, and execution of individualized monitoring and countermeasures in terrestrial clinical settings, remote operational missions, and

commercial space travel. This educational panel -- through descriptions of stress and stressors, presentation of a review of NASA databases and literature, textbooks on space psychology, original analog space research and translational methods gleaned from the review and research -- proposes terrestrial and commercial space countermeasures to support optimum psychological health and performance in high consequence remotely executed operational missions and intensive clinical settings and commercial space tourism.

[360] BEHAVIORAL HEALTH IN SPACEFLIGHT: A REVIEW OF CHALLENGES AND COUNTERMEASURES

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(EDUCATION - PROCESS)

PROBLEM STATEMENT: Successful execution of manned, long-duration spaceflight missions requires identification, education, and management regarding behavioral health stressors and stresses associated with extended time in isolated and confined environments. **TOPIC:** The Bellagio II Summit reviewed existing literature and NASA databases regarding spaceflight behavioral health challenges and countermeasures for maturity and potential applications to analogous terrestrial populations. Psychological stressors, or external environmental factors, in manned space missions include isolated and confined environments, danger, monotony/workload, mission duration, crew personality/composition, and increased autonomy. Interpersonal stressors include group size/heterogeneity, limited social contact, language/cultural differences, and leadership/governance. Psychological stresses, or the individual response to stressors, relate to personality, habitability, family, and post-return readjustment. Psychiatric stresses include adjustment/somatoform disorders, anxiety and depression, possible psychotic reactions, suicidal/homicidal ideation/intent, and substance use. Interpersonal stresses include loss of cohesion, personality conflicts, withdrawal/territorial behavior, subgrouping/scapegoating, displacement, and leadership changes. **APPLICATIONS:** Psychiatric countermeasures include psychoactive medications, counseling/psychotherapy, crisis intervention, real-time monitoring, and crewmember training. Psychosocial countermeasures involve crewmember selection, pre-launch psychological training, in-flight monitoring/support, morale-boosting activities, and post-mission re-adaptation support. Monitoring tools include wrist actigraphy, voice stress analysis (investigational), on-board monitoring by trained crewmembers, and the use of formal self-monitoring tools. The psychological, psychiatric, and interpersonal stressors and stresses of spaceflight are moderately well-understood, but evidence for proposed countermeasures is generally limited. Mental health assessment tools can be used to measure cognitive performance, fatigue, and neuropsychological function but are limited in measuring personality changes, mood, or interpersonal relations. **RESOURCES:** 1. Kanas N. *Humans in Space: The Psychological Hurdles* (2015). 2. Kanas N. and Manzey D., *Space Psychology and Psychiatry* (2008).

Learning Objectives:

1. Develop an understanding of the known psychological/psychiatric challenges of spaceflight.
2. Discuss proposed countermeasures and the level of evidence for each.
3. Understand current research and need for future research in each area.

[361] BEHAVIORAL HEALTH RESEARCH IN ANALOG ENVIRONMENTS: OPPORTUNITIES AND CHALLENGES

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(EDUCATION - PROCESS)

PROBLEM STATEMENT: Analog environments provide the highest-fidelity opportunity to investigate behavioral health issues

relevant for long-duration spaceflight. Analog environments, though, present their own set of unique logistical challenges. Critical differences exist between the analog where research is conducted and the spaceflight where the countermeasure will be developed. **TOPIC:** This talk will review the challenges and potential benefits associated with working in analog environments to investigate, develop, and test behavioral health countermeasures. We will review these issues and will focus specifically on behavioral health research conducted with computer-based training and treatment in the HI-SEAS Mars Analog missions and at Canada Forces Station – Alert, a Canadian military base in the Arctic. Long-duration spaceflight analogs for investigating behavioral health issues may have any of the following elements: 1) isolation, 2) confinement, 3) high operational pressure, 4) long duration. In reality, each element falls on a spectrum, but all contribute to the prevalence of conflict, stress, and depression. For example, the degree of isolation is strongly dependent on crew size and access to communication to those off-site. Although some analogs, such as military submarines or polar research stations, include all of these elements, there are no Earth-based analogs where these elements exactly match long-duration spaceflight. Interpreting research results in the context of these differences is critical for developing behavioral health countermeasures without making them “analog specific”. Further, by the nature of working in these environments, additional logistical challenges are present that may make collecting high-quality research data challenging. **APPLICATIONS:** This talk will serve to convey lessons learned from our research projects and will facilitate a broader discussion among researchers in the field regarding their experiences. The intent is to provide those interested in doing behavioral health research in an analog a set of guidelines to ensure their investigation is well matched with the intended study environment.

Learning Objectives:

1. Understand how research in behavioral health issues is conducted in relevant analog environments.
2. Gain exposure to potential analog environments and become familiar with their advantages and disadvantages.
3. Understand and interpret the behavioral health research results from analog environments.

[362] SPACE COMPUTER-BASED/ONLINE AND VIRTUAL REALITY DEPRESSION COUNTERMEASURES: TOWARDS TERRESTRIAL CLINICAL TRANSLATION

A. Florom-Smith¹ and C.P. DiBiase²

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(EDUCATION - PROCESS)

PROBLEM STATEMENT: A serious risk of spaceflight is depression, and among astronauts, depression prevalence may be higher than reported. Computer-based/online and virtual reality (CB/O; VR) countermeasures designed for astronauts offer confidential, individually tailored support that can mitigate adverse behavioral and psychiatric event development during missions. As about 8% of the U.S. population has depression, but only 35% report seeing a therapist, countermeasures that are easily accessed and facilitate confidential use are promising targets for translation to terrestrial, individually tailored patient interventions. **TOPIC:** A literature review of the state of the science of CB/O and VR space countermeasures was conducted. Using NASA and National Center for Advancing Translational Science/National Institutes of Health (NCATS/NIH) Translational Science Models, CB/O and VR countermeasures were evaluated for potential translation to terrestrial depression interventions. Countermeasure status, analog implementation, and use with terrestrial samples, if available, were assessed. Countermeasure translational science phases were assigned, gaps in knowledge were assessed, and areas requiring future research to facilitate translation for terrestrial, individual patient use were identified. In general, CB/O and VR countermeasures were categorized as NCATS/NIH translational science stage III, Clinical Research. These countermeasures have been tested and found efficacious with high performing individuals and terrestrial subjects. Additional evidence of effectiveness with more diverse terrestrial patient populations, with unique characteristics and needs, would be useful for successful translation to clinical implementation (NCATS/NIH stage IV). **APPLICATIONS:** For terrestrial, individual depression intervention

translation, CB/O and VR countermeasures require future research with varied patient populations, including those with chronic comorbidities, and those accessing other interventions, such as different types of exercise and/or medication. Further, research on tailored content for diverse cultures and age groups, mobile application options, and a means for linking patients with live therapists is needed. **RESOURCES:** NASA and National Center for Advancing Translational Science/National Institutes of Health (NCATS/NIH) Translational Science Models; <https://humanresearchroadmap.nasa.gov>, NASA Evidence Reports, NASA Technical Reports Server, PubMed.

Learning Objectives:

1. Recognize aspects of space computer-based and virtual reality depression countermeasures that support for terrestrial clinical translation.
2. Apply NCATS/NIH translational science phases to space computer-based and virtual reality depression countermeasures.
3. Identify unique populations and technology research needed to facilitate computer-based and virtual reality depression countermeasure to intervention translation.

[363] PSYCHOLOGICAL COUNTERMEASURES FOR HIGH CONSEQUENCE MILITARY OPERATIONS TOWARDS TERRESTRIAL OPERATIONAL TRANSLATION

J.K. Klingenberger, S.R. Darnell, A.M. MacQuarrie, C.J. Howell and S.R. Francis

U.S. Air Force, Washington, DC

(EDUCATION - PROCESS)

PROBLEM STATEMENT: The Bellagio II Summit reviewed behavioral health practices in space flight to identify mature topics for terrestrial applications. Stress associated with isolation and aggressive workloads are challenges mitigated during space missions. Similar issues exist for specially selected military members, assigned to unfamiliar, austere or hostile locations. The missions special duty operators undertake, have similar elements of risk, high visibility and the continuum of unfavorable national security consequences if not precisely executed. A gap exists in available behavioral countermeasures utilized by NASA and interventions widely employed by special duty military operators. **TOPIC:** Spaceflight agencies have developed a prescriptive set of programs to help individuals adapt to the psychological rigors of space travel. Individualized countermeasures (crew selection, psychosocial education, periodic “bull sessions,” leisure time, window views of earth, contact with significant people, family support, and post-mission debriefings) have been implemented. Recommended interventions have included pre-travel counseling with a focus on a prescribed plan to ensure resiliency. Military members may benefit from a similar checklist of options for group dynamics training, communication with family members, remote reach back of psychological providers, taking personally important items and sleep management. Although behavioral health challenges of spaceflight are moderately well understood, the evidence for effectiveness of these countermeasures is in preliminary stages. **APPLICATIONS:** Mitigating psychological spaceflight challenges such as isolation and loss of autonomy have parallel applications within special duty military populations. Behavioral health countermeasures researched by spaceflight agencies are promising to improve performance in military members assigned to special operational missions; however the evidence for effectiveness is still preliminary. The synergy of investigating behavioral countermeasures in military populations, executing technically difficult operations in continually unique environments, have correlations that could, in turn benefit NASA. **RESOURCES:** 1. Kanas, Nick, and Nick Kanas, Humans in Space: The Psychological Hurdles (2015). 2. Kanas, Nick, and Dietrich Manzey, Space Psychology and Psychiatry (2008). ‘NASA Research Roadmap: Risk of Adverse Cognitive or Behavioral Conditions and Psychiatric Disorders, Human Research Roadmap, 2017.

Learning Objectives:

1. Understand what psychological countermeasures are easily translatable for a wide range of remote operational missions.
2. Consider what research opportunities within special duty units, are possible to validate the utilization of specific behavioral health countermeasures in long duration space exploration.
3. Learn about emerging technologies that can benefit the psychological resiliency of individuals conducting special duty military missions

[364] PSYCHOLOGICAL COUNTERMEASURES FOR SPACE TOURISM: TOWARDS COMMERCIAL SPACE TRAVEL TRANSLATION

C.P. DiBiase⁴, J.K. Klingenberger², A. Florom-Smith¹ and M. Sides³
¹Human Factors, Embry-Riddle Aeronautical University, Daytona Beach, FL; ²Flight Medicine, U.S. Air Force, Williamsburg, VA; ³USAF(Ret.), Grayslake, IL; ⁴Integrated Mission Support Services, LLC, Kennedy Space Center, FL

(EDUCATION - PROCESS)

PROBLEM STATEMENT: Commercial space flight is in the initial stages of development and marketing to the general public. Guidance and research on commercial space flight is evolving, but at present, the FAA requires that "An operator must inform each space flight participant in writing about the risk of the launch and reentry, including the safety record of the launch or reentry vehicle type" (FAA 14 CFR Part 460, Subpart B. § 460.45). From centrifuge research studies simulating spaceflight, "Space doctors are finding that the most significant barrier to flying ordinary people may not be their physical ailments but something that is much less understood: anxiety." This spaceflight-associated anxiety could be mitigated by mid-level providers trained in operational risks associated with commercial spaceflight. **TOPIC:** An appropriate expectation of space tourism will be risk assessment and individualized mitigation of anticipated psychological/physiological events during their space travel. A space travel case management team would be comprised of registered nurses, a mid-level medical provider (Advance Practice Nurse/Physician Assistant) knowledgeable in the traveler's medical/psychological condition. The scope of care: 1. Review medical records and perform initial assessments; 2. Coordinate evaluations; 3. Provide coaching for the evaluation experience (example: centrifuge) and flight experience; 4. Monitor for changes in medical/psychological status prior to flight; and 5. Follow up post-flight. Success of space tourism will depend on travelers' positive reports of the experience; the likelihood of a positive subjective experience can be improved with care from providers specially trained to coach spaceflight participants through the psychological challenges of spaceflight. Mid-level providers are ideal for this role because of their training's emphasis on interviewing, counseling, and education as well as facilitating the individual patient's experience. **APPLICATIONS:** Propose that a Commercial Space Travel Medical Certification be developed and offered at AsMA Annual Scientific Meeting to train registered nurses and mid-level providers to the appropriate level of operational knowledge based on the exposures and risks of commercial space operations and travel. **RESOURCE:** Literature review of NASA Data Base and Center of Excellence Commercial Space Travel (COE CST).

Learning Objectives:

1. Develop an understanding of current medical/psychological standards for CST.
2. Know what current psychological/physiological screening tools for CST are ready for translation from NASA and analog space research.
3. Understand the current research on CST for the general public.

Wednesday, May 09
Chantilly East

4:00 PM

S-075: PANEL: THE 10TH ANNUAL RAM BOWL

Sponsored by American Society of Aerospace Medicine Specialists

Chair: Rebecca Blue
 Fayetteville, NY

Chair: A. Parmet
 Kansas City, MO

Chair: Jan Stepanek
 Scottsdale, AZ

PANEL OVERVIEW: The 10th Annual RAM Bowl features residents and teams competing for the Louis H. Bauer Trophy.

[365] THE 10TH ANNUAL RAM BOWL

A.J. Parmet⁴, J. Stepanek³, R. Johnson², R.S. Blue⁵, G.K. Anderson⁸, W.S. Silberman¹, B. Pinkston⁶ and C. Lowry⁷

¹Aviation Certification Services, LL, Oklahoma City, OK; ²Medical Management, Humana Government Business, Boerne, TX; ³Mayo Clinic, Scottsdale, AZ; ⁴Aviation Safety and Security, University of Southern California, Kansas City, MO; ⁵Preventive Medicine and Community Health, UTMB, Galveston, TX; ⁶FAA, Oklahoma City, OK; ⁷U.S. Air Force, Hurlburt Field, FL; ⁸USAF(Ret.), South Park, CO

(EDUCATION - PROCESS)

The 10th Annual RAM Bowl features residents and teams competing for the Louis H. Bauer Trophy. International residents will be able to participate. Aerospace Medicine Residents are required to demonstrate multiple competencies to satisfy the requirements of ACGME and ABPM and serve as specialists in the field. Multiple tools are available for developing appropriate didactic knowledge in aerospace medicine, public health, epidemiology, biostatistics and health care management. Teams complete in a college bowl format that tests aerospace medicine competencies, recall speed, teamwork and individual knowledge. Topics include the specialty aerospace medicine competencies including the flight environment (atmosphere, radiation, vibration, acceleration, and microgravity), clinical aerospace medicine, aircraft and space vehicle systems/operations, accident investigation, historical events, aerospace physiology, human factors, ergonomics, medical standards, federal aviation regulations, passenger transport, restraint and escape, cockpit resource management and Aeromedical transportation. Questions are divided into toss-up questions and bonus questions. Multiple rounds of competition will lead to the selection of this year's victor and awarding of the Louis H. Bauer Trophy, sponsored by the American Society of Aerospace Medicine Specialists.

Learning Objectives:

1. Preparation of Residents in Aerospace Medicine for the American Board of Preventive Medicine examination.
2. Review of Aerospace Medicine for attendees seeking maintenance of certification by the American Board of Preventive Medicine.

THURSDAY, MAY 10, 2018

Thursday, May 10
Chantilly East

8:15 AM

53rd ANNUAL HARRY G. ARMSTRONG LECTURE

John Charles, Ph.D.

"From Here to Mares: How the Twins Study and the Year-Long ISS Mission Have Moved Us Closer to the Red Planet"

Thursday, May 10
Wedgewood

10:00 AM

S-076: SLIDE: LONG-DURATION SPACEFLIGHT COUNTERMEASURES AND REHABILITATION

Chair: Mark Campbell
 Paris, TX

Chair: Patrick McGinnis
 Friendswood, TX

10:00 AM**[366] BIOPHOTONICS AS COUNTERMEASURE - FROM PREVENTING ASTRONAUT HEALTH DETERIORATION TO RESOLVING TERRESTRIAL DISEASES**

P.A. Souvestre¹, D.L. Pederson³ and M. A. dos Santos²

¹NeuroKinetics Health Services, Inc., Vancouver, BC, Canada; ²Microgravity Centre, PUCRS, Porto Alegre, Brazil; ³Dragonfly MedTech, Vancouver, BC, Canada