application process, the various ABPM pathways for certification, and the expected role of program directors within the certification application process. In addition to answering questions on certification, ABPM directors would like to engender discussion and feedback about certification issues and seek input regarding future directions for ABPM to consider, particularly in regards to website communication with diplomates and MOC. **SIGNIFICANCE:** The ABPM Directors for Aerospace Medicine will present updates of interest to residency program directors/ faculty and answer questions regarding certification examination status as well as discuss maintenance of certification issues that affect program directors and specialists in Aerospace Medicine.

Learning Objectives:

1. Familiarity with the new on-line application system.
2. Understand the important role that Program Directors play in verifying eligibility for Board Certification.
3. Basic understanding of the issues with Maintenance of Certification.

[010] PROGRAM EVALUATION AND IMPROVEMENT INITIATIVES: EXAMPLES FROM THE U.S. ARMY AND U.S. NAVY AEROSPACE MEDICINE RESIDENCIES

J. Venezia[2], J.J. Pavelites[2] and N. Almond[1]
[1]Aerospace Medicine Residency, NAMI, Pensacola, FL; [2]Graduate Medical Education, School of Army Aviation Medicine, Fort Rucker, AL

(EDUCATION - PROCESS)

Alignment of key elements of Accreditation Council for Graduate Medical Education (ACGME) programmatic requirements such as milestones, competencies and Clinical Learning Environment Review (CLER) objectives are important for effective and efficient residency training. ACGME describes many tools that include resident forums, Program Evaluation Committees and Residency Advisory Committees—all designed to assist in the Program Evaluation and Improvement (PEI) process. The uniqueness of the military residency construct including organizational structure, lines of funding, and mission requirements provide challenges that may require innovative solutions to satisfy this alignment. This panel presents PEI examples from the U.S. Army and the U.S. Navy Aerospace Medicine (ASM) residencies. The goals of these initiatives are to implement integrated, continuous PEI in order to better facilitate, improve, or enhance the educational experience. The first three presentations are from the U.S. Army Aerospace Medicine Residency and begin with an overview of the ASM Program. The second presentation will address the implementation of a unique flight training program designed to address ACGME requirements while facilitating capstone flight periods that demonstrate conditions of aeromedical consequence for experiential learning. The third presentation will describe the Operational Aerospace Medicine (OAM) world-wide teleconference, a resident conceived and run forum for timely information dissemination regarding health policy, research, safety, and medical evacuation while simultaneously providing a "reach back" forum for problems encountered within the operational environment. The final presentation will highlight the U.S. Navy Aerospace Residency's engagement within the Global Public Health Navy enterprise. This program is aimed at resident attainment of the Navy's Global Health qualification designation and the degree in Global Public Health from the University of West Florida. Following these presentations, an open panel discussion will be facilitated to elaborate on the presented PEI projects while soliciting unique approaches and best-practices from the audience for consideration by GME faculty.

Learning Objectives:

1. Describe the ACGME tools to include resident meetings, Program Evaluation Committees and Residency Advisory Committees that are used to assist in the Program Evaluation and Improvement process for medical residencies.
2. Discuss the integrated/ continuous model of Program Evaluation and Improvement as applied to the U.S. Army Aerospace Medicine Residency.
3. Explain the role of the Navy's Global Health qualification designation and the University of West Florida's Masters of Global Public Health in the U.S. Navy Aerospace Medicine Residency's contribution to the U.S. Navy's Global Public Health Enterprise.

MONDAY, MAY 7, 2018

Monday, May 07 ***8:00 AM***
Chantilly East

64th ANNUAL LOUIS H. BAUER LECTURE

Morgan Sandercock
"High Altitude Physiology Without an Engine"

Monday, May 07 ***10:30 AM***
Ballroom D

S-004: PANEL: AIRCREW NECK PAIN PREVENTION AND MANAGEMENT - INSIGHTS FROM NATO HFM RTG-252 PART I: CLINICAL

Sponsored by Life Sciences and Biomedical Engineering Branch

Chair: Christopher Goff
Patuxent River, MD

Chair: Barry Shender
Patuxent River, MD

PANEL OVERVIEW: Several surveys published by North Atlantic Treaty Organization (NATO) and other national air forces have chronicled the prevalence of neck pain in pilots and aircrew of most aircraft types. The incidents are greatest in high performance jet aircraft and helicopter aircrews. This is often associated with equipment (e.g., head supported devices), non-ergonomic seating, long duration missions, and environmental stresses (e.g., G-loading). Pain can impact performance, reduce situational awareness, affect behavior (i.e., limit aggressive maneuvering), and has led to aircrew grounding. The NATO Human Factors and Medicine (HFM) Research Task Group (RTG) Panel 252 on Aircrew Neck Pain has a mandate to contextualize and understand aircrew neck pain, conduct the necessary research to evaluate a variety of mitigating solutions, and generate recommendations for reducing the risk of aircrew neck pain. Thus, the overall objective of this NATO RTG is to seek and ultimately recommend evidence-based administrative, procedural, ergonomic, engineering, preventative, and treatment solutions to aircrew neck pain. HFM RTG-252 has developed two panels to communicate its interim findings. Part I focuses on clinical issues. It opens with a summary from an extensive literature review on military relevant neck pain epidemiology. While surveys agree on the prevalence of the issue, the variability in survey design makes it impossible to collate results meaningfully. To address this, the second talk describes a series of core questions recommended for all future questionnaires. Next, we describe two comprehensive aircrew conditioning programs sanctioned by air force leadership and incorporated into aircrew daily workplace schedules. The fourth talk is focused on a core tenant in reducing neck pain risk - a comprehensive education program, based on best practices, that focuses on anatomy, physiology, behavior, and a healthy lifestyle. The session concludes with a discussion of acute and chronic treatment options.

[011] AIRCREW NECK PAIN PREVENTION AND MANAGEMENT – INSIGHTS FROM NATO HFM RTG-252 PART I: A REVIEW OF THE LITERATURE

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

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: Neck pain and injury have long been known as risks for pilots of high performance fixed-wing aircraft, but in the past 20 years, an increase in neck problems has been documented in helicopter crews as well. This increase is thought to be mainly due to the proliferation of head-mounted displays related to the tactical advantages of night flying in military helicopter aviation. To set the stage for the panel discussion of neck pain problems and solutions in aviation, this

presentation will review the epidemiology of neck pain from different perspectives—rotary-wing vs. fixed-wing, pilots vs. rear crew, acute vs. chronic, etc. **TOPIC:** Neck pain that occurs in the high +Gz environment tend to be more acute, and is frequently linked to a specific injurious event, while the typical helicopter pilot's neck pain is gradual in onset and chronic, more like a musculoskeletal overuse injury. These patterns have become less clear as fighter helmets have become more heavy and helicopters more agile. Despite concerns about study methods over the years, the link between fighter pilots' exposure to high levels of +Gz and neck pain appears strong, with prevalence rates ranging up to 85%. A particularly risky combination is unusual neck postures during unexpected +Gz exposure. A causal link with chronic neck pathology is harder to demonstrate due to confounding factors. Between 20% and 75% of helicopter crewmembers admit to flight-related neck pain—both in pilots and rear crew. Neck problems in rotary-wing crew are usually linked to weight added to the head/helmet complex. Important factors include the total head-supported weight as well as the CG offset, which generates torque (that may be reduced by the use of a counterweight). The operational reasons for aeromedical concern regarding neck pain are based on two main factors: inflight pain and reduced range-of-motion. The literature is replete with reports of aircrew performance degraded by neck pain symptoms and effects. When neck pathology leads to temporary or, worse, permanent grounding, in the interest of aviation safety, the effects on the aircrew and the organization can be profound. **CONCLUSION:** Neck pain is a frequent problem in aircrew – both fixed-wing and rotary-wing. While the mechanisms and risk factors may be unclear, the need for prevention and treatment strategies is certain. These topics will be discussed throughout this panel session.

Learning Objectives:

1. To understand the epidemiology of neck pain in fighter pilots and helicopter crews, to enable the development of targeted countermeasures and risk reduction measures.

[012] AIRCREW NECK PAIN PREVENTION AND MANAGEMENT – INSIGHTS FROM NATO HFM RTG-252 PART I: CORE SURVEY QUESTIONS

E. Smith[1], N. Duvigneaud[2], B.S. Shender[3], A. Smith[4] and M.H. van den Oord[5]

[1]Canadian Forces Environmental Medicine Establishment, Toronto, ON, Canada; [2]Center for Musculoskeletal Medicine & Rehabilitation, Military Hospital Queen Astrid, Belgian Defence, Neder-Over-Heembeek, Belgium; [3]Human Systems, NAVAIR, Patuxent River, MD; [4]RAAF Institute of Aviation Medicine, Edinburgh, Australia; [5]Royal Netherlands Air Force, Kampweg, Netherlands

(EDUCATION - PROCESS)

PROBLEM STATEMENT: Surveys are a valuable tool to evaluate neck pain in aircrew. However, there is considerable variability among surveys and little guidance available as to which survey questions yield useful data. One of the objectives of the NATO HFM RTG-252 Panel was to develop a set of 'core' survey questions which should be included in any survey evaluating neck pain in aircrew. **TOPIC:** The variability in aircrew neck pain prevalence rates in the literature (even amongst those flying the same platform) may be due to true differences in the populations surveyed, but may also be partially attributed to variability in the survey questions. Even minor wording changes can result in different responses and prevent direct comparisons between populations. Therefore, one of the objectives of this NATO Panel was to reach consensus on a definition of flight-related neck pain and to identify a set of core questions. This will enable direct comparison of future survey results and create the potential to merge data from multiple populations surveyed in order to generate higher powered and more meaningful statistical analyses. The NATO HFM RTG-252 Panel has summarized lessons learned from members who have conducted neck pain surveys in their respective populations and used this to develop a set of 'core' survey questions and best practice recommendations regarding how to administer a survey on aircrew neck pain in a given population. The questions are grouped according to: Demographic Information; Physical Activity; Flight-Related Neck Pain and the Impact on Safety; and Flight Experience. The intent is that the core questions will form the common base of more comprehensive surveys, specifically designed for each unique study. Optional questions are also included for those who wish to assess: Risk Factors; Functional and Operational Impact of Neck Pain; and, Pain Reduction and Prevention Strategies. **APPLICATION:** To accurately assess whether a specific intervention has significantly affected the prevalence and/or incidence of flight related neck pain, surveys should be completed at baseline and at regular intervals, using prospective studies whenever feasible. To minimize variability and maximize quality data capture, the NATO HFM RTG-252 Panel recommends that these core questions be incorporated into every survey evaluating neck pain in aircrew.

Learning Objectives:

1. Understand the advantages of standardized 'core' survey questions.

[013] AIRCREW NECK PAIN PREVENTION AND MANAGEMENT - INSIGHTS FROM NATO HFM RTG-252 PART I: CONDITIONING PROGRAMS

E. Slungaard[2], H. Fleischer[3] and N. Duvigneaud[1]

[1]Center for Musculoskeletal Medicine & Rehabilitation, Military Hospital Queen Astrid, Belgian Defence, Neder-Over-Heembeek, Belgium; [2]RAF Centre of Aviation Medicine, Royal Air Force, Henlow, United Kingdom; [3]Taktisches Luftwaffengeschwader 74, Neuburg/Donau, Germany

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: The objective of the RTG-252 is to identify mitigating solutions for aircrew neck pain. Conditioning programs have been implemented as a possible solution to prevent and reduce neck pain in aircrew, with a number of programs in existence. **TOPIC:** The Aircrew Conditioning Programme (ACP) and the Human Performance Enhancement Program (HPE) have been developed as practical means to enhance aircrew performance and reduce strain injuries to the neck. Designed as preventative strategies, they incorporate best practice from sports medicine, aeromedical and operational expertise and evidence, with measurable outcomes. The ACP is intended to be delivered to both qualified aircrew and all student aircrew within the flying training pipeline, regardless of phase of training or aircraft. It has been designed to become more role and platform specific as student aircrew progress through flying training, with minimum standards recommended for each stage. Aircrew receive a period of specialist supervised instruction in all the exercises, enabling them to continue their individualized conditioning program independently. The ACP is delivered by physical training instructors (PTI) and physiotherapists, during mandated periods in both ground school and flying phases of training. The ACP consists of four main components: i) whole body flexibility and mobility, ii) cardiovascular fitness, iii) stability and motor control of the neck, shoulder girdle and trunk, and iv) strengthening exercises of the neck, back, abdominal, and leg muscles. Each exercise consists of a combination of those components, with visual and verbal feedback provided by the PTI and physiotherapist. The HPE is a holistic approach that incorporates an ideal physical-psychological balance to enhance performance. Within HPE, aircrew have access to flight surgeons, exercise specialists, physical therapists, nutritional and psychological counselling. The HPE conditioning program is designed for individual aircrew that includes specialist assessment and exercises that follow a similar structure to the ACP with annual assessments. **APPLICATION:** A comprehensive, individualized, and supervised conditioning program for the whole body that is mandated and delivered during the working day is recommended by the RTG as a potential solution to reduce the multifaceted problem of aircrew neck pain.

Learning Objectives:

1. To present RTG 252 recommended conditioning programs to prevent and reduce aircrew neck pain.

[014] AIRCREW NECK PAIN PREVENTION AND MANAGEMENT - INSIGHTS FROM NATO HFM RTG-252 PART I: EDUCATION

N. Duvigneaud[1], E. Smith[2], S. Feberg[3] and M.H. van den Oord[4]

[1]Center for Musculoskeletal Medicine & Rehabilitation, Military Hospital Queen Astrid, Belgian Defence, Neder-Over-Heembeek, Belgium; [2]Head of Military Medicine & The School of Operational Medicine, Canadian Forces Environmental Medicine Establishment, Toronto, ON, Canada; [3]Utti Jaegare Regiment, Finnish Airforce, Utti, Finland; [4]Center for Man in Aviation, Royal Netherlands Air Force, Soesterberg, Netherlands

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: Although aircrew education has been recognized as an essential part of neck pain prevention, some differences have been observed among the RTG-252 participating countries. The panel has identified and summarized the nations' common and best education practices. Three types of education are considered: academics, physical education, and practical advice. **TOPIC:** The following academic subjects are recommended to be included in the syllabus. First, aircrew should be aware that they are at greater risk of spinal injuries because of the contributing factors related to flying. They should have some knowledge of the anatomy of the spine and neurology to understand which spine injuries could happen. Aircrew must be familiar with the appropriate behaviors to decrease the risk of injury due to the additional gravitational forces (Gs) generated while flying, poor cockpit ergonomics, and other contributing factors (posture, head movements, flight equipment, helmet fit, flight duration, whole body vibrations, unexpected movements, individual factors, etc.). Moreover, the importance of general physical training and neck-specific training should be emphasized. Individual or group training sessions should be provided during the aircrew's career. Besides academics about the importance of rest and recovery, information about adequate sports nutrition is also indicated. Finally, the key to success of this solution is that the education is put into practice. **APPLICATION:** Proper education will help aircrew acquire knowledge and skills to mitigate the risk of neck pain and to enhance a healthy lifestyle throughout their career. The overarching recommendation is that aircrew education focuses on a holistic total lifestyle approach. The aircrew education program should start as early as possible during the pilot training. Refresher training emphasizing beneficial habits should be organized at regular intervals. Aircrew education is cheap, relatively easy and quick to implement in comparison to most engineering solutions. There is general agreement in the RTG that putting into practice aircrew education is an essential preventative solution.

Learning Objectives:

1. Understand that aircrew education is an essential human factor preventative solution for neck pain.

[015] AIRCREW NECK PAIN PREVENTION AND MANAGEMENT - INSIGHTS FROM NATO HFM RTG-252 PART I: TREATMENT

W.B. Dodson[1] and H. Fleischer[2]
[1]Aeromedical Research, 711HPW/USAFSAM, WRIGHT-PATTERSON AFB, OH; [2]Flight Medicine, German Air Force, Neuburg/Donau, Germany

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: Occasional neck pain has been a complaint of aviators throughout the history of manned flight. Factors have included exposure to increased gravitational forces (G-loading) and exposure to vibration. With the fielding of helmet-mounted display systems, increased weight and a shift of center of gravity forward of neutral became two additional neck pain factors. Neck pain can result in both temporary and permanent grounding of an aviator; both affect daily national defense readiness and the latter requires the training of a new aviator at a cost of up to $2 million U.S. (as well as the potential long-term cost of medical care). Flying with neck pain can 1) distract an aviator from the mission at hand and 2) cause an aviator to avoid maximal G-force combat maneuvers, both affecting mission performance and mission outcome. **TOPIC:** Neck pain intervention and prevention strategies continue to evolve. The HFM RTG-252 has been meeting to determine some of the current best practices to prevent or mitigate neck pain in aviators. Knowledge of these current practices could benefit all medical personnel who care for aviators. An overall approach which is similar to the "Professional Athlete Model" is known as the Human Performance Enhancement Program - these models focus on prevention and immediate access to medical professionals if needed. Best practices for staff members include aerospace medicine orientation training, availability of an on-call staff member 24/7, assigning staff to individual flying squadrons, and sending a staff member on deployments with the flying unit. Intervention and prevention strategies include aircrew conditioning programs, portable traction, spinal manipulation (such as done by osteopaths and others), medications, acupuncture, and non-traditional medicine. Surgery such as discectomy and/or fusion has very limited acute indications and is not considered in chronic cases unless significant symptoms have persisted despite the implementation of other interventions. **APPLICATIONS**: Material presented will allow military and civilian medical personnel from all nations who care for aviators with neck pain to learn some current approaches in neck pain care and prevention. This knowledge may minimize the impact neck pain has upon aviator performance and upon the grounding of aviators.

Learning Objectives:

1. Describe how to choose the staff to see aviators who have had neck pain.
2. Describe approaches to ensuring timely care access for aviators who have had neck pain.
3. Describe some approaches to treating and advising aviators who have had neck pain.

Monday, May 07 ***10:30 AM***
Ballroom E

S-005: PANEL: AEROMEDICAL RISK ANALYSIS PRACTICE UPDATES – PART 1

Sponsored by The American Society of Aerospace Medicine Specialists

Chair: Richard Allnutt
Wright-Patterson AFB, OH

Chair: Dan Van Syoc
Springboro, OH

PANEL OVERVIEW: During this panel, aeromedical clinical experts and Aerospace Medicine residents will present risk analysis-based clinical updates on topics related to the assessment and treatment of aviators and special operational duty personnel suffering from specified medical conditions of aeromedical interest. Presentations will include recommendations for treatment and discussions of the aeromedical implications of the specified disease conditions.

[016] ASAMS AEROMEDICAL RISK ANALYSIS - RENAL STONES

C. Mathers
Clinical Preventive Medicine, UTMB Health, Galveston, TX

(EDUCATION - CASE STUDY CLINICAL)

INTRODUCTION: The purpose of this presentation is to provide the aerospace medicine physician an update on the aeromedical risks associated with renal stones and to review current practice guidelines for the management of renal stones. **METHODS:** An overview of renal stones including epidemiology, pathophysiology, diagnosis, treatment as well as the aeromedical concerns will be presented. The authors will identify new relevant information regarding the aeromedical disposition of civilian airmen with renal stones. **RESULTS:** Current guidelines such as the CACI process for retained kidney stones will be covered and new approaches to the aeromedical disposition of renal stones will be identified. **DISCUSSION:** With medical knowledge in constant change, performing aeromedical risk analysis is a fundamental process for maintaining the validity of current practice recommendations.

Learning Objectives:

1. The participant will learn about potential aeromedical implications of kidney stones.
2. The participant will be able to utilize the CACI process for airman with retained kidney stones.

[017] CLINICAL UPDATE: PANCREATITIS

R.A. Allnutt
Residency in Aerospace Medicine, USAFSAM, Wright-Patterson AFB, OH

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: Pancreatitis can be sudden in onset, overwhelming painful and pose an immediate danger to flight and mission completion. **TOPIC:** Pancreatitis is a clinical condition marked by digestive enzyme activity in the ducts of the pancreas instead of the

intestine. There are many causes of pancreatitis. These include trauma, metabolic causes, infectious agents, medications, heredity, and connective tissue disorders. However the most common causes (accounting for +90 percent of cases) are due to cholelithiasis 40%, heavy alcohol use 35%, and idiopathic presentation 15-20%. **APPLICATIONS:** Single episodes of pancreatitis are often waived for flight status, especially for trained aviators. Chronic or recurrent pancreatitis is not waiverable while the disease process is active. If any underlying disease causing pancreatitis is waiverable and the aviator has no sequalae (e.g., diabetes, chronic diarrhea, chronic pain) then a waiver may be considered. Aviators treated with surgery seldom receive a waiver.

Learning Objectives:

1. Understand the risk to aviation of acute pancreatitis.
2. Understand the risk of chronic pancreatitis.
3. Understand the risk of recurrent pancreatitis.

[018] SARCOIDOSIS: AN AEROMEDICAL UPDATE

D.D. Regn
Aeromedical Consultation Service, USAF, Wright-Patterson AFB, OH

(EDUCATION - CASE STUDY CLINICAL)

MOTIVATION: Sarcoidosis is a multisystem disorder with the precise etiology and true incidence unknown. Sarcoidosis can involve all organ systems, with the potential for pulmonary, cardiac and ophthalmologic complications of aeromedical importance. Therefore, the condition requires close multi-specialist clinical monitoring. **OVERVIEW:** Sarcoidosis is a multisystem disorder characterized by the presence of discrete, compact, noncaseating epithelioid granulomata. The disease most often arises in the third to fourth decades of life, and shows an increased predilection for those of African-American, Caribbean, Japanese, Scandinavian, and Irish descent. Most commonly, sarcoidosis presents in one of three ways: as an asymptomatic finding on CXR; with nonspecific constitutional symptoms; or with organ-specific complaints. Due to the variability of symptoms, delay in diagnosis is common. The onset of symptoms may be acute. Acute presentation is more common in Caucasians than in African-Americans or Japanese, and may present as Löfgren's syndrome with BHA, ankle arthritis, erythema nodosum (EN) or generalized constitutional symptoms. An acute presentation portends the best prognosis, often resulting in spontaneous remission within two years. Chronic sarcoidosis, common in African-Americans, often presents with pulmonary symptoms. Sarcoidosis can affect the pulmonary, cardiac, integumentary, ocular, neurologic, musculoskeletal, gastrointestinal and even psychiatric health of those affected. The management of sarcoidosis therefore requires close monitoring. **SIGNIFICANCE:** Sarcoidosis is an insidious disease that may affect any organ system, with the potential for a myriad of complications to include arrhythmias, shortness of breath, blurry vision and seizures putting aviators at increased risk. Appropriate recognition, diagnosis and monitoring for complications of sarcoidosis thereby improves aviation safety.

Learning Objectives:

1. Identify the aeromedical implications of sarcoidosis.
2. Summarize methods to clinically monitor the disease process and the aeromedical waiver requirements for sarcoidosis.

[019] THE ZEBRA OF BELL'S PALSY MEETS SARCOIDOSIS

G.T. Gizaw
Residency in Aerospace Medicine, Naval Aerospace Medical Institute, Pensacola, FL

(EDUCATION - CASE STUDY CLINICAL)

PROBLEM STATEMENT: Sarcoidosis is primarily a diagnosis of exclusion. The variable presentation and progressive nature of this disease often leads to a diagnostic delay by greater than six months (Judson, 2003). There is limited data on the prevalence among Hispanics and Latinos in the U.S. (Mañá J1, 1992). **BACKGROUND / LITERATURE REVIEW:** Sarcoidosis affects many young adults with incidence peaking between 20 – 40, commonly in the U.S. among African Americans, Northern European Descendants, Asian and Puerto Ricans (Society, 2013). Neurosarcoidosis as an initial presentation is relatively uncommon and occurs about 5% of the time (TM, 2003). Only 50% may present with neurologic symptoms when initially diagnosed (Mitchell, 1999): (Iwai, 1993) Cranial Neuropathies are the most common presentation types (Barney, 1985). **CASE DESCRIPTION**: A 39-year-old Hispanic male presented with a one day history of loss of taste sensation, and a right temporal headache that woke him up from sleep. He noticed an inability to close his right eye, difficulty chewing and drinking on the same side with slurring of speech. No previous illness, recent camping, HSV, or surgeries. The ROS and PE were negative except for chief complaint and blood pressure of 154/100. A diagnosis of Bell's palsy was made and placed on tapering dose of Prednisone. Three weeks later with improved facial weakness but a new onset chief complaint of dysphagia and dysphonia. A ROS and PE were normal except chief complaint. ENT finding with laryngoscopy confirmed vocal cord paralysis on right. CXR confirmed prominence of the hila. CT of the chest finding was symmetric hilar and mediastina adenopathy with associated upper lobe pleural parenchymal thickening which favored stage 2 sarcoidosis. While waiting for biopsy, he developed with contralateral Bell's palsy. Right hilar endobronchial U.S.-Guided fine needle Aspiration indicated non-caseating granulomas in a background of lymphoid tissue without malignant cells. **OPERATIONAL / CLINICAL RELEVANCE:** When patients develop other cranial neuropathies, the investigator needs to consider Zebra pathologies like Sarcoidosis. The treatment can musk the underlying pathology therefore follow-up after completion of therapy is essential. Consider sarcoidosis as your differential for bilateral Bell's palsy. This case represents Neurological involvement of the multiple peripheral nerves (Jain, 2006).

Learning Objectives:

1. Isolated unilateral facial weakness is often secondary to idiopathic and consistent with Bell's palsy. However when patients develop other cranial neuropathies, the investigator needs to look for secondary causes become imperative. Consider Zebra pathologies as differential like Sarcoidosis, since facial nerve palsy may be caused by several pathologies.
2. The treatment for Bell's palsy may musk the underlying pathology therefore follow up treatment after completion of prednisone therapy is essential to rule out extension of symptoms like dysphagia, dysphonia or other cranial nerve pathologies in our case report.
3. Bilateral facial palsy has been reported with Lyme disease but also one should consider the possibility of Sarcoidosis. This case represents Neurological involvement of the multiple peripheral nerves (Jain, V,2006).

[020] ASAMS AEROMEDICAL RISK ANAYSIS – TESTICULAR CANCER

C.T. Haas[2], M.S. Thompson[2] and C. Mathers[1]
[1]Clinical Preventive Medicine, UTMB Health, Galveston, TX; [2]Aerospace Medicine, University of Texas Medical Branch, Galveston, TX

(ORIGINAL RESEARCH)

INTRODUCTION: The purpose of this presentation is to provide the aerospace medicine physician with a review on the aeromedical guidelines related to testicular cancer and to review current practice guidelines for the management of testicular cancer. Testicular cancer is the most common tumor in young adult males. Testicular cancer cure rates are high, but it has been shown that survivors are at potential increased risk from post-treatment comorbidities over the long-term. **METHODS:** An overview of testicular cancer including epidemiology, diagnosis, treatment as well as the aeromedical considerations will be presented. The authors will identify new information regarding the aeromedical disposition of civilian airmen with testicular cancer and particular attention will be paid to post-treatment management including monitoring for post-treatment side effects. **RESULTS:** Current FAA guidelines for testicular cancer will be reviewed and management considerations will be discussed for airmen with current or prior testicular cancer. **DISCUSSION:** The authors plan to discuss the disposition of airmen with a history of testicular cancer. The attendees will learn about how to utilize the CACI process for airmen with this history.

Learning Objectives:

1. To provide the aerospace medicine physician with a review on the aeromedical guidelines related to testicular cancer and to provide updates on clinical practice guidelines for those with active and past disease.

Monday, May 07 ***10:30 AM***
Wedgewood

S-006: PANEL: SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME (SANS) - CLINICALLY RELEVANT FINDINGS WHICH INFORM POTENTIAL ETIOLOGIES

Chair: Tyson Brunstetter
League City, TX

Chair: William Tarver
Houston, TX

PANEL OVERVIEW: Spaceflight Associated Neuro-ocular Syndrome (SANS), formerly known as "VIIP", is a condition that is unique to those who have flown on long duration space missions. Idiopathic Intracranial Hypertension (IIH) has been the primary terrestrial clinical model which space medicine has been working from. Monitoring and treatment plans have, essentially, been developed based upon IIH. Yet, as more data has been accumulated from flown astronauts, the IIH model has not continued to hold up. Variations in details are becoming apparent and significantly elevated intracranial pressure does not appear to be the primary source of pathology.

[021] DEFINING SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME (SANS): WHICH IMAGING TECHNOLOGY IS OPTIMAL?

T. Brunstetter[2,4], M. Nelman-Gonzalez[3], S.J. Clemett[1], S. Mason[5], M. Van Baalen[4], C.F. Sams[4], C. Gibson[5,6] and W. Tarver[4]
[1]ERC Inc./ NASA JSC, Houston, TX; [2]U.S. Navy, Houston, TX; [3]Human Health and Performance, KBRwyle / NASA, Houston, TX; [4]Space Medicine, NASA JSC, Houston, TX; [5]Space Medicine, KBRwyle/NASA JSC, Houston, TX; [6]Coastal Eye Associates, Webster, TX

(ORIGINAL RESEARCH)

INTRODUCTION: Spaceflight Associated Neuro-ocular Syndrome (SANS) was first discovered over twelve years ago, and since then, NASA medical/ocular data collection has increased. The data to date indicate that SANS is associated with multiple signs (e.g., optic disc edema [ODE], globe flattening, choroidal folds, retinal nerve fiber layer thickening, etc.); however, by definition, a SANS diagnosis is dependent upon the presence of ODE as visualized by fundoscopy. While being the clinical standard for grading ODE, fundoscopy is subjective. Optical coherence tomography (OCT) technology offers a more objective assessment of the retina and optic nerve head. First deployed to the International Space Station in 2013, OCT technology is now receiving increased attention as crewmember datasets expand and reveal new details that may better define the pathophysiology of SANS. Is it a better method to diagnose SANS? **METHODS:** A retrospective analysis of NASA astronaut fundoscopic and OCT images was performed to determine the optimal imaging technology in documenting and diagnosing SANS. **RESULTS:** Fundoscopy data indicates that 10 long-duration astronauts (out of 64 assessed) developed grade 1 to 3 ODE, and are, therefore, diagnosed with SANS. Other SANS signs are also visible on fundoscopy, including choroidal/retinal folds, retinal hemorrhages, and cotton wool spots. OCT revealed some level of ODE in 14-of-14 crewmembers having pre-flight and on-orbit OCT data, and was found to be significantly better at detecting subtle ODE and choroidal/retinal folds than fundoscopy. OCT data also indicate that the optic nerve head typically expands both anteriorly and posteriorly in SANS, while also reducing the volume of the optic nerve cup. **DISCUSSION:** There is currently no established, standardized OCT protocol for grading ODE. So while OCT is superior to fundoscopy in detecting low-grade ODE, further development must occur before it could be considered as the primary method for diagnosing SANS. In addition, fundoscopy may be a better method in detecting some types of retinal pathology, so its usefulness remains. An optimal solution may be to incorporate both fundoscopy and OCT technology synergistically to diagnose SANS. Could OCT with MultiColor Imaging fill both of these roles?

Learning Objectives:
1. The audience will learn the pros and cons of utilizing fundoscopy and optical coherence tomography technology to document the intraocular signs of Spaceflight Associated Neuro-ocular Syndrome (SANS), including the grading of optic disc edema.

[022] OPTICAL COHERENCE TOMOGRAPHY ANGIOGRAPHY-DERIVED PERIPAPILLARY HYPERINTENSITY IN OPTIC DISC EDEMA

L. Pardon[1], H. Cheng[1], J. Mendoza[2], R. Tang[1,2], L.J. Frishman[1] and N. Patel[1]
[1]University of Houston, Houston, TX; [2]MS Eye CARE, Houston, TX

(ORIGINAL RESEARCH)

INTRODUCTION: One sign of spaceflight associated neuro-ocular syndrome (SANS) is optic disc edema (ODE). Although the pathophysiology of ODE in SANS is unknown, congestion of the venous system is thought to be a potential cause. Venous congestion is also thought to be a cause of terrestrial ODE due to elevated intracranial pressure (i.e., papilledema). Optical coherence tomography (OCT) angiography (OCTA) allows for objective assessment of vasculature and may be a valuable tool for detecting vascular changes in ODE. The goal of this study was to describe and quantify vascular changes in non-astronaut civilians with ODE using OCTA and to determine correlation of OCTA findings with structural OCT parameters of the optic nerve. **METHODS:** Radial OCT and volumetric OCTA scans were acquired from 14 terrestrial subjects with ODE (12 confirmed papilledema, 2 pending lumbar puncture; mild ODE in 13 subjects) and 22 control subjects; one eye was randomly selected for analysis. A custom program identified Bruch's membrane (BM) opening (BMO); BMO points were superimposed full-thickness OCTA images and fit with an ellipse. Three annular zones within concentric ellipses were analyzed for pixel intensity (0-255): 1) Within BMO, 2) BMO to 500 µm, and 3) 500 to 1000 µm. 150 µm superficial and deep retinal slabs, referenced to the ILM (ILM150) and BM (BM150), respectively, were created to determine the location of enhanced OCTA signal in ODE. OCT-derived minimum rim width (MRW) and standard retinal nerve fiber layer thickness (RNFLT) were analyzed for correlations with the area of enhanced OCTA signal in ODE. **RESULTS:** 11 ODE subjects (79%) exhibited peripapillary hyperintensity (PPHI) on full-thickness OCTA images. Average pixel intensities within BMO and from BMO to 500 µm were greater in the ODE group compared with controls ($p = 0.0025$ and 0.015, respectively). In all cases, PPHI was present in BM150 but not ILM150 images. PPHI area was strongly correlated with minimum rim width ($R^2 = 0.91$, $p < 0.0001$) and moderately correlated with RNFLT ($R^2 = 0.68$, $p < 0.0005$). **DISCUSSION:** While there can be significant variability in subjective evaluation of the optic nerve, OCT allows objective quantification of changes. OCTA in ODE demonstrates PPHI in deep retinal layers, which is related to the extent of rim tissue swelling. We hypothesize that OCTA, in addition to OCT morphological measures, may be a useful imaging modality for detecting subtle optic nerve changes in SANS.

Learning Objectives:
1. Understand the optical coherence tomography angiography changes that occur in terrestrial optic disc edema.

[023] RE-EVALUATION OF IIH AS THE IDEAL TERRESTRIAL ANALOG FOR SANS

S. Batliwala[1], T. Brunstetter[3], W. Tarver[2], S.J. Clemett[5], M. Nelman-Gonzalez[4], J. Wells[4], S. Mason[4] and C.F. Sams[2]
[1]Medicine, John Peter Smith Hospital, Fort Worth, TX; [2]Space Medicine, NASA JSC, Houston, TX; [3]U.S. Navy on detail, NASA JSC, Houston, TX; [4]KBRwyle, Houston, TX; [5]ERC/Jacobs (JETS), Houston, TX

(ORIGINAL RESEARCH)

INTRODUCTION: Idiopathic intracranial hypertension (IIH) has long been considered the chief terrestrial analogue to Spaceflight Associated Neuro-Ocular Syndrome (SANS), presumably due to the theory that intracranial pressure (ICP) is elevated in microgravity. However, several critical ocular signs of SANS do not complement any reported cases of IIH on Earth. These findings mandate a closer look at

the potential limitations of IIH as a terrestrial SANS analog. **METHODS:** A retrospective literature review was conducted to discover reported ocular IIH findings that bear resemblance to the unique findings observed in SANS cases. Data were analyzed to compare and contrast SANS and IIH cases, especially parameters such as globe flattening, choroidal and retinal folds, choroidal vascular engorgement, and disc edema. **RESULTS:** IIH cases typically demonstrate a focal area of posterior globe flattening, compared to a general flattening seen in SANS cases. Furthermore, choroidal folds are frequently seen after retinal folds have developed in IIH, compared to choroidal folds developing before retinal folds in SANS. SANS cases also have prominent choroid vascular engorgement, exhibit a right eye bias for ocular signs, and often demonstrate a posterior displacement of the Bruch's membrane (BM) angle at the optic nerve head. Such features are rare and paradoxical in terrestrial IIH cases. **DISCUSSION:** The different characteristic of globe flattening in SANS and IIH cases suggests that increased ICP may not play a substantial role in SANS as originally hypothesized. The difference in timing of the appearance of choroidal and retinal folds between IIH and SANS also suggests that the pathogenesis of optic disc edema in the two entities may be different. The unexpected and counterintuitive posterior displacement of the BM angle in SANS suggests that the etiology of optic disc edema may originate within the center of the optic nerve as it traverses the LC. This is the converse of what is seen in IIH. Key differences between SANS and IIH may allow scientists to gain insight into alterative theories that could be contributing to the ocular changes observed in microgravity.

Learning Objectives:

1. Understand the subtle differences between the clinical findings of Spaceflight Associated Neuro-ocular Syndrome and its current terrestrial analog, Idiopathic Intracranial Hypertension.

[024] IRONING OUT THE DETAILS: A COMPARISON OF PROTOCOLS AND METHODS IN THE ASSESSMENT OF GLOBE FLATTENING

J. Fleischer[1], H. Aintablian[4], T. Brunstetter[3] and W. Tarver[2]
[1]Geisel School of Medicine, Hanover, NH; [2]NASA-JSC, Houston, TX; [3]Space and Occupational Medicine, U.S. Navy / NASA Johnson Space Center, Houston, TX; [4]College of Medicine - Phoenix, University of Arizona , Phoenix, AZ

(ORIGINAL RESEARCH)

INTRODUCTION: Globe flattening is a well-documented phenomenon in Idiopathic Intracranial Hypertension (IIH). It has also been observed in a large percentage of astronauts returning from spaceflight with ophthalmic changes, including those diagnosed with Spaceflight Associated Neuro-ocular Syndrome (SANS). Whether vision changes in IIH and SANS share a similar etiology is strongly debated, and comparing a feature commonly found in both pathologies (e.g., globe flattening) can enable a better understanding of the mechanism behind these changes. This study aimed to compare protocols used to measure globe flattening in SANS and IIH, and to determine if this information is useful in contrasting globe flattening characteristics between the two conditions. **METHODS:** A literature search was conducted to evaluate studies reporting globe flattening in pathologies related to IIH and SANS. A total of 17 studies were reviewed, including 8 utilizing cohorts with documented IIH, and 4 with documented vision changes in the astronaut population. Imaging protocols, image readers, and methods used to determine degree of globe flattening and reported globe flattening results were assessed. **RESULTS:** Thirteen of 17 studies reviewed reported globe flattening as a dichotomous variable (present or absent), including 7 of 8 studies utilizing cohorts with documented IIH, and 3 of 4 studies in the astronaut population. One study proposed an automated quantitation of the posterior scleral flattening. Globe flattening was assessed by ultrasound, CT, and MRI in 2, 4, and 11 studies, respectively. **DISCUSSION:** Based on a lack of quantitative data and the variation in imaging modalities used in the protocols of published studies, it is not currently possible to determine whether SANS globe flattening is really different from IIH globe flattening. Further investigation is required to determine what range of parameters and imaging modalities are acceptable when comparing images to assess globe flattening. An appropriate comparison will also need to utilize a more detailed and quantitative approach than what is found in most literature. Integration with finite element modeling will allow for further exploration of the forces causing deformation in globe flattening.

Learning Objectives:

1. The participant will be able to describe different methodologies that have been used to assess globe flattening.

[025] SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME: A POTENTIAL MECHANISM EXPLAINING THE UNILATERAL TENDENCIES

H. Aintablian[4], J. Fleischer[1], T. Brunstetter[3] and W. Tarver[2]
[1]Geisel School of Medicine, Hanover, NH; [2]Space Medicine, NASA-JSC, Houston, TX; [3]Space and Occupational Medicine, U.S. Navy / NASA-JSC, Houston, TX; [4]College of Medicine - Phoenix, University of Arizona , Phoenix, AZ

(ORIGINAL RESEARCH)

INTRODUCTION: The propensity for SANS and its associated ocular changes to be right-side dominant is well documented. Prevailing theories for this asymmetry include: (1) unequal optic canal diameters and (2) uneven pressure changes within the perioptic subarachnoid space. We report an anatomical variation in the transverse dural sinus in the normal terrestrial population, which may be key in the onset of asymmetrical SANS. **METHODS:** PubMed was searched for sources of asymmetrical anatomical variances within the orbital venous drainage system using the terms: "dural venous sinus asymmetry," "venous cranial variance," and "orbital venous drainage." After preliminary findings, Google Scholar and PubMed were used to further search for transverse sinus (TS) asymmetry. **RESULTS:** Abundant literature exists indicating a large populational asymmetry in the human TS under terrestrial conditions. In one analysis (100 MRI cases), the TS was found to be right dominant in 59% of cases. In another study (105 subjects), 21 (20%) had aplasias of the left sinus, and 41 (39%) had hypoplasia of the left sinus. Overall, this shows a consistency where 59% of the population has a dominant right TS, similar to the percentage of right sided SANS cases. **DISCUSSION:** The TS is one of the pathways of venous drainage from the orbit. The cavernous sinus, the main tract for orbital venous outflow, drains partially into the superior petrosal sinuses, which combines with the TS to form the sigmoid sinus. An asymmetry in TS anatomy, that would be normally asymptomatic terrestrially, could result in minor unilateral increases in venous pressure under microgravity conditions. It is possible that with elevations in intravenous pressure (e.g., associated with cephalad fluid shifts), the increased venous capacity of the right TS begins to strain the outflow of the cavernous sinus due to increased venous pooling, decreased laminar flow, and increased venous pressure. Over time, these minor venous pressure increases could lead to worsening pathophysiological changes of the orbit, which correlates with the increasing unilateral severity of SANS over time.

Learning Objectives:

1. To understand anatomical variances in the dural sinus network and how they may contribute to the asymmetry in SANS.
2. To review asymmetry in reported cases of SANS.

Monday, May 07 ***10:30 AM***
Ballroom B

S-007: PANEL: A FIRST STEP ON THE PATH TO IMPROVED AEROSPACE MENTAL HEALTH

Sponsored by Aerospace Human Factors Association (AsHFA)

Chair: Ray King
Washington, DC

Chair: David Schroeder
Oklahoma City, OK

PANEL OVERVIEW: Five presentations examine the lifecycle of the personnel selection process, starting with select-in and moving on to, and emphasizing, select-out considerations. Effective personnel selection is the first step on the path to a healthy workforce. While psychological testing plays a significant role, other sources of information must be

considered to include: driving, school, previous employment, and military records; letters of recommendation; and standardized interviews; in addition to aptitude assessment. While it is important to assess candidates for psychiatric illness at the time of entry into training and/or employment, on-going assessment over the course of a career is also necessary and is a bigger challenge. Pilots are a high functioning group, even when impaired. Moreover, pilots are heavily invested in their careers and are have few or no incentives to reveal psychological difficulties, regardless of how transient their issues may be. A just culture, however, allows for disclosure and remediation. The panel will conclude with a guided discussion and integration, to include international perspectives and the initiation of a consideration of the role of peer support (to be continued by subsequent panels).

[026] A FIRST STEP ON THE PATH TO IMPROVED AEROSPACE MENTAL HEALTH (INTRODUCTION)

R. King
FAA, Washington, DC

(EDUCATION - TUTORIAL)

AsMA has been at the forefront in the increasing interest in aviator mental health due to the efforts of the Aerospace Mental Health Working Group. There are important roles to be played by aerospace medical personnel and peer support groups for incumbent personnel. This panel will examine the role of psychological/psychiatric screening at the commencement of an aviator's career. While aptitude testing has long been recognized as valuable, even critical, the assessment of mental health has not been as universally or enthusiastically accepted. The psychological profile of a successful aviator has been documented to be composed of low neuroticism, high extraversion (with more gregariousness than warmth), and high conscientiousness (although with a determined effort to appear easy going). Their psychiatric profile, however, is more nuanced with surprisingly high amounts of compulsive, narcissistic, and histrionic personality traits being modal and even ideal for optimal success in aviation. Of course aviators are also highly intelligent which is ensured by aptitude testing, but they do not necessarily value intellectual pursuits. These characteristics are important to bear in mind when performing screening of aviation personnel. Individuals who have dependent personalities or who cannot effectively compartmentalize their non-aviation concerns due to anxiety or depression or cognitive inefficiencies need to be identified early so that they can be selected out and possibly referred for treatment. While it is important to have well-defined medical standards in aviation, it is also important for individuals who have received treatment and consider waivers, termed "special issuances" by some aeromedical authorities. Such an approach will best avoid driving psychiatric information "underground" or discourage treatment. Screening personnel at the commencement of training and/or before issuance of medical certification will best ensure a successful outcome when an aviator faces the inevitable challenges of a career in aviation, and life in general.

Learning Objectives:

1. Participants will understand the difference between SELECT IN and SELECT OUT in personnel selection.
2. Participants will come to appreciate the unique personality structure of aviators.
3. Participants will understand that aviators face most of the same life stressors that confront the rest of the population.

[027] LOOKING AT THE WHOLE PERSON: THE HARMONY OF HIRING SAFE, PRODUCTIVE, AND WELL-ADJUSTED PILOTS

C. Hoffmann
Human Capital Management and Performance, Chapel Hill, NC

(EDUCATION - TUTORIAL)

Airlines want safe and highly competent pilots. Mental health assessment is an important part of that effort, but arguably more important are airmanship and job knowledge, problem solving, cognitive ability and dimensions of normal personality. More planes crash due to pilot error than psychopathology. Airlines also want to achieve other goals and hire pilots who are easy to train, productive, customer focused, work well in a highly regulated, closely monitored and tightly scheduled environment requiring teamwork. Unfortunately, we often focus on individual dimensions of the job. We use job analysis to break down discrete behaviors, link them to capabilities required: conscientiousness, emotional resilience, judgment and decision-making, leadership and teamwork, communication skills, intelligence and job knowledge, cognitive ability, lack of psychopathology, etc. We then seek out existing tests and methods of assessing whether pilots have those capabilities. We correlate each of those measures to observations about whether the pilot is achieving the desired goals. Our last tricky task is to find a rule that we can use to say that if the candidate has X amount, we trust they can achieve the specified goal. Unfortunately, we often lose sight of the whole person and find ourselves arguing for each individual measure. We don't take advantage of how each measure and stage of the selection process: application review, testing, interviews, assessments and mental health assessments supports each other. This whole person approach can be done both mathematically and through protocols performed by trained and competent professionals. We will describe the stages of selection: recruitment, application review, testing, assessment and interview and finally psychological screening. We will describe the measures associated with each stage and how they can be used to get a more complete picture of the applicant's ability to be safe and achieve all the goals of the job.

Learning Objectives:

1. Participants will appreciate that more planes crash due to pilot error than psychopathology.
2. Participants will learn that selection takes place in a multi-stage process.
3. Participants will understand the role of job task analysis.

[028] ASSESSING PSYCHOPATHOLOGY IN AIRLINE PILOT APPLICANTS

J. Butcher
University of Minnesota, Minneapolis, MN

(EDUCATION - TUTORIAL)

People who are employed in high-risk occupations, such as airline pilots, air traffic controllers or police officers, and who experience personality disorders or mental health problems can significantly impact public safety. It is important that personnel occupying these positions are well-adjusted and capable of dealing with the stressful circumstances that many in those face. Applicants for high-risk occupations require careful pre-employment assessment for past or potential psychological problems that might result in behavior that could cause harm to others. Pathological behavior can adversely impact the work environment in many ways such as disrupted work relationships, failures to integrate into the workforce, performance problems that negatively impact safety and inter-personal effectiveness, and more. The number of serious mental health problems that can occur among pilots and the potential risk of danger to the public make it important for airlines to conduct careful pre-employment screening of pilot applicants. Importance of assessing personality factors such as interpersonal-social skills, family maladjustment, anger control problems, substance abuse are some of the more frequent behavioral problems among pilots that could, leads to serious consequences. There are a number of important variables for understanding personality assessment approaches in high-risk occupations. The core principles and applications of assessment strategies will be provided and discussion of possible limiting factors in decision making noted. The need for public safety dictates that responsible government oversight agencies establish criteria and procedures for assuring that only professionally qualified people who are in good health, both physical and mental, are placed in jobs.

Learning Objectives:

1. Participants will understand that people who are employed in high-risk occupations, such as airline pilots, air traffic controllers or police officers, and who experience personality disorders or mental health problems can significantly impact public safety.
2. Participants will appreciate that pathological behavior can adversely impact the work environment in many ways such as disrupted work relationships, failures to integrate into the workforce, performance problems that negatively impact safety and inter-personal effectiveness, and more.

3. Participant will understand that the need for public safety dictates that responsible government oversight agencies establish criteria and procedures for assuring that only professionally qualified people who are in good health, both physical and mental, are placed in jobs.

[029] MENTAL HEALTH ASSESSMENT AND PILOT SELECTION: HIGHLIGHTING THE CORE ISSUES

R. Bor
Centre for Aviation Psychology, London, United Kingdom

(EDUCATION - TUTORIAL)

Effective pilot selection plays a fundamental part in the safety, efficiency, cost base and public image of airlines, and at the same time ensures that pilots are able to successfully transition through the challenges they face at different stages of their careers. AsMA has strongly supported a balanced, liberal and 'just' approach to pilot mental health, and psychological/psychiatric assessments are an increasingly important part of this. This presentation highlights the main differences between mental health assessments and mental health screening. When carried out to the highest standards of clinical skill and practice, adhering to professional ethical codes of conduct (e.g., American Psychological Association, British Psychological Society) and appropriate forms of assessment are conducted wherever possible using pilot norms, such assessments may play an increasingly useful role in both the initial selection of pilots as well as in their ongoing monitoring. The main challenges currently faced in pilot mental health assessments include: (a) relying too heavily on non-standardized and poorly validated online tests; (b) the absence of pilot norms for many psychometric tests; (c) sacrificing in-depth and 'quality' assessments for rapid screening tools; (d) omitting essential collateral information such as mental status and school and medical records from the assessment report; (e) under-trained and less experienced professionals conducting assessments; (f) focusing on pilot aptitude and passing this off as pilot mental health in clinical reports (g) the cost and value to airlines of rigorous assessments and (h) implementing clinical assessments in an occupational setting. There is now compelling need to improve standards and clinical expertise in pilot psychological/psychiatric assessments, whilst recognizing that access to such expertise may vary regionally and from country to country.

Learning Objectives:

1. Participants will appreciate that effective pilot selection plays a fundamental part in the safety, efficiency, cost base and public image of airlines, and at the same time ensures that pilots are able to successfully transition through the challenges they face at different stages of their careers.
2. Participants will learn that the main challenges currently faced in pilot mental health assessments include: (a) relying too heavily on non-standardized and poorly validated online tests; (b) the absence of pilot norms for many psychometric tests; (c) sacrificing in-depth and 'quality' assessments for rapid screening tools; (d) omitting essential collateral information such as mental status and school and medical records from the assessment report; (e) under-trained and less experienced professionals conducting assessments; (f) focusing on pilot aptitude and passing this off as pilot mental health in clinical reports (g) the cost and value to airlines of rigorous assessments and (h) implementing clinical assessments in an occupational setting.
3. Participants will recognize that there is now compelling need to improve standards and clinical expertise in pilot psychological/psychiatric assessments, whilst recognizing that access to such expertise may vary regionally and from country to country.

[030] THE FAA AVIATION RULEMAKING COMMITTEE ON PILOT FITNESS AND THE ASMA EXPERT WORKING GROUP ON PILOT MENTAL HEALTH

C.M. Front
Aerospace Medicine, FAA, Washington, DC

(EDUCATION - TUTORIAL)

The Malaysia flight 370 and Germanwings flight 9525 tragedies prompted the Federal Aviation Administration (FAA) to charter an Aviation Rulemaking Committee (ARC) on Pilot Fitness. The ARC was composed of FAA experts in aerospace medicine, psychiatry, clinical psychology, and flight standards, with representatives from U.S. aviation trade associations, pilot organizations, and international aviation industry associations. AsMA's Expert Working Group on Pilot Mental Health was already completing its recommendations when the ARC was convened. Several members of the ARC also served on the AsMA Working Group, and the ARC was aware of that group's recommendations. There was significant concordance in the findings of the two groups. There were also points of divergence. Areas of agreement included: (a) Recognizing that requiring psychiatric or psychological evaluation for every airman medical certificate is unnecessary; (b) Prompting the FAA to enhance the training provided to designated Aviation Medical Examiners (AMEs) in assessing mental health problems; (c) Acknowledging the value of airline peer support programs that identify and intervene with pilots experiencing emotional distress or maladaptive behavior and provide a "safe zone" for pilot self-referral; (d) Promoting the education of aviation stakeholders regarding pilot mental health issues to reduce stigma and promote referral for services; and (e) Recognizing the variability in laws governing the mandatory reporting of medical issues that affect public safety and calling for a coherent national policy to standardize reporting. The AsMA Working Group and the ARC differed in their assessments of the utility of psychological evaluation in selecting pilots for commercial operations. The ARC recommended no mandate of formal psychological testing during the pilot hiring process. In contrast, the AsMA Working Group noted that "an initial and appropriate psychological evaluation, established by subject matter experts…is recommended for pilots entering airline employment and recurrently for pilots with a history of mental illness." International perspectives will also be considered, to include the recommendations of the European Aviation Safety Agency (EASA).

Learning Objectives:

1. Participants will learn about the points of concordance and divergence between the Aviation Rulemaking Committee (ARC) and the AsMA Pilot Mental Health Working Group.
2. Participants will learn that the ARC recommended no mandate of formal psychological testing during the pilot hiring process.
3. Participants will learn that the AsMA Working Group noted that "an initial and appropriate psychological evaluation, established by subject matter experts…is recommended for pilots entering airline employment and recurrently for pilots with a history of mental illness."

Monday, May 07 ***10:30 AM***
Topaz

S-008: PANEL: UPDATE ON PILOT FATIGUE: ARE WE DOING ENOUGH?

Sponsored by AsMA Air Transport Medicine Committee

Chair: Ries Simons
Soesterberg, Netherlands

Chair: Quay Snyder
Centennial, CO

PANEL OVERVIEW: Due to economic pressures and strong competition of airlines, job stresses of pilots are increasing. More demanding rosters and heavier workloads may lead to an increase of fatigue problems. Fatigue is considered an important cause of impairment of pilot performance and a threat to flight safety. Fatigue manifests in the aviation context not only when pilots fall asleep in the cockpit, but perhaps more importantly, when their cognitive performance is impaired and they are insufficiently alert during take-off and landing. There is no simple formula for evaluating the contribution of aircrew fatigue to a safety event. Reported fatigue related events have included procedural errors, unstable approaches, lining up with the wrong runway, and landing without clearances. Pilot fatigue is a continuing and complex problem in commercial aviation. Regulatory agencies, pilot organizations, and aircraft operators are debating over pilot fatigue issues while trying to find solutions to mitigate the risks associated with fatigue. In order to update the aeromedical community's knowledge of pilot fatigue, this panel presents different aspects of the issue. Discussions will include the role of fatigue in accidents and incidents, the usefulness and feasibility of

routine collection of fatigue ratings, an airline's approach to cope with pilot fatigue, the scientific background of Fatigue Risk Management, and what pilots can do to cope with fatigue problems.

[031] ANATOMY OF A FATIGUE-RELATED ACCIDENT

J.C. Miller
Miller Ergonomics, Buffalo, WY

(EDUCATION - PROCESS)

How do you know whether human fatigue was a factor in causing an accident? It is relatively easy for fatigue experts to see fatigue-related factors in mishaps. However, most accident investigators do not have this insight. Nor do accident investigators have a tool for determining whether fatigue may have been a factor in a mishap. Several investigative methods used successfully for investigations of fatigue contributions to aviation and highway accidents are available. These include 72-hour and 2-week activity histories. Also, a public-domain fatigue scorecard is available for accident investigators. My experiences over the last four decades indicate that the methods and scorecard should be useful in the field in mishap investigations in commercial and non-commercial highway accidents; mishaps in commercial, general and military aviation; errors in aviation maintenance; mishaps in military and commercial maritime operations; accidents in rail operations; and errors committed in control rooms and command and control centers.

Learning Objectives:

1. Become aware of investigative methods for investigations of fatigue contributions to accidents.
2. Understand the significance and structures of 72-hour and 2-week activity histories.
3. Identify the factors used in a public-domain fatigue scorecard that is available to accident investigators.

[032] WHERE ARE WE, AND WHERE ARE WE GOING?

D.M. Powell[1,2]
[1]Virgin Australia, Auckland, New Zealand; [2]Anaesthesia, University of Auckland, Auckland, New Zealand

(EDUCATION - TUTORIAL)

In the last generation, since the first time fatigue was identified as a primary cause in commercial airliner accidents, managing pilot fatigue has become integrated into core airline business, and woven into airline safety management systems. Large amounts of data have been collected from airline crews and numerous studies published looking at fatigue in pilots and other aircrew. Many major aviation regulators have introduced guidance or requirements for fatigue risk management, and some have undertaken extensive review of flight and duty time limitations. Where have these developments and understandings led us? What do we now know, and what still don't we know? What areas of aviation still struggle with managing fatigue? What has worked and what hasn't worked? What has been the impact on safety? This presentation reviews the history of fatigue risk management and attempts to identify the priorities for future work.

Learning Objectives:

1. Identify research priorities for studying fatigue and its impact on commercial aviation.

[033] U.S. FLIGHTCREW FATIGUE MANAGEMENT

T.E. Nesthus
Human Factors Research Division, FAA Civil Aerospace Medical Institute, Oklahoma City, OK

(EDUCATION - TUTORIAL)

Fatigue can affect a pilot's ability to safely perform assigned flight deck duties and may, therefore, have serious implications for aviation safety. A regulation to address this concern was implemented in 2014 and published as Title 14 Code of Federal Regulations (CFR) part 117, Flightcrew Member Duty and Rest Requirements. Additionally, U.S. Congress enacted a statutory requirement for commercial airlines to develop, implement, and maintain a Fatigue Risk Management Plan (FRMP) that outlines company policies and procedures for mitigating pilot fatigue on a day-by-day basis within the applicable regulations. Principles of circadian rhythm, sleep, and fatigue science were integrated into the regulation to minimize the effects of multiple contributing factors found in flight operations. The rule limits flight duty periods and flight times based on time of day, whether pilots are acclimated to theaters of operation, and the likelihood of sleep disruption during normal operations. For specific flight operations that exceed limitations of the regulation, § 117.7 provides an optional Fatigue Risk Management System (FRMS) application and authorization process to safely manage pilot fatigue. FRMS flight operations require exemption and data collection procedures to demonstrate an equivalent level of safety compared to a safety standard operation conducted within the limitations of the rule. Provided the results are consistent and supportive of safe flight, an Operation Specification is authorized for continued flight with fewer data reporting requirements. It is through these regulated procedures for flight operations within and outside of the regulation's limitations, that fatigue risk is identified, managed, and minimized for U.S. flightcrew in the promotion of improved flight safety.

Learning Objectives:

1. Attendees will learn about flight crew fatigue management in the U.S. including 14 CFR Part 117 Flightcrew Member Duty and Rest Requirements; an optional provision of fatigue mitigation in § 117.7 Fatigue Risk Management System (FRMS) for operations exceeding table limits; and a statutory requirement for commercial airlines to develop, implement, and maintain a Fatigue Risk Management Plan (FRMP) that outlines company policies and procedures for mitigating pilot fatigue on a day-by-day basis within the applicable regulations.

[034] PAST PRESENT AND FUTURE OF A COMMERCIAL SHORT HAUL AIRLINE'S FATIGUE RISK MANAGEMENT SYSTEM

T. Stevenson[1,2]
[1]The Healthy Company.com, Shoreham by Sea , United Kingdom; [2]Health and Human Performance , easyJet airline company limited, Luton, United Kingdom

(EDUCATION - PROCESS)

The evolution and development of a fatigue risk management system in a short haul commercial airline setting is described, from its inception as a reaction to a perceived operational risk, through development of best practice roster building as a mitigation for fatigue. The various influences, shapers, and refinements on that will be discussed. For example: regulator led change, personal preference, employee relations, and commercial pressures. Challenges for the future will be discussed specifically moving forward from short term fatigue to considering long term health issues and possible influences on occupational longevity for pilots' careers.

Learning Objectives:

1. To give background to necessity for fatigue risk management systems within an airline's safety management system.
2. Describe an understand the influences that have molded the latest iterations of fatigue risk management systems.
3. Look at the challenges for the future and whether future studies on fatigue might help us understand what makes a pilot have a healthy, safe, enjoyable and sustained career.

[035] WHAT CAN PILOTS DO TO COPE WITH FATIGUE?

R. Simons
European Society of Aerospace Medicine, Soesterberg, Netherlands

(EDUCATION - TUTORIAL)

Causal factors of pilot fatigue are related to time on task, time awake, quality and length of pre-duty sleep, circadian phase, work load, environmental conditions, health, medication/ substance use, and psychological factors. In many cases a combination of these factors is involved. To mitigate fatigue problems, aviation authorities and operators should do everything possible to optimize flight and duty time requirements and working environment for their aircrew, while the pilots should take their responsibility to optimize personal factors such as life style, health, psychological factors, and sleep strategies/hygiene. This presentation will discuss individual fatigue risk factors and risk-reducing factors. Recommendations will be made about how pilots can best cope

with the stresses of their job and how they can optimize their sleep and alertness.

Learning Objectives:

1. Attendees will learn about the personal measures that pilots can take to cope with the stresses of their job and how they can optimize their sleep and alertness.

Monday, May 07 ***10:30 AM***
Sapphire

S-009: SLIDE: N2 BUBBLES: BIGGER IN TEXAS?

Chair: Desmond Connolly
Farnborough, Hampshire, United Kingdom

10:30 AM
[036] A SYSTEMATIC REVIEW AND META-ANALYSIS OF DECOMPRESSION SICKNESS IN ALTITUDE PHYSIOLOGICAL TRAINING
J. Conkin[1], R.W. Sanders[4], M.D. Koslovsky[1], M.L. Wear[2], A.G. Kozminski[5] and A.F. Abercromby[3]
[1]KBRwyle, Houston, TX; [2]Flight and Medical Operations, KBRwyle, Houston, TX; [3]NASA-JSC, Houston, TX; [4]Preventive Medicine & Community Health, University of Texas Medical Branch, Houston, TX; [5]Internal Medicine, University of Michigan, Ann Arbor, MI

(ORIGINAL RESEARCH)

INTRODUCTION: A review of decompression sickness (DCS) cases associated with the NASA Altitude Physiological Training (APT) program at the NASA Johnson Space Center (JSC) motivated us to place our findings into the larger context of DCS prevalence from other APT centers. **METHODS:** We conducted a systematic review of JSC records from 1999 to 2016 and 14 publications from 1968 to 2004 about DCS prevalence in other APT programs. We performed a meta-analysis of 15 APT profiles (488 cases / 385,116 exposures). We used a meta-regression model to evaluate the relation between estimated exposures and probability of DCS in a test group, accounting for the heterogeneity between studies. **RESULTS:** In-house review identified 1 neurological case classified as Type II DCS and 6 pain-only cases classified as Type I DCS (1 from a trainer). There were 6 cases in 9,560 student hypobaric exposures from 3 NASA training flights; a student pooled prevalence rate of 0.44 cases / 1,000 exposures compared to 1.44 cases / 1,000 exposures from 12 published APT profiles covering 36 years. The combined pooled DCS prevalence rate was 1.16 cases / 1,000 exposures. This estimate was associated with significant heterogeneity. The meta-regression model identified 3 explanatory variables associated with experiencing DCS. In summary, longer denitrogenation time, greater exposure pressure, and shorter exposure time were associated with a decrease in the risk of DCS. **DISCUSSION:** The low DCS rate from NASA APT profiles is similar to that reported by others over a variety of APT profiles. The low rate speaks to the wide variability in human response to short-duration but high DCS stress hypobaric exposures. While this study had limited access to strictly profile level factors from historical records, future investigations would benefit from studying individual and profile level factors due to the known heterogeneity in individuals' DCS responses to hypobaric exposures.

Learning Objectives:

1. To better understand the low risk of DCS associated with otherwise safe and effective APT programs.
2. To understand how disparate publications about APT programs from 1968 to 2004 were combined into a statistical analysis about the risk of DCS.

10:45 AM
[037] A RARE COMPLICATION OF HYPOBARIC HYPOXIA TRAINING
M.G. Koshy
BAE Systems, Dhahran, Saudi Arabia

(EDUCATION - CASE STUDY CLINICAL)

INTRODUCTION: We report two cases of CAGE in aircrew following hypobaric exposure during routine physiological training. **CASE REPORT 1:** This 25-yr-old AWACS airman was undergoing hypobaric hypoxia training. During rapid decompression to 25000 feet over 30 seconds, he collapsed and developed typical tonic clonic seizures followed by severe headache and loss of vision. A diagnosis of CAGE was made and he was treated with U.S. Navy Table 6A. Further investigation revealed that he had a cystic lesion in the apex of the lower lobe of the left lung. **CASE REPORT 2:** Shortly after rapid decompression to 25000 feet, a 32 yr-old airman became disorientated before commencing hypoxia training. The chamber was returned to ground level where his symptoms progressed to include right sided hemiparesis. CAGE was diagnosed and he was treated with U.S. Navy Table 6A and discharged the following day. His symptoms recurred after discharge and he required further treatment before achieving full recovery. **DISCUSSION:** CAGE is a rare but recognized complication of hypobaric exposure and in this environment is related to sudden expansion of trapped gas which then reaches the left side of the heart via the pulmonary venous system. The rapid onset of symptoms helps to distinguish this entity from evolved gas disease. As a result of these cases, hypobaric training was changed to lower rate of ascent and introduction of ROBD is being actively considered.

Learning Objectives:

1. Understand the importance of recognizing lung or heart lesions that pre-dispose to evolved gas disease under hypobaric conditions.
2. Central nervous symptoms that occur within a few minutes of exposure to hypobaric conditions should be treated as CAGE unless otherwise proven.
3. All cases of CAGE require hyperbaric oxygen therapy.

11:00 AM
[038] INCIDENCE OF DECOMPRESSION ILLNESS AND SUBJECTIVE EFFICACY OF HYPOXIA TRAINING WITH AND WITHOUT O2 PRE-BREATHING IN SINGAPORE
L. Cheok and C. Koh
Republic of Singapore Air Force, Singapore, Singapore

(ORIGINAL RESEARCH)

INTRODUCTION: Countries utilizing hypobaric chambers for hypoxia training often have oxygen pre-breathing prior to hypobaric exposure to reduce the rate of decompression illness. Currently, data available describing rates of decompression illness with and without oxygen pre-breathing are predominantly from studies in Western population. There has been no published study describing these rates in an Asian population. On top of providing such data, this study was carried out to survey if trainees subjectively felt that having 30 minutes of oxygen pre-breathing decreased the hypoxic experience felt during training. **METHODS:** The Republic of Singapore Air Force records for hypobaric chamber hypoxia training 3 years before pre-breathing oxygen was introduced and 3 years after were analyzed to compare the rates of decompression sickness. An additional survey which aimed to compare trainees' previous hypoxia training experience to the current protocol as well as collect data on the type and severity of hypoxic symptoms was also conducted after the introduction of pre-breathing. **RESULTS:** 2 cases of decompression sickness were recorded in 1530 hypobaric chamber exposures to 25000ft over 3 years before pre-breathing was introduced, giving an incidence rate of 0.13%. After pre breathing was introduced, there were 2 cases of decompression sickness recorded in 1729 hypobaric chamber exposures to 25000ft, giving an incidence rate of 0.11%. 21% of survey participants reported that less hypoxic symptoms were experienced after implementation of pre-breathing. 27% of participants felt that severity of symptoms was less after introduction of pre-breathing. **DISCUSSION:** At 25000ft, the incidence of decompression sickness in Singaporeans remained largely similar with and without 30-min O2 pre-breathing. All 4 cases presented with joint pains and were similar in severity. There were no respiratory, neurological or cardiac symptoms. While the sample size of our study is smaller than previous studies, our study had much closer denominator numbers between case and control group, limiting sampling bias. Limitations include difficulty in differentiating decompression sickness from other similar diagnoses. The presence of oxygen pre-breathing affected the subjective efficacy of hypoxia training, and may have

decreased the utility of hypoxia training in imparting trainees with knowledge of their hypoxic symptoms.

Learning Objectives:

1. To appreciate the rates of decompression illness with hypobaric chamber hypoxia training in Asians with and without 30-min O2 pre-breathing.
2. To appreciate the subjective findings of trainees on efficacy of hypobaric chamber hypoxia training with and without 30-min O2 pre-breathing.

11:15 AM
[039] USING THE SHUTTLE STAGED PREBREATHE ATMOSPHERE AND VARIABLE PRESSURE SPACESUITS FOR EXPLORATION EXTRAVEHICULAR ACTIVITY

A.F. Abercromby[2], J. Conkin[1], J.R. Norcross[1] and M.L. Gernhardt[2]
[1]KBRwyle, Houston, TX; [2]NASA-JSC, Houston, TX

(ORIGINAL RESEARCH)

INTRODUCTION: NASA is developing a variable pressure extravehicular activity (EVA) spacesuit that is expected to be capable of operating at a range of pressures between 56.5 kPa (8.2 psid) down to 29.6 kPa (4.3 psid) or lower, which may provide the possibility of reducing the oxygen (O_2) prebreathe times necessary to achieve acceptable decompression sickness (DCS) risk. Previous modeling work predicted 8.4% DCS risk for an EVA beginning with crew saturated at the "exploration atmosphere" of 56.5 kPa (8.2 psia), 34% O_2, followed by 15 minutes of in-suit O_2 prebreathe, and 6 hours of EVA at 29.6 kPa (4.3 psia), while the prebreathe benefits of variable pressure suits are limited if crewmembers are initially saturated at 101.3 kPa (14.7 psia), 21% O_2. In this study we modeled notional prebreathe protocols for a variable pressure suit beginning at 70.3 kPa (10.2 psia), 26.5% O_2, which was the "staged prebreathe protocol (SPP)" atmosphere used operationally for 153-person microgravity EVAs during the Shuttle program with no reported DCS symptoms. Ambulation-induced nucleation is expected to increase DCS risk during planetary EVAs. **METHODS:** A probabilistic model of DCS risk based on a biophysical model of decompression stress was used to evaluate planetary EVA scenarios, beginning from saturation at 70.3 kPa (10.2 psia), 26.5% O_2, followed by 95% O_2 breathing at suit pressures ranging from 56.5 to 29.6 kPa (8.2 to 4.3 psia) for up to 6 hours. Previous validation of the model was based on significant prediction ($P<0.0001$) and goodness-of-fit with 84 cases of DCS in 668-human altitude exposures including a variety of pressure profiles. **RESULTS:** The model-predicted DCS risk for the 40-minute SPP followed by 6 hours at 29.6 kPa (4.3 psi) was 19.8%. Predicted risk decreased to 11.7% for 2 hours at 41.4 kPa (6.0 psia) followed by 4 hours at 29.6 kPa (4.3 psi). Two intermittent recompressions (IR) to 56.5 kPa (8.2 psi) for a total of 45 minutes further reduced predicted risk to 6.7%. **DISCUSSION:** Variable pressure suits may offer meaningful prebreathe benefits when used from reduced pN_2 environments, both through gradated decreases in-suit pressure as well as through IR during EVA. The potential benefits suggested by models must be weighed against potential increased fatigue, injury risk, and gas phase nucleation associated with working in high pressure suits.

Learning Objectives:

1. Assess the potential for variable pressure spacesuits to provide flexibility in ensuring acceptable risk of decompression sickness during extravehicular activities.

11:30 AM
[040] HYPERBARIC MEDICINE 2018: CURRENT PRACTICES

C.B. Dodson
USAFSAM Research Dept., 711th Human Performance Wing, Wright-Patterson AFB, OH

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: Undersea hyperbaric medicine (UHM) is an American Board of Medical Specialties subspecialty that is supported by the American Board of Emergency Medicine and the American Board of Preventive Medicine. In the United States over the past 25 years, the number of hyperbaric chamber sites has expanded to over 1200, a growth rate during the time period of over 500%. In carefully selected patients with certain diagnoses, hyperbaric oxygen (HBO2) treatment has the ability to save life, limb, and eyesight. Unlike most other specialties, exposure to the basics of UHM is not offered at many medical schools nor in many residencies. The clinical practice of UHM continues to evolve, and knowledge of current practices would benefit all medical personnel, especially aerospace physiologists and flight surgeons. **TOPIC:** The Undersea and Hyperbaric Medical Society (UHMS), based in the United States, maintains a list of diagnoses, which has grown over the decades. To be placed on the list, data from research and experience are carefully assessed by panels of experts with expertise in multiple specialties, not just in UHM. Over the recent years, the list has grown; currently, the list comprises 14 diagnostic categories. Carefully selected patients with diagnoses on this list, who have failed to improve in a timely manner with other indicated interventions, may be considered for HBO2 treatment consultation (bearing in mind that not all patients referred for HBO2 consultation will be selected for HBO2 treatment). **APPLICATIONS:** Some of the current parameters used in the patient selection process will be described, providing physicians, nurses, and other medical professionals with the knowledge and awareness of HBO2 treatment to enable them to select patients who might benefit from an HBO2 consultation and, if appropriate, subsequent treatment.

Learning Objectives:

1. Know the current diagnoses that are indications in 2018 for hyperbaric medicine consultation in carefully selected patients.
2. Know where to find the current UHMS list of diagnoses for 2018 that are indications for consideration of obtaining a consultation.
3. Know what resources in 2018 are currently manned 24/7 for hyperbaric medicine guidance concerning both initial care and consultation.

11:45 AM
[041] VENOUS GAS EMBOLI AND NITROGEN WASHOUT DURING SIMULATED HIGH-ALTITUDE FLYING; EFFECTS OF INTERMITTENT ELEVATIONS OF THE CABIN

R.K. Ånell
Dept. of Environmental Physiology, Royal Institute of Technology and Swedish Aerospace Physiology Centre, Mantorp, Sweden

(ORIGINAL RESEARCH)

INTRODUCTION: For tactical reasons, and since modern military aircraft commonly possess in-air refueling capacity, demands for long-duration, high-altitude missions with fighter aircraft are increasing. Therefore, and because of the low cabin pressure in such aircraft, we anticipate increased incidence of decompression sickness (DCS) among fighter pilots. The aim was to compare decompression stress during simulated sustained high-altitude flying vs high-altitude flying interrupted by periods of moderate or marked cabin pressure increase. **METHODS:** The level of venous gas emboli (VGE) was assessed from cardiac ultrasound images, using a 5-graded scale (0-4). Nitrogen wash-out/uptake was measured continuously using a modified closed-circuit electronic re-breather. Eight men were investigated in three different conditions: A) One 80-min continuous exposure to a simulated cabin altitude of 24,000 ft. B) Four 20-min exposures to 24,000 ft interspersed by three 20 min intervals at 20,000 ft. C) Four 20-min exposures to 24,000 ft interspersed by three 20-min intervals at 900 ft. **RESULTS:** Both the A and B condition induced marked and persistent VGE, with no inter-condition difference in the peak bubble score (median (range), A: 2.1 (1-3); B: 2.8 (2-3)), whereas, the score was considerably less in the C condition (1.1 (1-2)). In the C but not the B condition, the intermittent periods of increased ambient pressure reduced VGE substantially. Condition A, exhibited an initial high and exponentially decaying rate of nitrogen wash-out at 24,000 ft. In condition C, the rate of nitrogen wash-out was high and similar in each period at 24,000 ft, whereas, there was a nitrogen uptake during each 900-ft exposure. Condition B, exhibited nitrogen wash-out during each period at 24000 ft as well as during the initial period at 20,000 ft, but no nitrogen washout or uptake during the last period at 20000 ft. **DISCUSSION:** Contrary to current recommendations, intermittent reductions of cabin altitude to 20000 ft does not alleviate the DCS risk

during high-altitude flying, presumably because the concomitant pressure increase is not sufficient to eliminate VGE. It appears that continuous measurement of nitrogen wash-out/uptake does not reflect DCS risk in the present high-altitude exposures.

Learning Objectives:

1. Understand the mechanisms underlying occurrence of Venous Gas Emboli (VGE) during long-duration vs repeated exposures to high altitude.
2. Understand why nitrogen wash-out rate may not always be a valid marker of DCS risk.
3. Understand why altitude decompression sickness could be a problem in modern military aircrafts.

Monday, May 07 ***10:30 AM***
Ballroom A

S-010: SLIDE: SENSORS & SYMPTOMS: RESEARCH IN PHYSIOLOGICAL EVENTS

Chair: Scott Shappell
Daytona Beach, FL

Chair: Ian Mollan
Carterton, Oxfordshire, United Kingdom

10:30 AM
[042] DRY EEG TECHNOLOGY AND POTENTIAL APPLICATIONS IN OPERATIONAL ENVIRONMENTS

D.H. Snider[1] and G. M. Rice[2,3]
[1]Computer Science, University of West Florida, Pensacola , FL; [2]Aviation Medicine , NAMI, Pensacola, FL; [3]Aviation Medicine, Naval Aviation Schools Command, Pensacola, FL

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: Wearable dry-electroencephalographs (dry-EEGs) afford the potential to analyze, in real time, the brain waves of aviators in extreme environments. Understanding the technology behind these sensors and the interpretation of their data in terms of overall cognitive workload is a novel concept for most aerospace medicine specialists and is this presentation's primary objective. **TOPIC:** Over the last decade, technology utilizing Dry-EEG sensors has matured to point to where data correlates highly with traditional 20/10 wet EEGs, which require conductive gels. This advancement affords scientist the ability to evaluate this technology in simulated operational environments. For this study we evaluated the dry-EEG (DSI-7, Wearable Sensing, LLC, San Diego CA), which monitors brainwaves through 7 channels that have retractable silver electrodes to make contact with the scalp. Data is transmitted via Bluetooth™ to a personal computer running Wearable Sensing's DSI-Streamer software, which allows for monitoring and saving each sensor's signal in real-time. To calibrate the system, a minimum of 1 minute EEG activity is recorded to a file while the participant is at a low workload environment and another minute of EEG activity is written to a second file while the participant is at a simulated high work load environment. Low and high work load environments were created by exposing volunteers to sea level altitude and 25K utilizing the Reduced Oxygen Breathing Device (ROBD2, Environics, Inc., Tolland, CT). The Q States software uses a partial least squares machine learning algorithm to examine 3,000 variables extracted from the data to find the features which best separate the low and high states, and then trains a model to grade new EEG data on a scale from 0 to 1 where 0 represents the low (normoxic) state while 1 represents the high (hypoxic) state. These cognitive states are then correlated with performance on cognitive tasks and simulated flight to determine whether they are predictive of impending or current cognitive decrements. **APPLICATIONS:** The capability to monitor and interpret brain waves, in terms of cognitive workload, and to predict impending or current cognitive performance decrements has implications across a spectrum of operationally relevant fields, not just aviation. Future efforts to refine algorithms that reduce noise and amplify dry-EEG signals will be essential to transitioning this technology to our operational forces.

Learning Objectives:

1. Identify the differences in technology between dry and wet electro-encephalogram technology.
2. Understand how dry-EEGs acquire their data.
3. Identify the five different brain wave, and know what cognitive state they are associated with.

10:45 AM
[043] COMPARATIVE EEG SENSOR ANALYSIS FOR ATTENTIONAL STATE PREDICTION

A. Harrivel[1], C.M. Heinich[2], R.J. Milletich[3], J.R. Comstock[1], C.L. Stephens[1], M. Last[4,1], N.J. Napoli[5,1], N.A. Abraham[2], K.G. Toro[2], K.D. Kennedy[1] and A.T. Pope[1]
[1]Crew Systems and Aviation Operations, NASA Langley Research Center, Hampton, VA; [2]NASA Langley Research Center, Hampton, VA; [3]Booz Allen Hamilton, McLean, VA; [4]Analytical Mechanics Associates, Hampton, VA; [5]Systems and Information Engineering, University of Virginia, Charlottesville, VA

(ORIGINAL RESEARCH)

INTRODUCTION: This research aims to mitigate attention-related human performance limiting states (AHPLS) experienced by commercial pilots in-flight by improving training. It involves flight simulation induction of AHPLS such as Channelized Attention (CA) and Startle/Surprise (SS), and their detection using a Crew State Monitoring (CSM) system composed of multiple physiological sensors and machine learning classification algorithms. By feeding objective state information back to the pilot and instructor during ground-based training, the trainee may learn to recognize and recover from adverse states before critical errors are made during flight operations. This comparative analysis investigates the state prediction accuracy difference using a more easily applied and comfortable 4-channel EEG sensor. **METHODS:** Commercial pilot participants wore a suite of physiological sensors during a study approved by the NASA Langley Research Center Institutional Review Board. Pattern classification was used to predict the occurrence of CA and SS during flight simulation events designed to induce AHPLS. Classifier models were trained with benchmark task data and deployed on flight test data. Features were dynamically selected and parameters were tuned for each participant using training or non-test data. Accuracy of prediction was determined using a weighted area under the receiver operating characteristic curve (AUC) to account for imbalanced classes. Mean AUC (M) and standard deviation (SD) across 10 pilots are presented: 1) including seven EEG channels and engagement indices, and 2) instead including four EEG channels selected to represent those available from a lightweight commercial EEG sensing device. **RESULTS:** AUC for CA based on four channels (M=0.598, SD=0.088) was comparable to that based on seven channels (M=0.601, SD=0.115), and AUC for SS based on four channels (M= 0.667, SD=0.161) was slightly lower than that based on seven channels (M=0.677, SD=0.148). An AUC of 0.5 represents chance accuracy. **DISCUSSION:** These results warrant continued development of real-time classification of AHPLS using less-obtrusive EEG sensing. Next steps include the use of eye tracking and functional near infrared spectroscopy features, additional feature types, and further feature importance analysis. Accurate state prediction supports the development of physiological-sensor-based training methods to mitigate the onset of AHPLS and thus reduce accidents and incidents.

Learning Objectives:

1. Discover how physiological sensing and machine learning can provide objective information regarding mental state for improved operational safety.

11:00 AM
[044] CEREBROVASCULAR CO2 REACTIVITY IN DIFFERENT NORMOBARIC VS HYPOBARIC HYPOXIC VS NORMOXIC CONDITIONS IN PILOTS TRAINEES

M.R. Aebi[1,2], N. Bourdillon[2], A. Kunz[1], G.P. Millet[2] and D. Bron[1]
[1]Swiss Airforce, Aeromedical Centre, Duebendorf, Switzerland; [2]Sport Sciences, University of Lausanne, Lausanne, Switzerland

(ORIGINAL RESEARCH)

INTRODUCTION: In hypoxic environment, cerebral blood flow (CBF) regulation is vital to maintain adequate O_2 supply to the brain. Cerebrovascular CO_2 reactivity (cCO_2r) is a useful index of cerebrovascular function. The present study aimed to assess ventilatory and CBF responses to CO_2 in different normobaric and hypobaric hypoxia conditions important for pilots' safety. **METHODS:** cCO_2r was assessed in five randomized conditions (Normobaric Normoxia, NN; Hypobaric Hypoxia HH at 3000m and 5500m; Normobaric Hypoxia NH and Hypobaric normoxia HN at 5500m) on ten healthy participants (26 ± 4 years old) and consisted of 4 phases: (1) 1-min steady-state; (2) 1-min hyperventilation; (3) 30-s normal breathing; (4) 2.5-min hypercapnic breathing (5% CO_2; 11%, 40% and 21% O_2 for NH, HN and HH respectively). Blood pH was measured with a blood gas and electrolyte analyzer (finger sampling, CCA-TS2, OPTI Medical systems, Georgia, USA). cCO_2r was obtained by plotting middle cerebral artery velocity (MCAv, measured by transcranial Doppler, ST3, Spencer Technology, Seattle, WA) vs. end-tidal CO_2 pressure ($P_{ET}CO_2$ measured with a gas analyzer, K5, Cosmed, Rome, Italy). This relationship was fitted using a sigmoid model. One-way ANOVAs were performed to assess statistical significance. **RESULTS:** cCO2r was gradually affected in hypobaric conditions with altitude: The sigmoidal response midpoint was higher ($P<0.001$) in NN than in HH at 3000m or 5500m (34.8 ± 3.1 vs 27.5 ± 3.0 and 18.8 ± 1.2 mmHg) but similar than in NH (32.3 ± 2.4 mmHg). There was no significant difference between 5500m HH and HN (21.1 ± 2.2 mmHg), suggesting a minimal influence of hyperoxic breathing (HN) on cCO2r. These findings showed that midpoints of cCO2r were decreased (left shift) in hypobaric conditions. As expected, pH increased in HH (3000m: 7.51 ± 0.03; 5500m: 7.58 ± 0.03) compared to NN or NH (7.46 ± 0.01 and 7.47 ± 0.01, $P<0.001$). **DISCUSSION:** cCO2r was affected in all hypobaric conditions (including HN) but not in normobaric hypoxia, suggesting a specific influence of hypobaria *per se*, independently of the hypoxic severity. Training with pilots is often conducted in NH. So it is important to check if different responses exist in normobaric vs. hypobaric hypoxic conditions. Military pilots are daily exposed to hypobaric hypoxia. It is therefore paramount to investigate for pilots' safety how cerebrovascular responses are modulated in different hypoxic environments.

Learning Objectives:

1. The participant will be able to understand how cerebrovascular CO_2 reactivity is affected in different normobaric and hypobaric conditions.

11:15 AM
[045] VIABILITY OF PULSE OXIMETRY IN MODERN AIRFRAMES

C. Dooley, M.V. Fischer, J. Kaiser, H. Mahaney and E. Ennis
Air Force Research Laboratory/ 711 HPW , Wright-Patterson AFB , OH

(ORIGINAL RESEARCH)

INTRODUCTION: Modern airframes are outfitted with state-of-the-art sensor technology, monitoring everything from nose to tail. However, the most critical piece of the operation, the pilot, is barely monitored, if at all. With recent physiologic events, an effort was executed to collect information on the state of pilots during flight. Pulse oximeters were deployed with pilots across multiple squadrons. Collected flight data were analyzed to determine the feasibility of transmission and reflectance pulse oximetry to accurately provide critical physiologic flight data. **METHODS:** Over 400 h of pulse oximetry data were collected during flight across 259 sorties. Both helmet- and finger-mounted pulse oximeter sensors were used, relying on transmission and reflectance pulse oximetry, respectively. Helmet sensors were fit into modified ear cups in the helmet, designed to hold the sensor directly over the temporal capillary bed. Finger sensors were affixed to the ring finger on the pilot's non-dominant hand. All pilot participation was voluntary. Data passing quality standards were analyzed looking for anomalies that may resemble physiologic risks to the pilot (i.e., hypoxia, hypocapnia, etc.). Longitudinal analysis was also done in an effort to identify faulty sensors as well as pilot trends. **RESULTS:** Of the 259 sorties, the split between helmet- and finger-mounted pulse oximeters was 42% to 58%. Sixty percent of the data passed the quality assurance (QA) standards. For helmet-mounted sensors, 50% passed QA with an average reliable signal of 74% in flight and 66% overall. Finger-mounted sensors passed QA at a 74% rate with an average reliable signal of 75% in flight and 71% overall. Anomalies in the data were able to be identified and hypotheses as to what they corresponded to were made based on prior pulse oximeter research. However, direct correlation could not be made due to lack of access to aircraft data such as g's, altitude, or life support system readings. **DISCUSSION:** Pulse oximeter data are useful in controlled, mostly static environments, although in its current form underperforming in dynamic environments. A steady state reliability was reached with the data. However, while pilots were wearing pulse oximeters during two self-reported, minor physiologic events, the data were not able to provide reliable insight into the causes or occurrence. A major limitation to this data set was the lack of flight data to provide context to the pulse oximeter data.

Learning Objectives:

1. Pulse oximeter data is useful in mostly controlled static environments. When collected on fighter platforms reliability may be compromised due to pilot movement tasks, G forces, and other dynamic patterns.

11:30 AM
[046] PHYSIOLOGICAL EVENTS IN UK MILITARY AIRCRAFT 2008-2017

N.D. Green[2], V.M. Lee[1] and A. McGown[1]
[1]Air Division, QinetiQ, Farnborough, United Kingdom; [2]RAF Centre of Aviation Medicine, Henlow, United Kingdom

(ORIGINAL RESEARCH)

INTRODUCTION: Anecdotal evidence suggests increased reporting of in-flight physical and cognitive symptoms (physiological events) in military aircraft, possibly related to use of On Board Oxygen Generation Systems (OBOGS). This study assessed the pattern of physiological event reports in all UK military aircraft by oxygen system type. **METHODS:** The UK Military Aviation Safety Information Management System was searched for occurrence reports between Jan 2008 to Sep 2017 using keywords commonly used to describe physiological events. Each report was reviewed by aerospace medicine/physiology experts and adjudicated as to whether a credible cause of hypobaric hypoxia was present. **RESULTS:** 56 relevant reports were identified; mean event rate was 45 per million flying hours (PMFH), with no increasing or decreasing trend in annual rate. There were reports from 45 fast jet aircraft, 6 multi-engine aircraft and 5 piston/turboprop trainer aircraft. Of these reports, in 19 cases there was credible evidence that the crew had not been delivered with an adequate concentration of oxygen (e.g., mask removal, failure of oxygen system, etc.); these events were excluded from subsequent analysis. The remaining 37 events were assessed by oxygen system type: 40.5% occurred with OBOGS, 29.7% with gaseous oxygen, 27% with liquid oxygen and 2.7% breathing cabin air. The rate in OBOGS-equipped aircraft (114 PMFH) was approximately double that of other oxygen system types. In 61% of cases, hypoxia-like symptoms were reported after an oxygen system caution had occurred, but in which the crew were apparently being delivered adequate oxygen. There were 8 reports in which no obvious preceding event or causative factor could be identified (4 OBOGS, 2 liquid oxygen, 2 gaseous oxygen systems). One of the most serious events occurred in a crew breathing gaseous oxygen who suspected oxygen contamination but in which no oxygen system fault or contaminant was later identified. **DISCUSSION:** Physiological events are reported by crews using all oxygen system types, but are more frequent using OBOGS. The high proportion of reports in crews who were apparently well oxygenated by a back-up oxygen supply may suggest an expectation of hypoxia, and that better education about life support system functionality could be beneficial.

Learning Objectives:

1. Participants will be able to understand how oxygen system type is related to the likelihood of an inflight physiological event being reported.
2. Participants will be able to evaluate the cause of in flight physiological event reports more readily.

11:45 AM
[047] UK TYPHOON REPORTS OF HYPOXIA SYMPTOMS 2008-2017

V.M. Lee[1], N.D. Green[2], D.M. Connolly[1] and A. McGown[1]
[1]Human Performance, QinetiQ, Farnborough, United Kingdom; [2]RAF Centre of Aviation Medicine, Henlow, United Kingdom

(ORIGINAL RESEARCH)

INTRODUCTION: Over recent years there has been increasing concern regarding the prevalence of 'physiological events', in particular hypoxia-like symptoms, reported by aircrew of high performance aircraft. While there has been extensive activity in investigating these incidents there remains uncertainty as to the causes. In light of recent reports by other nations, a review of incidents reported by UK Typhoon aircrew was instigated by the UK MOD with a view to understanding the level of symptom reporting and whether the UK Typhoon is experiencing unexplained reports of hypoxia-like symptoms. **METHODS:** The UK Military Aviation Authority Aviation Safety Information Management System was interrogated for all Typhoon Defence Air Safety Occurrence Reports (DASORs) raised between January 2008 and July 2017 with key words related to hypoxia and hypoxia symptoms in the title, narrative or comments sections. These DASORs, including any attached follow-up investigations and comments, were then reviewed by three aviation medicine/physiology specialists with extensive research and test and evaluation experience associated with the Typhoon life support system. **RESULTS:** During the period analyzed, 5003 Typhoon incidents were reported. Of these, only 18 made reference to hypoxia or associated symptoms. This equates to an incident rate of 0.31 per 1000 flying hours. There was evidence in 7 of these incidents to suggest possible interruption of adequate oxygen supply that may have led to hypoxia. In a further 7 incidents, symptoms were reported to occur only after appearance of life support system related captions on the cockpit warning panel. An analysis of symptoms and incident circumstances suggested that these were probably attributable to hyperventilation. A single event reporting very transient symptoms was considered unlikely to be associated with hypoxia or breathing gas. Only two cases were reported where, with the details provided in the DASOR, there was no apparent explanation for symptoms. **DISCUSSION:** Based on the available evidence from UK Typhoon DASORs, there is no apparent trend towards increasing physiological events or unexplained hypoxia-like symptoms. The incidence of symptom reporting is low with no more than one occurrence per year since 2013.

Learning Objectives:

1. The participant will be able to understand the prevalence of hypoxia symptoms arising in the UK Typhoon aircrew since 2008.

Monday, May 07 ***2:00 PM***
Ballroom D

S-011: PANEL: AIRCREW NECK PAIN PREVENTION AND MANAGEMENT - INSIGHTS FROM NATO HFM RTG-252 PART II: APPLIED SCIENCE

Sponsored by Life Sciences and Biomedical Engineering Branch

Chair: Christopher Goff
Patuxent River, MD

Chair: Barry Shender
Patuxent River, MD

PANEL OVERVIEW: The North Atlantic Treaty Organization (NATO) has conducted research panels focused on spinal pain and injury since 1995 (*The Musculoskeletal and Vestibular Effects of Long Term Repeated Exposure to Sustained High-G* working group that resulted in Advisory Report AGARD-AR-317). The focus then was on high performance jet pilots but spinal issues are also a significant issue in helicopter aircrew. Factors associated with pain generation often cited include equipment (e.g., head supported devices), non-ergonomic seating, long duration missions, and environmental stresses (e.g., G-loading). Pain can impact performance, reduce situational awareness, affect behavior (i.e., limit aggressive maneuvering), and has led to aircrew grounding. The NATO Human Factors and Medicine (HFM) Research Task Group (RTG) Panel 252 on Aircrew Neck Pain has a mandate to contextualize and understand aircrew neck pain, conduct the necessary research to evaluate mitigating solutions, and generate recommendations for reducing the risk of aircrew neck pain. Thus, the overall objective of this NATO RTG is to seek and ultimately recommend evidence-based administrative, procedural, ergonomic, engineering, preventative, and treatment solutions to aircrew neck pain. HFM RTG-252 has developed two panels to communicate interim findings. Part II focuses on the effect of equipment properties and aviation environment on neck pain, as well as some potential solutions. Since pain is subjective, it is important that we start with a common set of metrics and definitions in order to propose solutions and gauge their effect. Often a discussion of neck pain issues focuses on head supported mass. Therefore, the second talk describes how this is determined. The third talk discusses studies conducted that identify workplace behaviors that may exacerbate pain. Next, the contribution of vibration exposure towards pain generation and the means to reduce that effect is presented. The panel ends with a discussion of the use of modelling and simulation to identify pain mitigation strategies.

[048] AIRCREW NECK PAIN PREVENTION AND MANAGEMENT - INSIGHTS FROM NATO HFM RTG-252 PART II: PAIN DEFINITIONS AND METRICS

T. Weme[2], E. Smith[1], N. Duvigneaud[3] and B.S. Shender[4]
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(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: Neck pain is prevalent in society as a whole; complete prevention would be impossible. In order to find solutions to mitigate neck pain in aircrew it is essential to clearly define the problem and set a threshold for actionable complaints. **TOPIC:** Pain is characterized by the mechanism of injury, timing, and resulting associated symptoms, which can include radiculopathy, myelopathy, and altered range of motion. With respect to timing, the NATO RTG defines acute neck pain as 0-7 days, sub-acute as 1-12 weeks, and chronic as >3 months. To define quality, the most commonly referenced definition for pain is that of the International Association for the Study of Pain (IASP): "an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage. Pain is always subjective". The subjective nature of pain and the lack of an aviation-specific definition of neck pain make it difficult to determine when pain becomes significant enough to cause functional and operational impact. The NATO RTG has developed the following statement: "*Significant Flight-related neck pain refers to pain that occurs during or within 24 hours after flight. It does not refer to pain that is due to other activities or causes*." Further defining the term 'significant' is challenging and has considerable impact on management of aeromedical disposition in aircrew. It is generally accepted that pain which distracts the attention of aircrew from their duties, potentially impacting safety of flight and mission accomplishment is significant. Unfortunately, this is again very subjective and difficult to quantify, as individual pain tolerance and the clinician's level of experience with managing neck pain will vary. The most recognized tool to assess the impact of neck pain on an individual's function is the neck disability index (NDI). However, as most of the items in the NDI relate to activities of daily living, this is not the most appropriate way to ascertain the degree of functional disability of aircrew. **APPLICATIONS:** Clear definitions of timing and significant flight related pain allow clinicians and researchers alike to align their efforts and management plan. A modified version of the NDI containing questions relating specifically to aviation is required to properly assess aircrew functional disability and determine aeromedical disposition. This is an area of future recommended work.

Learning Objectives:

1. To promote consensus for the definition of pain and provide insight to the challenges of applying standardized definitions and metrics for neck pain in aircrew.

[049] AIRCREW NECK PAIN PREVENTION AND MANAGEMENT - INSIGHTS FROM NATO HFM RTG-252 PART II: HEAD-SUPPORTED MASS SELECTION CRITERIA

B. Shivers[3], J. McEntire[3], F. Brozoski[3], P. Estep[3], A. Madison[3], C. Goff[4], S.E. Day[2], T. Karakolis[1], P.S. Farrell[1] and C. Chancey[3]
[1]Human Systems Integration Section, Defence Research and Development Canada, Toronto, ON, Canada; [2]Human Performance, QinetiQ, Farnborough, United Kingdom; [3]Injury Biomechanics Division, U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL; [4]United Kingdom Ministry of Defence, Fareham, United Kingdom

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: In terms of helmet and helmet-mounted system utility, mass properties are often considered ancillary to protection capability and potential operational enhancement; however, in terms of neck and cervical spine pain/injury and health-related performance, mass properties (mass, center of mass, and mass moment of inertia) are of the highest importance. Prioritization of selection criteria for helmets and helmet-mounted systems (head-supported mass; HSM) is a continual challenge for decision makers across NATO nations. **TOPIC:** While there is substantial overlap in the HSM systems used by NATO nations, the selection processes and prioritization of criteria vary greatly between nations. A poll of NATO nations was conducted to identify how each nation determined HSM selection criteria. HSM selection criteria were defined in multiple ways: internally developed within a branch of service [U.S. Army (USA), U.S. Air Force (USAF), and U.K. Ministry of Defence (MOD)]; adopted from a sister service (U.S. Navy); adopted from a partner nation (France and Australia); specific to a mission or time of day (U.K. MOD); flight test and user acceptance (Netherlands and France); or aircraft dependent (F35 jet; newly fielded in most NATO nations). The USA and the USAF have two of the most common internationally accepted sets of criteria relative to HSM mass properties. The USAF has separate acute neck injury criteria specific for fast jet and bomber ejections (pure mass limits), while the USA has an acute neck injury criteria for a high acceleration rotary wing crash (mass and vertical mass offset threshold). The USA also has a performance decrement criterion that provides a mass and longitudinal mass offset threshold. **APPLICATIONS:** Current U.S., U.K., and Canada efforts supporting HFM-252 are combining volunteer research and modeling to update existing criteria to include: current and emerging HSM configurations used across NATO nations; investigation of the impact of head mass, inertia, movement, and environmental Gz on aircrew neck muscles; derivation of empirical relationships between mass properties, and neck loading and muscle activation; and comparison of operational helmet systems and their likelihood to mitigate chronic neck pain.

Learning Objectives:

1. Understand the role of mass properties and neck pain/injury prevention in prioritization of head-supported mass (HSM) selection criteria used by NATO nations.

[050] AIRCREW NECK PAIN PREVENTION AND MANAGEMENT - INSIGHTS FROM NATO HFM RTG-252 PART II: INFLUENCE OF AIRCREW BEHAVIOUR

S.E. Day[2], P.S. Farrell[1], C. Goff[3], M. van den Oord[4] and H.E. Wright Beatty[5]
[1]Human Systems Integration Section, Defence Research and Development Canada, Toronto, ON, Canada; [2]Human Performance, QinetiQ, Farnborough, United Kingdom; [3]Platform Systems Division, Dstl, Fareham, United Kingdom; [4]Center For Man in Aviation, Soesterberg, Netherlands; [5]National Research Council, Ottawa, ON, Canada

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: Understanding how aircrew behavior contributes to neck pain and how these behaviors are affected by their environment leads to aircrew training and cabin ergonomics recommendations. **TOPIC:** The combination of non-neutral postures, poor cockpit / cabin ergonomics, and vibration or G, while wearing a heavy, unbalanced helmet all influence the way a task is achieved and can increase the risk of neck pain. Task analysis is one method used to analyze aircrew behavior, identify high risk postures (extreme postures held for a short time or quasistatic postures held for a long period) and recommend biomechanically advantageous postures to reduce the risk of neck pain. The outputs from task and physical demands analyses (video footage, motion capture, and digital human modelling) of biomechanically compromising postures (both mild and severe) have led to ergonomically supportive equipment and aircrew training recommendations. The task and physical demands analyses of rotary wing aircrew behaviors have indicated that task sharing yields a 37% reduction in muscle fatigue, as well as the identification of more neutral postures that provide up to 64% less neck loading. Scanning tasks that minimize neck movements by engaging the torso will also reduce neck loading. Both task sharing and improved postures could be incorporated in formal aircrew training. Improved design and provision of dedicated hand-holds and padding in key cabin areas will ameliorate kneeling, stooping, and lying postures. Aircrew behavior is also a factor in the choice of counterbalance weight (CBW) when wearing night vision goggles (NVGs), which is linked to helmet stability. In a study carried out by the UK, no link was found between the counterbalance chosen and the mass of the NVGs used, with aircrew frequently choosing to add mass without regard for the additional mass added to the front of the helmet, by the NVG. **APPLICATION:** Understanding the influence of how aircrew perform tasks (aircrew behavior) on neck pain has led to five key recommendations: 1) Task training that emphasizes biomechanically advantageous postures; 2) Task sharing amongst co-pilots when operationally feasible; 3) Avoid rapid head movements by engaging the torso;4) Ergonomic hand-holds and padding in key cabin areas to improve posture and comfort; 5) Understand the utility of CBW and its application to each aircrew role.

Learning Objectives:

1. The risk of aircrew neck pain is not just related to the equipment and environment that they operate; how aircrew chose to do a task is equally important.

[051] AIRCREW NECK PAIN PREVENTION AND MANAGEMENT - INSIGHTS FROM NATO HFM RTG-252 PART II: VIBRATION MITIGATION

H.E. Wright Beatty, A.J. Law, E. Chen, A. Fereidooni and V. Wickramasinghe
Aerospace, National Research Council Canada, Ottawa, ON, Canada

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: Neck pain is one of the primary adverse health effects of chronic exposure to whole-body vibration experienced by helicopter aircrew. Accounting for vibration related head movement in exposure standards and mitigating the vibration transmission experienced by aircrew during flight is critical for health and safety, and also supports the prevention and management objectives of the NATO HFM RTG-252 Aircrew Neck Pain panel. **TOPIC:** Physiological and biomechanical responses of pilots to vibration exposure have been examined during helicopter flight and on the National Research Council (NRC) Human Rated Shaker facility. While electromyography (EMG) and subjective assessments of discomfort are generally used as indicators of neck strain, acceleration and movement of the head and neck are currently not accounted for in the vibration and shock exposure standards (e.g., MILSTD 1472, ISO 2631-1-1997). Using NRC's Human Rated Shaker facility, pilots were exposed to different levels of vibration which are representative of flight in NRC's Bell 412 helicopter (civilian variant of the Canadian Forces Griffon). During vibration testing, they sat on either standard or vibration mitigating cushions. Active vibration mitigation, through vibration cancellation, is also being examined given that passive vibration mitigation solutions (e.g., seat cushions) are often not effective for all aircrew. An active seat system which counters low frequency vibration (4-8 Hz) through multi-axis vibration control was developed and tested by the NRC. For comparison, one passive vibration mitigation cushion tested reduced the ISO-2631 health- and comfort-weighted accelerations at the seat by 12.7% and 8%, respectively, while the active seat system has shown non-weighted reductions

of vibration amplitudes of up to 50%. **APPLICATIONS:** Amplified pilot head acceleration, compared to the standard reference at the seat, provides justification for the revision of vibration exposure standards (e.g., MILSTD 1472, ISO 2631-1-1997) to account for head and neck movement. While various vibration mitigating solutions (e.g., vibration attenuating seat cushions, helicopter maintenance procedures) have shown some effectiveness, these solutions are unlikely to provide relief for all aircrew. The use of active vibration cancellation technology is being examined further at NRC as a recommendation for improved long term health of individuals who regularly experience whole-body vibration.

Learning Objectives:

1. Given that adverse long-term health implications, such as neck pain, exist due to aircraft vibration, attempts should be taken to mitigate vibration exposure for aircrew as well as account for head and neck movement in exposure standards.

[052] AIRCREW NECK PAIN PREVENTION AND MANAGEMENT - INSIGHTS FROM NATO HFM RTG-252 PART II: AIRCRAFT WORKSPACE SOLUTIONS

P.S. Farrell[1], G. Fusina[2] and J. Baudou[3]
[1]Human Effectiveness Section, Defence Research and Development Canada, Toronto, ON, Canada; [2]Operational Health and Performance, DRDC, Toronto, ON, Canada; [3]Engineering, THALES Avionics, Le Haillan Cedex, France

(ORIGINAL RESEARCH)

INTRODUCTION: Human Factors and Medicine Panel 252 on Aircrew Neck Pain seeks to identify aircrew neck pain administrative and engineering mitigating solutions. Aircraft Workspace solutions involve repositioning cockpit and cabin controls, displays, and equipment in order to promote biomechanically advantageous postures and minimize neck loads as a way of reducing neck pain. **METHODS:** Modelling and Simulation (M&S) was used to explore proposed cabin and cockpit solutions such as Joystick control rather than collective and cyclic, display repositioning, and support handles. Cumulative neck loads were calculated for every task posture for each aircrew role within two missions, flown during the day and then at night, and with and without the proposed solution. It is expected that the proposed solution would yield more neutral body postures, which would translate into less neck loads. One M&S analysis included repositioning the Control Display Unit (CDU) and a Multi-Function Display (MFD) with altimeter information as well as video feed from an under-belly camera. The virtual CDU was tilted upwards so that the Non-Flying Pilot (NFP) did not have to flex their neck as much. The MFD information meant that the Flight Engineer (FE) did not need to adopt extreme postures to check under the aircraft. **RESULTS:** Cumulative Neck loads were collected for 1) Flying Pilot (FP), NFP, and FE, 2) logistics and training missions, 3) day and night flights, and 4) the original configuration versus this new display repositioning solution. For the logistics mission, the resultant neck torque was about 20% less with the display repositioning solution compared to the original configuration for every case, except for the FP role at night (no difference). For the training mission, there was about 15% torque reduction for the FE only, and no difference for the pilots. **DISCUSSION:** M&S shows that Aircraft Workspace solutions may reduce neck loading for some aircrew roles and not others, depending on the mission type. Also, M&S allows one to explore various solutions before committing to human-in-the-loop test and evaluation. Finally, Aircraft Workspace solutions in combination with administrative and other engineering mitigation solutions will need to work synergistically to reduce neck loads and ultimately neck pain.

Learning Objectives:

1. Solving aircrew neck pain is a multi-facet problem that requires multiple disciplines.
2. Cockpit and cabin controls, displays, and equipment may be (re) designed in manner that promotes biomechanically advantageous postures and minimise neck loads towards reducing neck pain.
3. There is no single silver bullet solution. Rather, engineering as well as administrative solutions must work synergistically to reduce neck loads and ultimately neck pain.

Monday, May 07 ***2:00 PM***
Ballroom E

S-012: PANEL: AEROMEDICAL RISK ANALYSIS PRACTICE UPDATES – PART 2

Sponsored by The American Society of Aerospace Medicine Specialists

Chair: Richard Allnutt
Beavercreek, OH

Chair: Dan Van Syoc
Springboro, OH

PANEL OVERVIEW: During this panel, aeromedical clinical experts and Aerospace Medicine residents will present risk analysis-based clinical updates on topics related to the assessment and treatment of aviators and special operational duty personnel suffering from specified medical conditions of aeromedical interest. Presentations will include recommendations for treatment and discussions of the aeromedical implications of the specified disease conditions.

[053] THE AEROMEDICAL IMPLICATIONS OF UTILIZING PSYCHOTROPIC MEDICATIONS, PART 2

T.L. Correll
Aerospace Medicine Consultation Division, USAFSAM, Wright-Patterson AFB , OH

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: The U.S. Air Force School of Aerospace Medicine, an internationally renowned center for consultation, education, and operational research, promotes readiness and protects force and community health in a variety of areas, including clinical aeromedical evaluation of rated aircrew to determine readiness to return to flying status. The purpose of this presentation is to highlight the key components of utilizing psychotropic medications in Air Force aviators. **TOPIC:** We will examine how aviators with disqualifying psychiatric diagnoses receive the best possible assessment and treatment (including, potentially, psychotherapy, healthy lifestyle interventions, and psychotropic medication) and then obtain a waiver to resume flying duties. **APPLICATIONS:** Air Force aviators have the potential to receive comprehensive and optimal mental health care to obtain the best possible outcomes for their psychiatric symptoms/illness. We will discuss key learning points related to psychotropic medication use that can be broadly applicable in many clinical settings.

Learning Objectives:

1. We will discuss key learning points related to psychotropic medication use that can be broadly applicable in many clinical settings.

[054] THE AEROMEDICAL IMPLICATIONS OF UTILIZING PSYCHOTROPIC MEDICATIONS, PART 1

R. Peirson[1,2]
[1]Aeromedical Consultation Service - Neuropsychiatry, United States Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH; [2]Psychiatry, Wright State University School of Medicine, Dayton, OH

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: The U.S. Air Force allows very few psychotropic medications for use with aviators. Due to the pressure to return air crew to flying duties, many flight surgeons are inclined to minimize treatment, rather than aggressively treating mental disorders. Focusing only on the narrow range of allowable medications at the lowest possible dose, short-term treatment options may be considered inaccessible to many flight surgeons. The purpose of this presentation is to highlight treatment regimen trends observed in aviators seen at the Aeromedical Consultation Service from 2013 to 2018. **TOPIC:** The presentation will emphasize the need to offer state-of-the-art mental health treatment to aviators, despite perceived disincentives to involve mental health consultants. Best-practice treatment strategies for depression and anxiety will be presented and treatment histories from

aviators seen at the Aeromedical Consultation Service will be used to highlight the need for targeted, evidence-based treatment. Augmentation regimen will be reviewed, emphasizing the need to treat the aviator not the aviation career. Finally, the pitfalls of psychostimulant use will be discussed. **APPLICATIONS:** The trends of treatment observed in Air Force aviators and recommendations for enhancement have utility to military audiences but are generalizable to commercial and general aviation. We will discuss key learning points related to psychotropic medication use that can be broadly applicable in many clinical settings.

Learning Objectives:

1. The participant will learn the trends in medication regimen experienced by aviators seen by the Aeromedical Consultation Service.
2. The participant will learn how psychotropic prescription trends compare to treatment guidelines.
3. The participant will learn how to maximize treatment within the expectations of the Waiver Guide.

[055] GENDER DYSPHORIA AND ITS AEROMEDICAL IMPLICATIONS

W. Rodriguez-Jimenez[1] and J.A. Frazier[2]
[1]University of Texas Medical Branch, Galveston, TX; [2]Federal Aviation Administration, Washington, DC

(ORIGINAL RESEARCH)

INTRODUCTION: The purpose of this presentation is to provide the aerospace medicine physician an update on the aeromedical implications associated with gender dysphoria and its certification process. A review of common terminology and current practice guidelines for the diagnosis and management of gender dysphoria will be provided. **METHODS:** An overview of gender dysphoria including epidemiology, definitions, diagnosis, management as well as the aeromedical concerns will be presented. The authors will present the most current information regarding the aeromedical disposition of civilian airmen with gender dysphoria. **RESULTS:** Current civilian aviation guidelines for gender dysphoria will be covered and approaches to the aeromedical disposition of gender dysphoria will be identified to provide guidance to the aerospace medicine physician. **DISCUSSION:** With evolving clinical practice guidelines, performing analysis of the potential aeromedical implications is a fundamental process for maintaining the validity of current aerospace practice recommendations. KEYWORDS: gender dysphoria aeromedical implications and certification

Learning Objectives:

1. Review the epidemiology, definitions, diagnosis, management as well as the aeromedical concerns of gender dysphoria.

[056] THE NATURAL HISTORY OF CORONARY ARTERY DISEASE IN U.S. AIR FORCE AIRCREW - 2018 UPDATE

E.D. Davenport
USAFSAM, Wright-Patterson AFB, OH

(ORIGINAL RESEARCH)

INTRODUCTION: Atherosclerotic cardiovascular disease (CVD) is the leading cause of denial or loss of licensure in both civilian and military aviators. For pilots and other military aviators, the various modes of presentation (sudden cardiac death, myocardial infarction (MI), unstable angina, and arrhythmia) are of paramount concern because of possible sudden incapacitation or performance decrement. A retrospective review of known CVD in aviators was analyzed to evaluate for possible strategies to prevent sudden incapacitation. **METHODS:** The U.S. Air Force School of Aerospace Medicine's Clinical Sciences Database contains over 1.2 million cardiac studies on approximately 288,000 aviators, with 211 unique aviators with CVD to include 35 with MIs and 80 revascularizations. These retrospective data were used to evaluate prevalence, baseline risk factors, presenting symptoms, and outcomes of aviators with CVD. **RESULTS:** Annual cardiac event rates in apparently healthy Air Force aviators are approximately 0.5% per year for males aged 35-54 yr. In those requiring revascularization, the most common presenting symptom was MI at 34%, followed by chest pain at 30%, while screening only found 13%, although not currently required in aircrew. At 10-yr follow-up there was one recurrent MI and no death. Rates of cardiovascular outcomes (primary and secondary) were lowest in those who performed moderate exercise, had lower carbohydrate diets, and drank coffee and alcohol regularly. **DISCUSSION:** Military aviators have a much decreased yet still significant risk of atherosclerotic CVD compared to the civilian population. Secondary risk factor modification and follow-up with non-invasive testing appear to work well, as military aviators with known CVD have lower morbidity and mortality rates than in published non-aviator literature. Further studies are necessary to evaluate primary prevention and screening methods to decrease MI and revascularization in military aircrew before the event.

Learning Objectives:

1. Understand the prevalence of coronary artery disease in the military aviator.
2. Fully recognize the short- and long-term risk of coronary artery disease in the aviator.
3. Understand fully the risks and benefits of both primary and secondary prevention of cardiovascular disease in the aviator population.

Monday, May 07 ***2:00 PM***
Wedgewood

S-013: SLIDE: TRANSLATIONAL SPACE MEDICINE

Chair: Yael Barr
Friendswood, TX

Chair: Volker Damann
Königswinter, Germany

2:00 PM

[057] TRENDS IN SPACE BIOMEDICAL RESEARCH – WHERE DO THEY LEAD?

P.C. Rambaut
University of Hawaii, Hilo, HI

(ORIGINAL RESEARCH)

INTRODUCTION: Commencing about a decade before the flight of Yuri Gagarin in 1961 a number of space biomedical issues had been predicted. With the start of the Apollo missions about a dozen such issues were recognized. These ranged from motion sickness to the effects of ionizing radiation. Much of the research undertaken to investigate these issues has been published in peer-reviewed journals. By analyzing trends in these publications it was hypothesized that a reordering of biomedical priorities would become apparent and that this would reflect improvements in the spacecraft habitat, progress in the development of countermeasures and a better definition of future missions. **METHODS:** A key word search was conducted of NIH and NASA databases for space biomedical research papers published since 1951. Results were categorized according to discipline, i.e., cardiovascular, vestibular etc. and, within each discipline, according to principal focus, i.e., signs/symptoms, mechanisms or countermeasures. **RESULTS:** A total of 24,044 original papers were identified. Of these some 3745 cited a space biomedical issue as their underlying rationale. Since the Salyut and Skylab space station deployments in the early 1970's the total number of papers has increased by about 6% per year. Some 8% of these papers have been theoretical and have focused on why biological processes are affected by the absence of gravity. The remainder has reported empirical research carried out in simulated and actual spaceflight, with humans, with other species and with cellular and subcellular systems. Five physiological disciplines have received the most attention, i.e., vestibular, cardiovascular, muscular, skeletal and radiobiological with the rank order of these disciplines changing over time. **DISCUSSION:** None of the originally identified space biomedical issues has been closed entirely and no new issues have emerged with the possible exception of visual impairment. Today, simple observations of space-borne biomedical phenomena have given way to increased research on mechanisms and countermeasures. The latter is focused principally on shrinking muscles, thinning bones, immune changes, vision problems and the effects of ionizing radiation. While research was once driven by a politically-mandated schedule to place a man on the Moon, current research is open-ended, scientifically

broad and, judging from its continuing expansion, arguably not on the critical path to a putative Mars mission.

Learning Objectives:

1. Appreciate the accelerating pace of Space Biomedical Research and the increasing tendency for this research to address broad scientific questions not necessarily related to any specific mission.

2:15 PM
[058] IMMUNOSUPPRESSION IN SPACE: SYSTEM-LEVEL, SINGLE-CELL HUMAN ADAPTATIONS TO MICROGRAVITY

J.M. Spatz[1], M. Hughes Fulford[1], D. Gaudilliere[3], E. Ganio[3], N. Aghaeepour[3] and B. Gaudilliere[2]
[1]School of Medicine, University of California San Francisco, San Francisco, CA; [2]Anesthesiology, Stanford University Medical Center, Stanford , CA; [3]Stanford University, Stanford, CA

(ORIGINAL RESEARCH)

INTRODUCTION: Exposure to microgravity during spaceflight produces measurable immunological dysregulation coupled with increased viral shedding that are a significant risk for long duration deep space exploration class missions. NASA has identified these risks as requiring further in-flight human *in-vivo* evidence. We hypothesize exposure to uG during spaceflight alters the cellular and functional of the immune system, producing a state of immunosuppression. **METHODS:** We developed a mass cytometry (CyTOF) assay to comprehensively characterize the effect of simulated microgravity, achieved via the NASA rotating wall vessel system, on peripheral blood mononuclear cells (PBMCs) from eight healthy human subjects. This method allowed for the first time the abundance and functional responses of major immune cell subsets at the single-cell level following either static or simulated μG conditions followed by activation with Concanavalin A (Con A) and anti-CD3/CD28. **RESULTS:** Our results highlighted biology consistent with our observed mRNA reductions of IL2Ra, tumor necrosis factor a (TNFa), CD69, and CCL4 in PBMCs in simulated microgravity vs. static controls ($p < .001$) by qPCR; it also confirmed $CD4^+$ and $CD8^+$ T-cell mRNA changes previously seen in spaceflight. Importantly, kEN CyTOF results identified decreased CD25 in natural killer cells, CD69 in Tregs, and increased pSTAT5 in $FoxP3^+$ regulatory T cells (Tregs) ($p < .001$ for all) in activated PBMCs exposed to simulated μG vs. static controls. **DISCUSSION:** This study applied high-dimensional mass cytometry, for the first time, to characterize the immunological consequences of simulated microgravity at the single cell level. An analytical approach developed by the investigators was utilized that is adapted to the inter-connected immune networks identified in high-parameter single-cell analysis methods. These findings corroborated and expanded previous knowledge of mRNA analysis of astronaut samples in space by demonstrating the magnitude and directionality of immune adaptations were specific to each cell type. Interestingly, while the immune changes to microgravity involved global suppression of NK cell function representing decreased innate immunity, B cell-mediated or humoral immunity was left largely unchanged. In an analog environment, our results identified previously unknown, clinically relevant, cell-type specific changes across the entire immune system implicated in human adaptation to μG.

Learning Objectives:

1. The participant will be able to understand the immunological consequences of microgravity at the single cell level.
2. The participant will be able to learn to examine immunologic mass cytometry that can be applied in the study of humans in aerospace medicine and extreme environments.

2:30 PM
[059] INNER SPACE IN OUTER SPACE: MICROBIAL MONITORING AT THE HI-SEAS LONG-DURATION MARS SIMULATIONS

B.A. Johnson[3], Y. Sierra-Sastre[2] and S.E. Gifford[1]
[1]Physical Medicine and Rehabilitation, Washington University St. Louis School of Medicine, St. Louis, MO; [2]Hawaii Space Exploration Analog and Simulation (Mission I), Rockville, MD; [3]School of Medicine, The Johns Hopkins University, Baltimore, MD

(ORIGINAL RESEARCH)

INTRODUCTION: Microbial monitoring in the confined environment of a future Mars habitat will be essential to ensure astronaut health, planetary protection, and prevention of microbial deterioration of materials. A series of microbiological analyses were conducted during the Hawai'i Space Exploration Analog and Simulation (HI-SEAS). During HI-SEAS Mission I (April-August 2013), environmental surveillance of microbial loads on surfaces and in meals was conducted. During Mission IV (August 2015-August 2016), changes in crew nasal microbiome were charted. **METHODS:** During HI-SEAS I, food-spoilage and pathogenic microorganisms were measured in leftover meals. An ATP luminometer device and swabs were used to monitor hygiene levels in the habitat kitchen and bathroom areas. During HI-SEAS IV, nasal swabs of each crew member were collected every two weeks. The 16S DNA was extracted and sequenced to track changes in microbiome composition. **RESULTS:** Leftover meals had low microbial loads, with no E. coli present, unless stored longer than three days. Rehydrated fruits exhibited S. aureus. The bathroom door handle showed higher levels of E. coli coliforms than the faucet handles or toilet seat. In the kitchen, ATP luminometer levels (RLU/cm2) were highest for the microwave touch panel, hot tea handle, and sink faucet. Crew nasal microbiome trends differed widely for each subject. While s3 had a steady bacterial profile, s2 showed an increase in microbial diversity, and s5 a contraction. S6 maintained high levels of Staph bacteria (~50% of total), and s3 increased from 17% to 30% from start to end. **DISCUSSION:** Crew and habitat environmental microbial load has profound implications for long duration space missions: while food prep contamination was minimal, time limits must be imposed on consuming leftovers to avoid aerobic bacterial buildup. Targeted elimination of S. aureus from dried fruit should be considered, as well as prophylactic treatment of crewmembers with nasal S. aureus. Bathroom accumulation of E. coli merits re-visitation of lavatory cleaning methods, and the installation of antimicrobial surfaces in kitchen appliances and door handles. Further research on techniques to accomplish these goals is recommended.

Learning Objectives:

1. To understand the impact that crew and habitat microbiomes can have on human health in space.
2. To convey microbial findings observed in these simulated space environments and compare them to those found in current space environments like the International Space Station.
3. To explore possible interventions to promote diverse and balanced inner and outer space microbiomes in future simulated and real space environments.

2:45 PM
[060] THE EFFECTS OF HYPERGRAVITY AND RADIATION EXPOSURE ON PLANTS AND THEIR TERRESTRIAL AND SPACE APPLICATIONS

M.A. dos Santos[3], B.A. de Souza[3], N. Guimarães[3], F.C. Escobal[3], P.A. Souvestre[2] and T. Russomano[1]
[1]Faculty of Life Sciences & Medicine, Kings College London, Center of Human and Aerospace Physiological Sciences, London Bridge, United Kingdom; [2]NeuroKinetics Health Services, Inc., Vancouver, BC, Canada; [3]Microgravity Centre - Joan Vernikos Aerospace Pharmacy Laboratory, PUCRS, Porto Alegre, Brazil

(EDUCATION - PROCESS)

MOTIVATION: The Bellagio II Summit discussed on the influence of Spaceflight environment on plants and their compounds with respect to nutrition and use of pharmacology. Plant germination and growth are influenced by countless environmental factors, such as gravity and radiation type and magnitude. Since many plants are well known for their nutritive and medicinal values, the need for their cultivation and consumption aboard spacecraft during Space missions is unquestionable. Internationally recognized peer-reviewed terrestrial simulation studies have demonstrated that centrifuge-induced Hypergravity generates seed germination amount, accelerates plant growth and modifies plants metabolites. Whether in Low Earth Orbit or in Deep Space, cosmic radiations can also positively impact on plant growth and metabolite production. **OVERVIEW:** Effects of diverse gravitational fields and types of radiation on plant germination and development were reviewed for

application in both Space missions and food and pharmaceutical industries on Earth. Faster germination and increased growth of Rocket plant seeds, as well as higher rates of germination of carrot seeds were observed when subjected to intermittent exposure at +7Gz. Scientific literature shows that using UV-C radiation increased arugula's production of antioxidant and polyphenols compounds, and shortened strawberry's maturation by 4 to 8 days, without affecting average fruit weight. However, Gamma radiation, also be used to disinfect vegetables reduced fava beans' average height, without affecting germination. **SIGNIFICANCE:** Our review in specialized literature identified that terrestrial studies conducted worldwide have demonstrated positive effects of Hypergravity and Radiation on plants life cycle and compounds generation with results appearing to be significantly beneficial to healthy human consumption. Noteworthy findings suggest that several plants present faster rates of germination and growth under given measurable Hypergravity and Radiation conditions. Therefore, Hypergravity and Radiation can be controlled and used towards food production and medication develop, hence enabling humankind survival further whether on Earth or in hostile environments such as spaceflight and extra-terrestrial bases. This should motivate translation of the cultivation of such plants and vegetables using such methods, not only on Earth everywhere, but also in more extreme environments, such as onboard space stations and spacecraft.

Learning Objectives:

1. To present the effects of different gravitational accelerations and radiation on plant compounds with nutritive and medicinal values.
2. To discuss how different simulated hypergravity exposures can affect plant germination, growth and production of secondary metabolites.
3. To understand what type of radiation affects plant secondary metabolite production.

3:00 PM
[061] FIRST GERMAN COMMERCIAL FEMALE ASTRONAUT SELECTION

C. Stern, M.W. Trammer, I. Chaudhuri-Hahn and P. Tuschy
Flight Medicine Clinic, German Aerospace Center, Cologne, Germany

(ORIGINAL RESEARCH)

INTRODUCTION: Sixty women have been to space--none of them were German. That was the reason for the CEO of a German space personnel provider to advertise a vacancy for a first German female astronaut. The searched precondition was having a Masters and job experience in the field of science, space, medicine or engineering. The application had to be accompanied by a meaningful video. More than 400 well-educated women applied. **METHODS:** The medical and psychological selection was performed by the German Aerospace Center and followed in the structure the last European astronaut selection. There were120 women selected by the private company due to their application. They all had to fill out a pseudonymized questionnaire that was created by the Flight Medicine Clinic of the German Aerospace Center as an initial medical screening. It included medical questions as well as questions concerning sporting activities and nutrition. There were 85 persons recommended for further evaluation. They completed the first step of the psychological selection from which 30 women entered the second stage of the psychological selection. Eight applicants were finally psychologically selected and underwent the medical selection. This included examinations in hematology, internal medicine, stress ECG, ophthalmology, neurology, ENT, gynecology, dentist, psychiatry, bone density, and anthropometry. **RESULTS:** During the initial medical screening phase applicants were denied because of metric, trauma or pregnancy reasons. In the end six applicants were considered medically fit by an experienced space medicine board for becoming a commercial astronaut. Reasons for rejection were the exclusion criteria mentioned in Medical Standards and Certification Procedures For Space Flight Participants. No medical data were given to the private company. **DISCUSSION:** The international space agencies' standards for commercial astronauts differ a lot from the requirements for professional astronauts. Therefore the rate of denials for medical reasons was much smaller compared to the last ESA astronaut selection. As many applicants came out of the space area it made sense to pseudonymize the medical information for decision making to exclude possible bias.

Learning Objectives:

1. The participant will be able to understand the process of medical selection of commercial astronauts.

3:15 PM
[062] THE IMPACT OF WEIGHTLESSNESS ON RETINAL FUNCTION AND STURCTURE OF THE TAIL-SUSPENDED RATS

T. Chen, W. Yan, Y. Ma, X. Li, Z. Ren, P. Long and Z. Zhang
The School of aerospace medicine, the Fourth Military Medical University, Xi'an, China

(ORIGINAL RESEARCH)

INTRODUCTION: Spaceflight has been developing from short-term flights to long-term ones, during which the impact of weightlessness on the astronauts' health presents a more imperative problem. However, previous studies focused mostly on the weightlessness-induced changes of the cardiovascular, skeletal, and muscular systems, while studies on the eyes are relatively rare. And the mechanism was not fully illustrated. This study aimed to explore the impact of weightlessness on the retinas of the tail-suspended rats, a commonly used model for simulating weightlessness. **METHODS:** Sprague-Dawley rats were randomly divided into two groups, the tail-suspension group (M, n=12) and the normal control group (N, n=12). Rats of the M group were tail-suspended with 30°degree, while the control rats live ad libitum. After 4 and 8 weeks, all rats (n=6 for each group of each checkpoint) were subjected for examination of the retinal function and morphology. Specifically, electroretinogram (ERG) and visual-evoked potential (VEP) were conducted to assess the retinal function. Optical Coherence Tomography (OCT) and paraffin section were carried out to observe the structure of retinas. **RESULTS:** No obvious changes were found in the retinal function and structure of rats after 4 weeks of tail-suspension. However, surprise appeared when rats were examined after 8 weeks. No significant difference of the body weight existed between both groups of rats, while the weight of soleus muscles of the tail-suspended rats were dramatically reduced compared to the control rats (0.083±0.005 g vs. 0.145 ± 0.017 g). In the 8 weeks M group, the b-wave amplitudes of ERG declined (158.80 ± 23.69 μV vs. 686.60 ± 86.20 μV), and the latency of P1-wave of VEP prolonged (96.67 ± 4.41ms vs. 89.83 ± 4.98 ms). The outer nuclear layer reflected from OCT and retina sections became thinner in the tail-suspended rats (20.32 ± 1.92 μm vs. 35.13±1.02 μm). **DISCUSSION:** 8 weeks of tail suspension caused photoreceptors degeneration on rat retinas, which were a bit different from those found in human. Further illustration of the signal pathways of the weightlessness-induced retinal degeneration of rats might give clues to the protection of human vision in the long-term spaceflight.

Learning Objectives:

1. The participant will be able to predict the impact of microgravity on retinal.

Monday, May 07 ***2:00 PM***
Ballroom B

S-014: PANEL: THE UNITED STATES AIR FORCE COMBINED MISHAP REDUCTION SYSTEM (AFCMRS) – A COMPREHENSIVE REVIEW OF THE AIR FORCE'S PRIMARY SAFETY CULTURE SURVEY

Chair: Samuel Oldham
Albuquerque, NM

Chair: Stephen Stouder
Albuquerque, NM

PANEL OVERVIEW: In the last 10 years, human factors were associated with 83% of all Air Force Class A aviation-related mishaps involving fatality, destroyed aircraft, or over $2 million in damages. The Air Force Safety Center uses human factors trends for proactive mishap prevention programs. AFCMRS is an anonymous, no-cost, web-based operational effectiveness and safety culture survey. It is empirically based, customizable, and organizationally scalable to

maximize applicability to all Air Force work centers. It specifically focuses on how resources, processes, culture and leadership influence organizational effectiveness and safety. This panel includes: 1. A review of AFCMRS program utilization benefits and costs, and its connection to the larger Air Force safety mission; 2. Evaluation of the relationship between participation in AFCMRS and mishap reduction; 3. Observed relationships between commander participation and safety culture; 4. Efforts to enhance AFCMRS interpretation; and 5. Future plans to integrate AFCMRS with the proactive flight safety programs.

[063] U.S. AIR FORCE COMBINED MISHAP REDUCTION SYSTEM

C.R. Pack, T.S. Strongin and B. Musselman
Human Factors Safety Division, U.S. Air Force Safety Center, Albuquerque, NM

(EDUCATION - PROCESS)

MOTIVATION: Previous mishap analysis and research positively correlates resources, processes, culture and leadership to organizational effectiveness and safety culture. **OVERVIEW:** The U.S. Air Force Safety Center employs the Air Force Combined Mishap Reduction System (AFCMRS) to provide commanders proactive actionable resource, process, culture and leadership analysis to positively influence organizational effectiveness and safety. **SIGNIFICANCE:** This presentation outlines AFCMRS structure, program execution, input requirements, product output, and its role in unit organizational culture. Further, attendees will be shown how this anonymous, no-cost, web-based tool can increase operational effectiveness and safety culture by bringing to light positive aspects and areas for improvement within their organization. Additionally, this presentation provides foundation knowledge for the remaining presentations in this panel.

Learning Objectives:

1. The audience will understand how AFCMRS addresses the critical importance of organizational effectiveness and safety.

[064] U.S. AIR FORCE ORGANIZATIONAL SAFETY CULTURE AND MISHAP OCCURRENCE

S. Stouder[1] and E. White[2]
[1]Human Factors Safety Division, U.S. Air Force Safety Center, Albuquerque, NM; [2]Booz Allen Hamilton, Albuquerque, NM

(EDUCATION - PROCESS)

MOTIVATION: The Air Force Combined Mishap Reduction System (AFCMRS) is an anonymous, no-cost, Web-based operational effectiveness safety culture survey. Previous studies demonstrated a high correlation between AFCMRS survey questions and subsequent mishap events. Those pilot studies suggested that AFCMRS is a valid tool to measure organizational safety culture and has a strong correlation with subsequent mishap rates; however, those studies were accomplished with a limited sample size (e.g., specific units with one organizational culture). The present study expanded on this limited research. **OVERVIEW:** AFCMRS is offered in fifteen different surveys, customized with organizational missions and tasks. To date, the survey has been administered over 650,000 times. The survey collects and summarizes Airmen's opinions concerning their units' organizational safety climate (resources, processes, culture and leadership). AFCMRS results are used at every level of command to help commanders improve their understanding of a unit's safety culture and guide their interventions for improvement. In 2015, AFCMRS data for 60 Air Force squadrons were used to predict mishap likelihood for the same squadrons over the following 12 months. In 2016, AFCMRS data for units assigned to one Air Force major command (i.e., one unifying organizational mission across multiple bases) were re-analyzed, revealing high correlation between specific AFCMRS survey questions and subsequent mishap events. The present study examined AFCMRS data across the Air Force (i.e., multiple missions, multiple organizational cultures) using factor analysis to identify clusters of variables which correlate with and may be predictive of mishaps. **SIGNIFICANCE:** Human Factors research continues to provide evidence that organizational culture and leadership contribute significantly to aviation mishaps. Tools such as AFCMRS surveys successfully identify improvement areas across a variety of missions and organizational cultures, and are invaluable to mishap reduction. This study seeks to improve the utility of AFCMRS by demonstrating how AFCMRS accurately measures organizational safety culture across the Air Force, and that survey results correlate with subsequent mishap rates.

Learning Objectives:

1. The participant will be able to identify predictive uses of the Air Force Combined Mishap Reduction System survey.

[065] CULTURE SURVEY: IS ACCEPTING A DEBRIEF A DETERMINANT VARIABLE?

B. Musselman[1], B. Baugh[2] and M. Simpson[3]
[1]Human Factors Safety Division, U.S. Air Force Safety Center, Albuquerque, NM; [2]Embry-Riddle Aeronautical University, Daytona Beach, FL; [3]Textron Systems, Hunt Valley, MD

(EDUCATION - PROCESS)

MOTIVATION: The U.S. Air Force directs its leaders to promote a strong safety culture. In able to do this, leaders need to understand their units' safety culture weaknesses and strengths to establish policies and processes that promote a strong safety culture. The U.S. Air Force provides unit commanders a means to survey their safety culture using the Air Force Combined Mishap Reduction System (AFCMRS), an anonymous, no-cost, web-based safety culture survey. Once the surveys are completed, unit commanders are provided an opportunity to receive a 45-minute debrief highlighting safety culture strengths and areas for improvement, as well as, functionality of the system. **OVERVIEW:** Not all commanders take the opportunity to receive the feedback and not all organizations have a healthy safety culture. The purpose of this study was to investigate if a relationship exists between commanders who elect to receive a debrief and high safety culture survey scores, and if relationship exists between commanders who do not elect to receive a debrief and low safety culture survey scores. **SIGNIFICANCE:** AFCMRS survey results for operations, maintenance and support squadrons who took surveys between October 1, 2014 and September 30, 2017 were assessed. The data was analyzed using correlation statistics. The results aim to identify if unit commanders who seek to understand their safety culture via AFCMRS already have a stronger safety culture than those who do not seek to understand.

Learning Objectives:

1. The audience will know the correlation between commanders who do and don't receive a debrief and safety culture.

[066] DO CERTAIN AIR FORCE COMBINED MISHAP REDUCTION SYSTEM (AFCMRS) QUESTIONS BEST PREDICT OVERALL UNIT SAFETY CULTURE?

H. Tevebaugh[1], E. White[2] and S. Stouder[1]
[1]Human Factors Safety Division, U.S. Air Force Safety Center, Albuquerque, NM; [2]Booz Allen Hamilton, Albuquerque, NM

(EDUCATION - PROCESS)

MOTIVATION: The U.S. Air Force directs its leaders to promote a strong safety culture. In able to do this leaders need to understand their unit's safety culture weaknesses and strengths to establish policies and processes that promote a strong safety culture. The U.S. Air Force provides unit commanders a means to survey their safety culture using the Air Force Combined Mishap Reduction System (AFCMRS), an anonymous, no-cost, web-based safety culture survey. **OVERVIEW:** AFCMRS currently has fifteen surveys available for commanders to assess different aspects of their organizations safety culture. AFCMRS survey results for operations, maintenance and support squadrons who took surveys between October 1, 2014 and September 30, 2017 were assessed. The data was analyzed using a point-biserial correlation, a special case of the Pearson's product-moment correlation. This study investigated whether certain AFCMRS questions best predicted a unit's overall safety culture (overall high or low safety culture). Further, AFCMRS includes four major categories (resources, processes, culture and leadership) and the study examined whether specific categorical questions best predicted the overall category score. **SIGNIFICANCE:** AFCMRS surveys can successfully identify key areas of improvement for commanders to focus their unit's safety culture.

Learning Objectives:
1. The audience will learn the questions that best predict a unit's overall safety culture.
2. The audience will learn the key questions in each category: resources, processes, culture and leadership.

[067] INTEGRATION OF SAFETY CLIMATE SURVEY DATA WITH TECHNOLOGY-ASSISTED PROACTIVE FLIGHT SAFETY PROGRAMS

S. Oldham[1], E. White[2] and S. Stouder[1]
[1]Human Factors Safety Division, U.S. Air Force Safety Center, Albuquerque, NM; [2]Booz Allen Hamilton, Albuquerque, NM

(EDUCATION - PROCESS)

MOTIVATION: Aerospace human factors experts play a key role in retroactively analyzing and proactively predicting the effects of human fallibility in powered flight. By bringing critical understandings human performance to the table, they help optimize human-machine interactions in a fashion that can maximize productivity while reducing exposure to unnecessary risk. This presentation focuses on current efforts at the Air Force Safety Center to bridge the gap between the aeromedical community and pilot/operator community in the proactive flight safety mission. **OVERVIEW:** The Air Force Safety Center currently uses a number of empirically derived, evidence-supported tools to prevent flight-related mishaps. These tools include the Air Force Combined Mishap Reduction System (AFCMRS), Military Flight Operations Quality Assurance (MFOQA), Line Operations Safety Audit (LOSA), and airmen self-reporting of near-miss events (Aviation Safety Action Program, ASAP). All are derived from human factors and ergonomics research, and several were directly adapted after strong success in the commercial aviation industry. Administration and management of these tools are currently divided between the aeromedical (AFCMRS) and pilot/operator (MFOQA, LOSA, ASAP) teams at the Safety Center, with historically limited active integration between their safety assessment systems. This presentation reviews recent efforts to enhance collaboration across these teams. **SIGNIFICANCE:** In the social, political, and economic realities of the 21st Century, the aviation enterprise continues to face increasing service demand being placed upon a relatively static number of increasingly capable airframes. This demands enhanced safety in a manner that optimizes, rather than detracts from, operational resources and realities. The Air Force is not immune to these realities, and only by proactively capitalizing on our human resources to better enhance interdisciplinary safety can air operations continue historic trends of sharply reduced mishaps. This presentation reflects one particular effort and hopefully presents a template by which human factors professionals and pilots/operators can identify new avenues for enhanced cooperation and success.

Learning Objectives:
1. The audience will understand the current Air Force Safety Center collaborative efforts to enhance proactive safety programs.

Monday, May 07 ***2:00 PM***
Topaz

S-015: PANEL: THE IMPORTANCE OF SLEEP FOR HEALTH

Chair: J. Lynn Caldwell
Yellow Springs, OH

Chair: John Caldwell
Key West, FL

PANEL OVERVIEW: Research over the past 2 decades has documented that sleep disturbances exert powerful effects on the risk of infectious disease, the occurrence and progression of major medical illnesses, psychiatric conditions, and all-cause mortality. Thus, it is critical that health care professionals are fully informed on these issues, especially those responsible for safeguarding our operational personnel. This panel will present information about the role of sleep in overall health and chronic disease, the importance of adequate restful sleep in maintaining good mental health, the association between sleep disorders and several serious medical conditions, and the impact of circadian rhythm disruptions on health and wellbeing. It is anticipated that this information will increase the prioritization of sleep in daily life.

[068] THE IMPORTANCE OF SLEEP FOR HEALTH

J. Caldwell[2] and J.A. Caldwell[1]
[1]Military Nutrition, U.S. Army Research Institute of Environmental Medicine, Key West, FL; [2]Aeromedical Directorate, Naval Medical Research Unit Dayton, Yellow Springs, OH

(EDUCATION - TUTORIAL)

MOTIVATION: Sleep deprivation and sleep disruptions have long been concerns for aviation and other operational personnel because of the adverse performance effects they are known to create. However, the importance of sleep for overall health has not received the attention it deserves despite a growing body of research on the link between sleep and general wellbeing. Both the American Academy of Sleep Medicine and the Sleep Research Society have recently noted that sleep is not only important for human performance, but for general health, cardiovascular health, metabolic health, mental health, immunologic health, cancer, pain, and longevity as well. As such an increased focus on the importance of sleep is needed throughout society. **OVERVIEW:** Research over the past 2 decades has documented that sleep disturbances exert powerful effects on the risk of infectious disease, the occurrence and progression of major medical illnesses, psychiatric conditions, and all-cause mortality. Thus, it is critical that health care professionals are fully informed on these issues, especially those responsible for safeguarding our operational personnel. This panel will present information about the role of sleep in overall health and chronic disease, the importance of adequate restful sleep in maintaining good mental health, the association between sleep disorders and several serious medical conditions, and the impact of circadian rhythm disruptions on health and wellbeing. It is anticipated that this information will increase the prioritization of sleep in daily life. **SIGNIFICANCE:** Insufficient and/or disordered sleep jeopardizes the health, wellbeing, and safety of military, space, and other personnel. It is thus crucial for healthcare providers to understand the full importance of high-quality, sufficiently-restful sleep for the long-term physical and mental health of our operational personnel.

Learning Objectives:
1. Understand the importance of high-quality, restful sleep for the long-term physical and mental health of all personnel.

[069] THE IMPORTANCE OF SLEEP FOR LONG-TERM HEALTH AND WELLBEING

J.A. Caldwell[1] and H.R. Lieberman[2]
[1]Military Nutrition, U.S. Army Research Institute of Environmental Medicine, Key West, FL; [2]Military Nutrition, U.S. Army Research Institute of Environmental Medicine, Natick, MA

(EDUCATION - TUTORIAL)

INTRODUCTION: Adequate restful sleep is vital from both a performance and health perspective. However, the importance of sleep is often overlooked. American adults often get less than the recommended 7 hours of sleep per night, and the quality of their sleep frequently is less than optimal. A 2014 National Sleep Foundation survey found that 35% of American adults rated their sleep quality as "poor" or "only fair", 45% reported difficulty falling asleep at least one night per week, and 23% reported trouble staying asleep on five or more nights per week. A growing body of research demonstrates that poor sleep quality and quantity exerts multiple negative effects on long-term health. **METHODS**: A review of select studies on the health consequences of insufficient sleep was conducted. **RESULTS**: Routinely sleeping less than 7 hours per night is associated with adverse health outcomes, including weight gain and obesity, diabetes, hypertension, heart disease and stroke, depression, and increased risk of all-cause mortality. In addition, short sleep duration has been linked to impaired immune function, increased pain, increased inflammation, and dangerous potentially life-threatening impairments of cognitive performance. The precise physiological basis of these sleep-related health effects are not fully understood, but it is clear an increased focus on obtaining sufficient restful sleep is warranted. **DISCUSSION**: Substantial evidence demonstrates the importance of

sleep for optimal health and wellbeing, but work-related pressures, modern technology, and lifestyle choices often result in insufficient or disrupted sleep. Healthcare providers, based on comprehensive, up-to-date information on these matters, can contribute to positive societal attitudes about sleep and help their patients understand the importance of sleep for healthy living. **SUPPORT**: Supported by USAMRMC and DMRDP. The opinions or assertions contained herein are the private views of the author(s) and are not to be construed as official or reflecting the views of the Army or the Department of Defense.

Learning Objectives:

1. Understand the link between inadequate sleep and health problems.

[070] CIRCADIAN RHYTHM DISRUPTION AND HEALTH

H.P. Van Dongen
Sleep and Performance Research Center, Washington State University, Spokane, WA

(EDUCATION - TUTORIAL)

INTRODUCTION: Shift work, irregular schedules, and transmeridian travel, which are increasingly common in the 24/7 society, cause misalignment between sleep/wake cycles and the circadian rhythm of the endogenous biological clock. This circadian rhythm disruption, in interaction with environmental, behavioral and societal factors, poses a threat to health and well-being. Mounting evidence indicates that circadian rhythm disruption and displacement of the sleep/wake cycle have a wide range of adverse consequences for short-term and long-term health. **METHODS:** A review of select studies on the health consequences of shift work and circadian rhythm disruption was conducted. **RESULTS:** Research indicates that circadian rhythm disruption is associated with adverse outcomes in at least four broad domains of health: metabolic health, risk of cancer, cardiovascular health, and mental health. Circadian rhythm disruption affects these domains by inducing sleep loss, sympathovagal and hormonal imbalance, inflammation, impaired glucose metabolism, and dysregulated cell cycles. This leads to a range of medical conditions, many of which are chronic, including obesity, metabolic syndrome, type II diabetes, gastrointestinal dysfunction, compromised immune function, cardiovascular disease, excessive sleepiness, mood and social disorders, and increased risk of cancer. The precise physiological and genetic underpinnings of these circadian rhythm-related health effects have yet to be elucidated. **DISCUSSION:** A substantial amount of evidence points to the importance of proper alignment between endogenous circadian rhythmicity and the timing of the sleep/wake cycle. Professional demands, modern technology, and lifestyle choices often lead to circadian rhythm disruption, misaligned sleep timing, and associated sleep deficiency and sleepiness, as well as degraded health outcomes. Healthcare providers, provided with up-to-date information, can help emphasize the importance of circadian rhythms and appropriate timing of sleep for general health and wellbeing. **SUPPORT:** Supported by CDMRP. The opinions or assertions contained herein are the private views of the author and are not to be construed as official or reflecting the views of the Department of Defense.

Learning Objectives:

1. Understand the link between circadian rhythm disruption and health problems.

2:00 PM

[071] UNDERSTANDING MEANINGFUL RELATIONSHIPS BETWEEN INSUFFICIENT SLEEP AND MENTAL HEALTH STATES

A.J. Brager
Behavioral Biology, Walter Reed Army Institute of Research, Washington, DC

(EDUCATION - TUTORIAL)

INTRODUCTION: Nearly half of Americans are chronically sleep deprived. Despite increased use of technology designed to set sleep goals, polls from the National Sleep Foundation (NSF) and Center for Disease Control (CDC) consistently show a pervasive cycle of compromising sleep over lifestyle choices. These polls also show a pervasive cycle of increased anxiety and depressive-like states linked to the inability to achieve adequate sleep due to lifestyle. Thus, the inability to achieve adequate sleep is thought to create a vicious cycle of increased anxiety- and depressive-like states, which in turn can increase risk for insomnia and anxiety, depressive, and affective disorders. **METHODS:** A review of select studies on the consequences of chronic insufficient sleep on mental health states. Special emphasis is paid to insomnia and anxiety and depressive disorders. **RESULTS:** In general, tasks that examine cognition and the neurobiological study of the brain have determined that chronic insufficient sleep is psychologically and physiologically stressful. Heightened stress responses increase risk for insomnia. Insomnia is a primary (and overlapping) symptom of anxiety disorders, depressive disorders, and psychosis. Typically, more pervasive insomnia is associated with more pervasive mental instability. Neurobiological studies of the brain show areas with overlapping activation (and in some cases deficiency) between insomniacs and those diagnosed with affective illness. **DISCUSSION:** There is a growing body of evidence that the relationship between sleeping problems and the extent of affective illness is causative and not correlative. Although a week of chronic insufficient sleep initially induces a stress response, prolonged insufficient sleep lasting months or years increases risk for anxiety, depressive, and affective disorders. In general, sleeping problems precede the diagnosis of affective illness and affective illness, in turn, exacerbates sleeping problems. Therefore, prioritizing sleep hygiene ought to be a primary goal of individuals with a family history of affective illness and treating sleep problems ought to be a primary objective of psychologists and psychiatrists. **Support:** Military Operational Medicine Research Program, Department of Defense.

Learning Objectives:

1. Chronic insufficient sleep is psychologically and physiologically stressful.
2. Insomnia is a primary (and overlapping) symptom of anxiety disorders, depressive disorders, and psychosis.
3. Prioritizing sleep hygiene ought to be a primary goal of individuals with a family history of affective illness and treating sleep problems ought to be a primary objective of psychologists and psychiatrists.

[072] THE LINK BETWEEN SLEEP DISORDERS AND HEALTH

J. Caldwell
Aeromedical Directorate, Naval Medical Research Unit Dayton, Yellow Springs, OH

(EDUCATION - TUTORIAL)

INTRODUCTION: An estimated 70 million Americans suffer from some type of sleep disorder and as a result, are at increased risk of performance difficulties from excessive daytime sleepiness and a wide array of adverse health consequences. According to the National Academies, the magnitude of the effects of sleep pathology is shocking, and the current health-care system is not sufficiently prepared to address the burden of sleep disorders on society. Enhanced education of health-care professionals has been recommended to facilitate our clinical capacity to address the health problems associated with disordered and insufficient sleep. **METHODS:** A search of the literature regarding the association between sleep disorders and health was conducted. A review of select information was summarized. **RESULTS:** Research shows a link between untreated sleep disorders and adverse health conditions. The most commonly-diagnosed sleep disorder is obstructive sleep apnea (OSA)--a condition which leads to excessive daytime sleepiness and elevated blood pressure, both of which contribute to the development of hypertension and cardiovascular disease. In addition, OSA has been linked to impaired glucose tolerance, increased insulin resistance, and poor appetite regulation, all of which contribute to diabetes and obesity. Another commonly reported sleep disorder, insomnia, has been linked to psychological problems including anxiety and depression. Other less commonly-diagnosed sleep disorders such as narcolepsy and restless leg syndrome appear to be less problematic in terms of long-term health, but there is evidence they are comorbid with psychiatric disorders, central nervous system tumors, and head trauma, among others. **DISCUSSION:** Sleep disorders are thought to lead to long-term health problems and an increased mortality risk. Education regarding the consequences of untreated sleep disorders is needed to bolster health-care providers' efforts to manage the individual and societal problems disrupted and disordered sleep create.

Learning Objectives:

1. Understand the link between untreated sleep disorders' effects on health and well-being.

Monday, May 07 ***2:00 PM***
Sapphire

S-016: SLIDE: AEROMEDICAL STANDARDS

Chair: Heather Langille
Ottawa, Ontario, Canada

Chair: David Salisbury
Ottawa, Ontario, Canada

2:00 PM
[073] PARAGLIDING - WHEN EXTREME SPORTS BECOME AVIATION: IMPROVING SAFETY AND PERFORMANCE IN PARAGLIDER PILOTS
M. Wilkes
Extreme Environments Laboratory, University of Portsmouth, Portsmouth, United Kingdom

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: 127,000 paraglider pilots fly worldwide. Recreational pilots regularly cover distances over 100 km, with a record of 568 km in a single, unpowered, 11-hour flight. The altitude record is 26,400 feet, without supplementary oxygen. A mountain sport has become aviation, but remains largely unexplored by the aviation medicine community. **TOPIC:** Paraglider pilots must overcome turbulence, G forces, cold, hypoxia and the risk of decompression illness; avoid other aircraft and maintain sufficient spatial awareness to move across the landscape searching for lift. It is cognitively demanding and subjectively exhausting. Most paragliding accidents have been attributed to errors of piloting or judgment rather than equipment failure, so pilots must develop a mature understanding of risk and safety behavior to survive its learning curve. Accidents often occur in remote locations and injuries are typically severe: casualty care is usually provided by fellow pilots for some time before trained rescuers arrive. Paragliding evolved from mountaineering and parachuting rather than aviation, so what was once a culture of 'extreme sports' risk-taking must grow into one of aviation safety. The Free Flight Physiology project is a multidisciplinary, international collaboration to improve paraglider pilot safety and performance. In 2016-17, we measured baseline physiology in paragliding flight at moderate altitudes (up to 10,000 ') and extreme altitudes (up to 24,000 ') [pending publication]. We are now beginning a series of experiments directed at supplementary oxygen use in the paragliding environment. We have also sought to raise awareness in the pilot community of the medical and human factors aspects of paragliding through talks, podcasts and magazine articles. Finally, we have developed a two-day course specifically focused on accident prevention and the management of paragliding trauma in the remote environment. **APPLICATIONS:** We will discuss: the scope of paragliding flight; the physical, cognitive and environmental stressors for pilots; extreme sports vs. aviation culture; the challenges of paragliding research and the role of aviation medicine in improving paragliding safety and performance.

Learning Objectives:
1. Understand the development and scope of paragliding flight.
2. Appreciate the physiological, environmental and cognitive stressors of paragliding.
3. Explore the role of aviation medicine in improving paragliding safety and performance.

2:15 PM
[074] ADVANCED NEURO-TECHNOLOGIES & AEROSPACE MEDICINE IMPLICATIONS
M.J. Antunano
Civil Aerospace Medical Institute, Federal Aviation Administration, Edmond, OK

(EDUCATION - PROCESS)

Increasing capabilities of digital electronic devices such as the number of transistors on integrated circuits doubling approximately every two years (Moore's Law), decreased RAM cost, increased RAM size, decreased average microprocessor cost, increased microprocessor clock speed, and increased computing processing power, have had a significant impact on accelerated scientific breakthroughs in medical technologies, including neuro-technologies. The implementation of advanced medical technologies are rapidly changing the scope and complexity of Aerospace Medicine and its impact on aerospace operations, including: 1) Clinical aerospace medicine issues such as health monitoring, disease prevention, medical screening, diagnosis, treatment and rehabilitation of aerospace crews and passengers, 2) Medical safety implications for emergency and elective transportation of patients by air, 3) Medical certification/licensing implications (fitness for flight) for flight personnel, 4) Aerospace human factors considerations, 5) Human-machines-environment interactions, 6) Post-accident/incident investigation factors and analytical tools, etc. This presentation will discuss the practical Aerospace Medicine implications of a variety of neuro-technologies including: transcranial magnetic stimulation, transcranial direct current and alternating current stimulation, implantable brain-computer interfaces, brain-controlled prosthetics, brain-controlled robotic limbs, traumatic brain injury detectors, handheld intracranial hematoma detectors, portable intracranial pressure monitors, neuro-signal acquisition and processing wireless devices, etc. Advanced developments in neuro-technologies have the potential to support the expansion of human aerospace activities while improving operational safety and maximizing human effectiveness and efficiency. However, the relative lack of knowledge and experience with some of these medical technologies make it challenging to approve their use among aerospace crews and other occupants. Additional scientific studies are needed to identify the practical consequences (positive and negative) of using advanced neuro-technologies during human exposure to the stress factors of aerospace flight.

Learning Objectives:
1. Understand the aerospace medicine implications of advanced neuro-technologies.

2:30 PM
[075] RETROSPECTIVE ASSESSMENT OF ANTHROPOMETRIC STANDARDS FOR THE U.S. ARMY INITIAL ROTARY- WING TRAINING PROGRAM
A.N. Moczynski[1], C.A. Weisenbach[1], J.S. McGhee[1] and M. Quattlebaum[2]
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(ORIGINAL RESEARCH)

INTRODUCTION: Proper anthropometric cockpit compatibility with aircraft is paramount to pilot performance and safety. Currently, the U.S. Army uses total arm span (TAS), sitting height (SH), and leg length (LL) to determine cockpit fit. If an applicant's measurements fall outside of regulator standards, they may elect to demonstrate to a senior instructor pilot (SIP) that they can fit in Army helicopters. If the SIP agrees that the applicant can actuate the switches and controls, the applicant is considered anthropometrically acceptable and a waiver may be granted. The waiver process is expensive and often discourages applicants from perusing a waiver. The goal of the current study is to characterize the applicant pool over a ten-year period to determine the viability of the current anthropometric requirements. **METHODS:** Anthropometric measurement and waiver information pertaining to anthropometry were collected for all individuals who applied for flight school between 1 JAN 2005 and 31 DEC 2014 using the Aeromedical Electronic Resource Office (AERO). **RESULTS:** There were 42,799 individuals in this cohort, not including individuals with incomplete data sets, of which 815 failed to meet regulator anthropometric standards. Of these 815 first-cut failures, 437 attempted to obtain a waiver and undergo SIP evaluation. An insufficient TAS was found in 80.3% of these applicants, while an insufficient SH and LL was found in 4.6% and 28.6% of applicants, respectively. Of the 437 who underwent secondary evaluation, 423 (96.8%) successfully passed SIP evaluation and obtained a waiver to enter flight training. **DISCUSSION:** This study accurately characterizes the anthropometry of a large cohort of applicants to the U.S. Army flight training program. The presently used cut-off points result in 815 applicants being initially rejected ostensibly for failing to fit in Army

aircraft. Of those initially rejected, the vast majority of those rejected would be found acceptable for aviation service by an SIP's evaluation. We assume that the ability of the SIPs to judge anthropometric compatibility constitutes a gold standard. Bringing the published anthropometric standards into closer alignment with the measurements of applicants approved by SIPs would broaden the applicant pool and decrease the significant costs of the waiver process.

Learning Objectives:

1. Understand the current method of determining anthropometric cockpit compatibility in initial Army rotary wing training program applicants and which anthropometric standards cause the greatest number of applicants to fail regulatory standards.

2:45 PM

[076] TECHNOLOGY, DEMOGRAPHY AND PUBLIC ASPIRATIONS DRIVE THE NEED TO REFINE 'THE 1% RULE'

S. Sharma, A.M. Drane, P. Clem and M. Seah
Civil Aviation Safety Authority, Phillip, Australia

(EDUCATION - PROCESS)

BACKGROUND: Life expectancy in Australia has risen to 80 for males and 84 for females. Survival rates for non-communicable diseases and malignancies have improved. And many Australians do not retire. Such demographic shift is evident with an increasing number of older pilots maintaining their commercial and private medical certificates well into their 70s and 80s, respectively. Technology drives the development of efficient and safer aircraft and focus attention upon the "human factor". **METHODOLOGY:** Recognising medical incapacitation as one factor in the system of aviation safety, this paper highlights some contributory risks. These include the demographic changes in the Australian population and recent advances in the management of major diseases. Prevalent aviation activities across the continent have been factored in. Operational factors, including aircraft endurance and system redundancy, are considered. Deliberating upon these factors, the aviation community needs to update the historic assumptions and modernize the current approach to risk assessment. **DISCUSSION:** The 1% rule was first propagated for an acceptable risk of major adverse cardiac event in two-pilot commercial operations. This has been adapted by ICAO as a useful framework for medical assessment. Nevertheless, while underlying assumptions have changed over the last 20 years, implementation has been questioned by experts with little change in the way it continues to be applied. There is a perception that this stance is out of sync with modern operations in efficient machines, resulting in a clamor for its revision. A structured approach to aeromedical risk assessment is now based on ISO31000. The medical, technical and legal considerations drive CASA to address the existing approach to risk assessment. Furthermore, growing public aspirations require that regulators are seen to be in touch and open to new approaches to aviation safety. This paper submits that an update of the underlying assumptions in development of aeromedical risk tolerance is needed.

Learning Objectives:

1. Deliberate upon the technological and demographic changes to update the current approach to aeromedical risk assessment.

3:00 PM

[077] PREVALENCE AND DISTRIBUTION OF DENTAL AMALGAM AND COMPOSITE RESTORATIVES IN GERMAN AIR FORCE COMBAT PILOTS

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(ORIGINAL RESEARCH)

INTRODUCTION: Despite the extensive use of amalgam in former, and the increasing use of composites in modern dentistry, little is known about the resistance of such materials in high-performance aircraft pilots. Considering the potential effects of altitude-, pressure-, acceleration- and stress-related physiological demands in-flight, a differential effect on different dental materials could be hypothesized. In this pilot study, the prevalence and distribution of dental amalgam and composite fillings in a representative cohort of German Air Force combat pilots was investigated. **METHODS:** Latest dental database entries of n=457 fighter-jet pilots were retrospectively extracted and stratified according age, flight hours, and dental amalgam vs. composite materials, respectively. Data were statistically compared to the respective entries of helicopter (n=1,011) and fixed wing (n=478) aircraft pilots, as well as to those of non-flying ground crew (n=1,510) personnel. No distinction was made between different individual composite materials. **RESULTS:** Database query revealed a total of 2791 inlays in fighter-jet pilots, relating to a mean of 5.7 inlays per pilot, as compared to 6.9 or 6.3 inlays in helicopter or fixed wing aircraft pilots, and 5.5 inlays in non-flying personnel. Composite materials were represented considerably more frequently than amalgam (64 vs. 36% of all inlays in jet pilots), with no significant difference between all aviators (67 vs. 33%) and non-aviators (69 vs. 31%). While average numbers of amalgam increased dependent on age in all groups from ≤1.5 in younger pilots to ≥2.8 in older pilots, numbers of composites remained stable in the range of 4.5±0.3 per pilot, indicating environmental stability at least equal to composite materials. Regression analysis did not reveal any correlation between the total of hours flown and the numbers of amalgam or composites applied to the pilot. **DISCUSSION:** In this cross-sectional study, no evidence was found towards any effect of environmental changes on the retentive strength of dental amalgam or composite restoratives in high-performance or other aircraft pilots. We conclude that with regard to longevity and fracture resistance, both materials appear to be suitable for use in aviation dentistry.

Learning Objectives:

1. The participant will learn to differentiate between filling materials available in aviation dentistry and their specific profiles with regard to longevity and fracture resistance.
2. The participant will learn about the average amount and oral distribution of amalgam and composite fillings in military aircraft pilots.

3:15 PM

[078] OCCUPATIONAL GENETICS - GUIDELINES AND CODES OF PRACTICE

J. Saary[1,2]
[1]*Occupational Medicine, University of Toronto, Toronto, ON, Canada;* [2]*Canadian Forces Environmental Medicine Establishment, Toronto, ON. Canada*

(EDUCATION - PROCESS)

MOTIVATION: Like many areas of medicine in this era, our understanding of human genetics is rapidly evolving. It took over a decade and cost billions of dollars to sequence the first human genome, and can now be done for less than $1000 in less than a week. Concern among health care providers and employers about limitations of use of genetic information has been increasing as genetic testing becomes more widely available, particularly with the explosion of readily available direct-to-consumer testing options. **OVERVIEW:** Biomarkers of, and chromosomal aberrations resulting from, occupational exposures have been known for decades. As a result, in the field of Occupational Medicine much deliberate consideration has already been given to emergent issues related to genetic testing. A compilation of this information is directly relevant to other fields of medicine. This presentation aims to translate knowledge about the implications of genetic testing by describing a range of international codes of practice and criteria for testing. It will also discuss genetics in the context of occupational exposure limits (OELs) and the duty to protect, as well as the application of group testing compared to individual testing for selection standards. It will outline some contrary perspectives and elaborate why risk aversion is itself a risk. **SIGNIFICANCE:** The concepts in this presentation complement other translational work such as the Bellagio II Summit. Having awareness of available guidelines and perspectives enables a more educated perspective and more insightful consideration of key issues prior to program development.

Learning Objectives:

1. Identify several exposures and conditions which have been associated with genetic / chromosomal changes.
2. Evaluate implications for genetic screening and surveillance.
3. Predict the consequences of risk aversion for genetically-based risk assessment.

Monday, May 07 ***2:00 PM***
Ballroom A

S-017: SLIDE: AVIATION HAZARDS AND ACCIDENT STUDIES

Chair: Douglas Boyd
Houston, TX

Chair: Jochen Hinkelbein
Cologne, Germany

2:00 PM
[079] APPLICATION OF EPIGENETIC TYPING IN AIRCRAFT ACCIDENT INVESTIGATION
M.J. Schwerer[1] and M. Graw[2]
[1]Aircraft Accident Investigation, German Air Force Centre of Aerospace Medicine, Fuerstenfeldbruck, Germany; [2]Forensic Medicine, Ludwig-Maximilians-University, Munich, Germany

(ORIGINAL RESEARCH)

INTRODUCTION: To clarify the identities of unknown victims from aircraft accidents is one of the most challenging tasks in mishap investigation. Visual comparison between the decedents and pictures in missing-persons lists can be impossible as a result of severe destruction of the bodies. To shed light on the phenotype of unknown persons, epigenetic testing has recently been introduced in forensic medicine. Applying DNA-based techniques, an unknown person's age, hair and eye color, ancestry, or even life style habits can be reconstructed. Present laboratory techniques for this are standardized for material from living persons. Proceedings for samples from dead persons are up to now poorly available. **METHODS:** DNA obtained from blood and organ samples from a study group comprising 50 decedents was investigated. Molecular pathology involved real-time-PCR and pyrosequencing techniques subsequent to bisulfite conversion. Epigenetic markers published to be reliably informative in samples from living persons were selected for our evaluation of post-mortal specimens. Standard curves were provided from the previous evaluation of the epigenetic profile in a control group of 100 corpses. **RESULTS:** Body specimens including blood and tissues rich for lymphocytes were shown to be applicable for epigenetic typing. The accuracy of the results decreased with the quality of DNA obtained from a sample as shown by the assessment of DNA degradation. Especially bodies with severe decomposition, from submersion in water or from fire events showed limited accuracy. However, orienting results were still obtained even in such cases. **DISCUSSION:** Epigenetic testing on body material is a reliable tool in the investigation of aircraft accidents involving unknown victims, for example on the ground or from emergency evacuation flights without previous documentation of the passenger's identities. Phenotypic characteristics of these victims including their biological age can be reconstructed. Hence, even decedents with severe destruction can be subject to a comparison with pictures or descriptions in missing-persons lists. Thereby, the analysis of samples from blood relatives for a final genetic identification can be confined to a minimum.

Learning Objectives:
1. Understand the difference between *epigenetic* typing, which provides information on a person's appearance, biological age, etc. and *genetic* identification of an accident victim.
2. Know the advantages of epigenetic typing in forensic casework and accident investigation, especially that no samples from blood relatives are necessary to clarify an unknown person's phenotype.
3. Formulate proceedings for the own working environment how epigenetic typing can be integrated e.g. in an agency's emergency plan for aircraft accidents.

2:15 PM
[080] INCORPORATING ADVANCED FORENSIC PATHOLOGY TECHNIQUES IN FATAL AIRCAFT MISHAP INVESTIGATIONS
E. Mazuchowski[1,2]
[1]San Antonio Military Medical Center, San Antonio, TX; [2]Armed Forces Medical Examiner System, Dover AFB, DE

(EDUCATION - PROCESS)

MOTIVATION: Aerospace medical professionals are often required to participate in fatal aircraft mishap investigations. In order to accurately inform the investigation board, the aerospace medical professional must be able to incorporate the findings of the forensic pathology investigation of the deceased individual(s) into the overall mishap investigation. It is important for the aerospace medical professionals to understand some of the advanced forensic pathology techniques that are currently being utilized. **OVERVIEW:** Since 1st Lieutenant Thomas Selfridge's fatal mishap over a century ago, the goals of a fatal aircraft mishap investigation have remained the same: identify the individual(s) involved; determine the injuries sustained and cause of death; determine what caused the mishap to occur; and make recommendations for the prevention of future mishaps and deaths. The forensic pathology investigation is a critical part of the overall mishap investigation as it determines the identification of the decedent, the injuries sustained, and the cause of death and manner of death. Advanced techniques in fingerprint analysis, dental analysis, and DNA analysis have allowed for the rapid determination of the identification of the deceased individual especially when there is fragmentation of the body. In addition, DNA analysis, in conjunction with histologic examination, has been used to determine whether or not and what type of biological tissue may present on certain aircraft structures. Advances in forensic radiology imaging, such as the utilization of post-mortem computed tomography, have enhanced the ability to accurately document the injuries sustained including pneumothoraces and subtle fractures of the axial skeleton. This complete and accurate depiction of the injuries sustained is necessary to determine how the forces may have acted on the body during the mishap sequence. Advances in computer graphics and software have allowed for the visual depiction of the injuries sustained that can be incorporated into the overall mishap investigation report. **SIGNIFICANCE:** In order accurately incorporate the findings of the forensic pathology investigation into the overall mishap investigation; the aerospace medical profession must understand the advanced forensic pathology techniques that are currently available.

Learning Objectives:
1. Understand the goals of the forensic pathology investigation.
2. Understand the advanced techniques utilized in forensic pathology.
3. Understand how advanced radiologic techniques can be used to depict subtle injuries.

2:30 PM
[081] IN-FLIGHT DECISION-MAKING BY GENERAL AVIATION PILOTS OPERATING IN AREAS OF EXTREME THUNDERSTORMS
D. Boyd
University of Texas, Houston, TX

(ORIGINAL RESEARCH)

INTRODUCTION: General aviation accounts for 94% of civil aviation fatalities in the USA. Although thunderstorms are hazardous to light aircraft, little research has been undertaken on in-flight pilot decision-making regarding their avoidance. The study objectives were: (i) determine if the thunderstorm accident rate has declined over the last two decades (ii) assess in-flight (en route/landing) airman decision-making regarding adherence to FAA separation minima from thunderstorms. **METHODS:** Thunderstorm-related accidents were identified from the NTSB database. To determine aircraft-thunderstorm proximity/relative position, airplane location (determined using a flight-tracking -Flight Aware® website), was overlaid on a graphical weather image. Statistics employed Poisson and Chi-Square analyses. **RESULTS:** The thunderstorm-related accident rate was undiminished over the 1996-2014 period with 70% having a fatal outcome. In a prospective analysis, the majority (en route 77%, landing 93%) of flights violated the FAA-recommended separation distance from extreme convection. Of these, 79 and 69% (en route and landing respectively) selected a route downwind of the thunderstorm rather than a less hazardous upwind flight path. Using a mathematical product of binary (hazard zone infringement, relative aircraft-thunderstorm position) and nominal (thunderstorm-free egress area) parameters, airmen were more likely to operate in the thunderstorm hazard zone for landings than en route operations. **CONCLUSION:** The thunderstorm-related accident rate, of which 70% are fatal, remains

unabated largely reflecting non-adherence to the FAA-recommended separation minima and selecting a more hazardous route (downwind) for circumnavigation of extreme convective weather. These findings argue for additional emphasis in *ab initio* pilot training/recurrency on thunderstorm hazards and safe practices (separation distance and flight path).

Learning Objectives:

1. Participants will learn the that general aviation accidents related to extreme convection carry a threefold higher fatality rate than mishaps not due to thunderstorms.
2. Attendees will learn that the unabated thunderstorm-related general aviation accidents reflects non-adherence to FAA recommendations specifying aircraft-thunderstorm separation minima and relative location.

2:45 PM
[082] INTERRATER RELIABILITY OF DOD HFACS 7.0

J.J. Condino and J. Hunt
U.S. Navy, Pensacola, FL

(ORIGINAL RESEARCH)

INTRODUCTION: DoD HFACS 7.0 are used to classify causal factors during U.S. Naval Aviation Mishap Investigations. Because of this it is important that the classification can be used accurately and consistently across Aviation Mishap Boards (AMB). The objective of this study was to evaluate the interrater reliability of the updated DoD HFACS 7.0 as used in the training environment by Aviation Safety Officer (ASO) students at the U.S. Naval School of Aviation Safety. **METHODS:** Subjects are over 200 students at the ASO course, where they received 28 hours of human factors training. Students are divided into simulated AMB groups, and they then analyze a Naval aviation mishap and create safety investigation reports (SIRs) using DoD HFACS 7.0 to code the causal factors of the mishap. 19 rotary wing and 19 fixed wing tactical air SIRs were collected and the causal codes analyzed for reliability using the multi-rater kappa free Kfree analysis. **RESULTS:** When analyzing all the codes (causal and not causal), Kfree was 0.73 with 95% CI [0.67, 0.80] and 0.68 with 95% CI [0.61, 0.75] (substantial agreement) for the rotary wing and fixed wing respectively. However, when only looking at the causal codes, Kfree was much lower at 0.42 with 95% CI [0.34, 0.50] and 0.40 with 95% CI [0.32, 0.48] for the rotary wing and fixed wing. **DISCUSSION:** These results were similar to previous work on the first version of DoD HFACS, which also found that overall Kfree was acceptable when including codes that were not causal to the mishap. When only looking at selected codes, agreement is much lower. Every subject in this study had formal training in DoD HFACS 7.0, and in the real world an AMB will likely only have one or two trained members. DoD HFACS 7.0 is able to achieve substantial agreement overall, however that is largely due to the high agreement on codes that are not causal to the mishap. More effort is required to make the DoD HFACS 7.0 more reliable in Naval Aviation.

Learning Objectives:

1. Discover the interrater reliability of DoD HFACS 7.0 during simulated Aviation Mishap Boards at the U.S. School of Aviation Safety.
2. Generate a discussion of what the results mean, and implications for the future role and processes of DoD HFACS 7.0 in Aviation Mishap Boards.

3:00 PM
[083] A REVIEW OF AEROSPACE MEDICINE RELATED AVIATION SAFETY OCCURENES OVER A 12 MONTH PERIOD

B. Posselt and K. Brunton
Royal Air Force, Bedfordshire, United Kingdom

(ORIGINAL RESEARCH)

INTRODUCTION: The UK Ministry of Defence has an aviation safety reporting system in place across all three Services. Individuals involved with any aspect of aviation who identify a flight safety concern are encouraged to submit a Defence Aviation Safety Occurrence Report (DASOR) through the electronic Air Safety Incident Management System (ASIMS). DASORs are then investigated and reviewed by suitably qualified and experienced personnel to try and prevent re-occurrence or progression into more significant issues. The aim of this study was to analyze aerospace medicine related DASORs to identify current and emerging trends that have flight safety implications. **METHODS:** On a monthly basis, all DASORs are scrutinized to assess for aerospace medicine relevance. All DASORs reported from September 2016 to August 2017 were reviewed manually. Specific search terms were not used because this would have overlooked some reports as a result of their varied written descriptive content. **RESULTS:** A total of 12,710 DASORs were reviewed of which 975 (7.69%) were deemed to be of aerospace medical significance. These aerospace medicine incidents were divided into categories: Aircrew Equipment Assembly (AEA) related (49%), physiological (26.9%), as a result of human factors (11.4%), related to fatigue (4.9%), or miscellaneous (6.9%). The commonest individual themes, occurring consistently throughout the year were laser incidents (7.7%) and smoke or fumes in the cockpit (11.4%). **DISCUSSION:** The majority of aerospace medicine related DASORs pertained to AEA and their integration. Other example cases range from more serious reports of laser incidents to the seemingly benign issue of poor accommodation and inadequate in-flight meals. Each report enables recommendations to be made to the appropriate duty holder or project team and provide an evidence base to feed into larger investigations. In addition, DASORs can influence procurement, equipment modifications, policy and training. The ASIM system, with DASORs, provides a clear mechanism for reporting all flight safety incidents and hazards, with monthly and yearly reviews of aerospace medicine related reports enabling current issues and emerging trends to be identified.

Learning Objectives:

1. The audience will learn about the reporting system used by the UK MoD and the recent trends in flight safety occurrences.

3:15 PM
[084] AVIATION-RELATED NON-FATAL INJURIES AND ILLNESSES BASED ON WORKERS' COMPENSATION CLAIMS, ALASKA 2014-2015

K.M. Moller[2], J.R. Watson[2] and M.B. O'Connor[1]
[1]National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Anchorage, AK; [2]National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention, Spokane, WA

(ORIGINAL RESEARCH)

INTRODUCTION: Commercial aviation in Alaska is unique in that many of the operations take place in remote locations under extreme weather conditions. These locations frequently have a limited number of employees performing multiple tasks and have limited infrastructure, which requires tasks such as baggage handling to be performed manually. Epidemiologic studies using workers' compensation data to examine the types and causes of non-fatal injuries and illnesses among Alaskan aviation workers have not previously been performed. **METHODS:** Workers' compensation injury and illness claims for 2014–2015 were obtained from the State of Alaska Department of Labor and Workforce Development. Aviation-related claims were identified using keyword searches of the narrative field, aviation-specific North American Industrial Classification System (NAICS) codes (e.g. NAICS code 481*, 611512), and NAICS codes of industries likely to occur in an aviation setting. Potential claims were manually reviewed to determine if aviation related. Injury description codes using Workers Compensation Insurance Organizations' system for part of body, cause of injury, and nature of injury were provided in the claims data. Occupational groups were coded from the free-text occupation description variable. **RESULTS:** There were 704 aviation-related injury and illness claims during 2014–2015. Scheduled passenger air transportation [NAICS code 481111] accounted for 72.4% of all claims followed by scheduled freight air transportation [NAICS code 481112] (11.8%). Ramp agents incurred the most injuries (35.2%). The lower back was the most commonly injured body part (16.2%) and was one of the top three most frequently injured body parts among pilots, mechanics, flight attendants, and ramp agents. Among all workers, lifting, pushing, or pulling (26.1%) was most often cited as the cause of injury, followed by falling, slipping, or tripping (18.5%). **DISCUSSION:** Many occupational groups shared similar injury profiles, possibly due to the workers performing overlapping tasks. Future coding of claims using the

Standard Occupational Classification (SOC) System will allow for injury rate calculations to better identify and characterize high-risk occupational groups. In-depth analyses of injury rates, types, and circumstances can inform the development of injury prevention interventions specific to occupational groups or tasks.

Learning Objectives:

1. Analyze injuries and illnesses of aviation-related workers in Alaska.

Monday, May 07 ***2:00 PM***
Senators

S-018: PANEL: ADVANCED AEROSPACE MEDICINE FOR INTERNATIONAL MEDICAL OFFICERS (AAMIMOS) AEROMEDICAL CLINICAL CASE PRESENTATIONS

Chair: Thomas Clarke
Wright-Patterson AFB, OH

Chair: Jeffrey Lawson
Wright-Patterson AFB, OH

PANEL OVERVIEW: The Advanced Aerospace Medicine for International Medical Officers (AAMIMO) course is an intensive six (6) month long curriculum taught at the USAF School of Aerospace Medicine (USAFSAM), Wright-Patterson AFB, OH. As part of this course, flight surgeons from around the globe select aeromedical cases for presentation from their respective country's Air Force experience or cases of interest from the USAFSAM Aeromedical Consultation Service (ACS). Cases are selected for presentation based upon clinical learning interests of the student and the topical currency of the diagnosis. Each case presentation will include a PowerPoint presentation with an introduction, case report, discussion and aeromedical disposition implications for their respective countries, the U.S. Department of Defense and the Federal Aviation Administration. Following a brief conclusion, limited questions are allowed for each presenter by the panel chair(s).

Monday, May 07 ***4:00 PM***
Ballroom D

S-019: PANEL: CHANGING THE PARADIGM ON FIGHTER PILOT NECK PAIN: EPIDEMIOLOGY, MISSION IMPACT, PREVENTION, AND REHABILITATION

Chair: Odd-Ivar Lundseng
Buckeye, AZ

Chair: Ryan McHugh
Luke AFB, AZ

PANEL OVERVIEW: Fighter Pilots experience higher than average rates of neck and back pain due to the ergonomics of their aircraft and the physiology of high-G missions. Physiologic insults lead to acute muscle injury, which when improperly addressed and repeated over time, develop into chronic pain, degeneration, and disability. This pattern has been well established in both objective and subjective studies. The incidence and prevalence are at pandemic levels in high performance aviation, yet until recently there has been little coordinated effort to establish a validated best practice solution for preventing and treating this disabling occupationally induced disease. Current medical primary care best practices for the treatment of acute musculoskeletal injury do not appropriately treat the issue nor do they prevent sequelae of disease. Recognizing that the physiology and pathology of occupations are not all created equal, providers for high performance aviators must lead a healthcare paradigm shift that decreases the physical and psychological barriers to medical care, improves timely care and bolsters the connection between the fighter flying mission and the medical system that cares for it. Using original data the panel will: (1) present the anatomy, physiology and pathophysiology involved in fighter pilot neck pain; (2) discuss incidence, prevalence, and demographics of fighter pilot neck pain in U.S. aviators across multiple aircraft platforms; (3) explore differences in cockpit ergonomics and pilot flight equipment that contribute to neck and back pathology during flight; (4) demonstrate the mission impact of neck and back pain including decreased ability to execute the full envelope of the aircraft, decreased ability to use all available tactics and decreased durability/longevity of pilots; (5) discuss established best practices for pain management and best rated treatments by high performance aviators; (6) present best practice solutions for effectively preventing and treating fighter pilot neck and back pain; and finally (7) expound real world solutions, pitfalls and execution game-plans for implementing best practices at different air bases.

[085] EPIDEMIOLOGIC ASSESSMENT OF NECK PAIN IN U.S. AIR FORCE FIGHTER PILOTS

R.S. Mayes[2], A. Turner[2], B. Clap[3], B.H. Reed[3] and E. Ennis[1]
[1]FHS, USAFSAM, Wright-Patterson AFB, OH; [2]USAFSAM, Wright-Patterson AFB, OH; [3]OCS, USAFSAM, Wright-Patterson AFB, OH

(ORIGINAL RESEARCH)

INTRODUCTION: Fighter pilots flying currently fielded high performance aircraft experience a litany of physiologic stressors during flight. These unique stressors including neck pain contribute to a unique set of physiological problems. **METHODS:** The U.S. Air Force (USAF) School of Aerospace Medicine (USAFSAM) is conducting a number of intra- and extramural research projects focusing on the epidemiology, etiology, and potential therapeutic practices available for neck and back pain in aviators. This presentation is intended to provide a snapshot of the impact neck pain has on fighter pilots with substantial responses from a questionnaire developed by USAFSAM distributed to significant number of pilots across the Combat Air Forces. **RESULTS:** 68.9 % of the respondents reported experiencing neck pain due to flying. One-third (63%) reported suffering neck pain during sorties in the previous 90 days. Neck pain adversely affected the mission for 78.3% of respondents. Even though 14.3% have been placed on duties not to include flying due to neck pain, 26.8% of the respondents reported that they removed themselves from the flight rotation due to neck pain. Of all respondents, 42.6% reporting knowing other pilots who were receiving medical and therapeutic treatment outside of USAF medical services. **DISCUSSION:** The increased interest in neck and back pain expressed by Air Force leadership and from flight crew shows a need for deeper investigation into this topic and requires a systematic approach. These data were collected to understand the basic epidemiology and operational impact for high-performance aircrew and to collect data on solutions that pilots are utilizing; these data may help to quickly identify what therapies are most effective. The data demonstrate that pilots experience a substantial amount of neck pain and suggest that the high G-force environment, burden from aircrew flight equipment, and the physical demands of flight all play a role.

Learning Objectives:

1. Describe the prevalence of neck pain in the sampled community within Combat Air Forces and identify treatment modalities that have been perceived as effective within the pilot community.

[086] 5TH GENERATION SPECIFIC FIGHTER NECK PAIN CONCERNS: ERGONOMICS AND MISSION IMPACT

M.H. Lindsey[1], B. Anderson[2], A. Turner[3] and J. Kaiser[4]
[1]19th Fighter Squadron, 15th Medical Group, Honolulu, HI; [2]Luke AFB, AZ; [3]USAFSAM, Wright-Patterson AFB, OH; [4]Wright-Patterson AFB, OH

(ORIGINAL RESEARCH)

INTRODUCTION: High performance aviators have a higher incidence of neck pathology, both subjective and objective, than comparable cohorts. There are many different possible causes for this

including the physiology of high performance missions, aircrew flight equipment, cockpit ergonomics, and mission specific movements. Additionally, there has been little insight into how much direct impact on mission completion neck pain has caused. We seek to delineate the cockpit specific issues that lead to neck pain as well as quantify the direct impact on mission completion. **METHODS:** A retrospective questionnaire was distributed to 4th and 5th generation fighter pilots. The questionnaire quantified mission specific decrement due to neck pain. Also, an extensive literature review was performed to categorize and catalog neck strain factors among high performance military aviators. Furthermore, a comparative analysis was performed which characterized differences in helmet type, visual accessory location, visual field impedance, differences in cockpit size and layout. Lastly, a representative pilot from each different airframe demonstrated typical movements within each cockpit and an analysis of body positions was made. **RESULTS:** 83 pilots responded at the time of this writing from 3 airframes (F-16, F-22, and F-35) were analyzed. 94% reported neck pain worsened by flying and 69% reported neck pain within the last 90 days. There was not statistical differences between the airframes. 52% reported pain to the medical provider. Neck and back pain was not statistically different with age. 89% reported significant impact on the mission due to neck pain with 63% reporting severe impact. The most significant impacts were 1) restricted movements under Gz; 2) difficulty with high Gz missions; 3) more difficult BFM; 4) difficulty with check-6 maneuver; 5) more conservative tactics. Significant environmental differences include 1) helmet type; 2) seat recline angle; 3) visual fields; 4) cockpit space 5) check-6 movements. Common features include 1) frontal offset flight equipment; 2) high Gz environment. **DISCUSSION:** Fighter pilot neck pain is an epidemic occupational hazard that produces significant mission impact. Pilots are unable to fly the full envelope of the airplane and use all available tactics while in pain resulting in mission decrement. Despite differences in ergonomics, the common end point is compromised muscle positions while performing high Gz maneuvers.

Learning Objectives:

1. Understand the different movements created within the cockpit of legacy and 5th generation aircraft and how each one promotes neck and back pain.
2. Characterize the impact of fighter pilot neck pain on USAF mission completion including fighter tactics, aircraft envelope, and pilot longevity.

[087] THE HUMAN PERFORMANCE TEAM: A PARADIGM SHIFT IN FIGHTING PILOT NECK AND BACK PAIN

B. Anderson
Luke AFB, AZ

(EDUCATION - PROCESS)

INTRODUCTION: The modern state of aviation medicine has yet to scientifically validate a reproducible solution for high performance aviator neck and back pain. For nearly five decades military pilots have been flying aircraft capable of sustaining up to 9-Gz, often without sufficient ergonomic support within the cockpit or adequate prevention and treatment strategies outside of the cockpit to prevent acute muscle injury. The Human Performance Team (HPT) endeavors to maximize the mental and physical readiness of human airpower. To that end, they have designed a concept that greatly prevents acute neck and back injuries in addition to treating these acute injuries in a manner that allows aviators to max perform their aircraft on a daily basis in addition to preventing chronic sequelae of acute soft tissue injuries. This talk will provide insight into how modern air forces can change the paradigm of medical management for high performance aviators, with a focus on prevention and timely rehabilitation of acute injuries. **METHODS:** Analysis of the current aerospace medicine literature and that from several different medical disciplines that support the high-performance athlete model provided a template for skilled soft tissue manipulation and quick evaluation of acute injuries to prevent chronicity and further degeneration of the surrounding tissues. In addition, when acute injuries are sustained, rapid evaluation and treatment by trained providers (e.g. athletic trainers, physical therapists, etc.) allows often immediate return to unencumbered high-performance flight. **RESULTS:** Data from previous studies discussed during this panel validate the need for a shift in the medical care paradigm for high performance aviators; hence, the HPT. The results of the HPT concept have yet to be scientifically measured, but deserve significant consideration for future research ventures within the high-performance aviation medicine (HPAM) community. **DISCUSSION:** It is clear that the HPAM community is in need of a solution for neck and back pain and degeneration in high performance aviators. This panel has clarified the incidence and prevalence of this disease and this talk presents novel ways to decrease aviation induced neck and back pain via employing a medical team that approaches the aviator, rather than waiting for the aviator to approach the medical team.

Learning Objectives:

1. The current paradigm for delivering medical care for high performance aviation neck and back pain prevents timely care of injuries, leading to chronic sequelae and decreased operational capability.
2. The high performance athlete industry capitalizes on pre-hab and immediate rehab of injuries, allowing athletes to perform at high levels day after day.
3. Adopting a high performance athlete view of the high performance aviator population provides immediate care to acute needs, preventing chronic sequelae and decreased operational capability.

[088] PILOT QUESTIONNAIRE TO CHARACTERIZE NECK PAIN RELATED TO FORWARD HELMET CENTER OF GRAVITY (U.S. AIR NATIONAL GUARD)

A. Turner[2], R.S. Mayes[2], M. Cowgill[2], B. Clapp[2], E. Ennis[1] and M.E. Martinez[2]
[1]FHCF, AFRL-USAFSAM, Wright-Patterson AFB, OH; [2]USAFSAM, Wright-Patterson AFB, OH

(ORIGINAL RESEARCH)

INTRODUCTION: Neck pain in the fighter pilot community has been documented for over 30 yr. High +Gz maneuvers and awkward head and neck positions combined with large helmet weights and helmet modifications that displace the center of gravity all contribute to a high risk of fatigue, pain, and injury in the population. The overall goal of this effort is to characterize neck injury, collect prevention and treatment methods used, and assess effectiveness of these methods on preventing, reducing, and eliminating neck pain within the Air National Guard (ANG) fighter pilot community. **METHODS:** A questionnaire will be developed and administered to several ANG fighter pilot squadrons to collect data in the following five areas: 1) pilot information such as physical characteristics, age, rank, flying experience, etc.; 2) approved preventative activities performed prior to flying, such as stretching, exercise, and the perceived effectiveness of those activities; 3) neck pain history, including reported and unreported incidents, duration, severity, location, type, etc.; 4) flight-incurred or flight-related injury, its effect on performance, and possible causes/trends of neck pain; and 5) corrective actions taken, both standard and non-standard, and impact on completion of mission. The target populations are the ANG fighter pilot communities. **RESULTS:** Ninety four percent of the respondents reported neck pain in the past 90 days of completing the questionnaire, and 100% reported increased difficulty in performing within the jet due to neck pain. While 28% reported being on duties not to include flying, 59% reported removing themselves from the flight schedule due to neck pain. Respondents reported 78% knew other pilots who were receiving medical and therapeutic treatment outside of the U.S. Air Force (USAF) medical services. **DISCUSSION:** By collecting information on current preventative measures and the associated efficacy, possible prophylactic treatments or engineering solutions may be revealed that could change guidelines for pilot training and injury prevention. If a positive correlation exists between programs being implemented and funded solely by these different squadrons, it could lead to USAF-wide change that could make programs similar to this available to all fighter squadrons. The data presented help with the argument for or against the program.

Learning Objectives:

1. Describe the prevalence of neck pain in the sampled community and identify prevention/treatment measures that may be of benefit.

Monday, May 07 ***4:00 PM***
Ballroom E

S-020: SLIDE: TO DNIF OR NOT DNIF: UNIQUE AIRCREW TREATMENT

Chair: Brendon Farrell
East McKeesport, PA

4:00 PM
[089] DIAGNOSTIC PERFORMANCE OF MRI / US-FUSION-BIOPSY TO DETECT CLINICALLY RELEVANT VS. NON-RELEVANT PROSTATE CANCER IN PILOTS
F.M. Jakobs[1], M.A. Hoffmann[2,3], C. Ruf[4] and M. Schreckenberger[2]
[1]Department of Epidemiology, German Air Force Centre of Aerospace Medicine, Fuerstenfeldbruck, Germany; [2]Department of Nuclear Medicine, Johannes Gutenberg-University Mainz, Mainz, Germany; [3]Supervisory Center for Medical Radiation Protection, Bundeswehr Medical Service Headquarters, Koblenz, Germany; [4]Department of Urology, Bundeswehr Central Hospital, Koblenz, Germany

(ORIGINAL RESEARCH)

INTRODUCTION: Standard methods of diagnosing prostate cancer (PCa) in pilots are still based on non-specific screening methods, such as prostate-specific antigen (PSA) plasma levels and digital rectal examination which then is confirmed by ultrasound-guided transrectal (TRUS) or transperineal biopsy. Recent advances in multiparametric magnetic resonance imaging (mpMRI) and mpMRI/ultrasound-fusion-guided biopsy may help to reduce false positive and negative rates of PCa diagnosis thus providing an option when differentiation of clinically significant and insignificant PCa is essential. **METHODS:** This retrospective pilot study included 99 male patients with increased PSA plasma levels and previous negative standard biopsy procedures. MpMRI was performed followed by mpMRI-ultrasound-fusio-targeted biopsy of the prostate. Results of mpMRI (PI-RADS Score) for detection and localization of lesions were correlated with those of histopathology (Gleason Score). **RESULTS:** Lesions of 72/99 (73%) men were determined to be suspect of malignancy (categorized as PI-RADS 4 or 5). Malignancy could not be confirmed by histopathology in 33/99 patients (33%). In 42/66 (64%) of patients a low-grade PCa (Gleason Score 6 + 7a) was found, whereas in 24/66 (36%) of patients a high-grade PCa (Gleason Score ≥7b) was determined. The proportion of corresponding mpMRI results for high-grade PCa was 21/24 (88%), which related to a sensitivity of 88% and a negative predictive value of 85% (p=0,002), whereas the respective proportion for low-grade PCa was 35/42 (83%), relating to a sensitivity of 83% and a negative predictive value of 71% (p<0,001). **DISCUSSION:** In view of changing demographic preconditions and considering the need of sustained physical fitness in highly educated and trained aircrew personnel, it is essential to diagnose potentially incapacitating disease as early as possible. Our results suggest that mpMRI combined with ultrasound-fusion-targeted biopsy of the prostate is able to detect considerably higher rates of clinically relevant PCa as is known from conventional diagnostic approaches. We conclude that mpMRI/ultrasound-fusion-guided biopsy may represent a novel approach not only for detection and monitoring of malignant disease, but additionally for active surveillance of pilots with non-significant tumors of the prostate.

Learning Objectives:
1. The participant will be able to understand different methods of diagnosing prostate cancer up to current innovations in Multiparametric Magnetic Resonance Imaging (mpMRI) and Ultrasound-Fusion-Imaging targeted biopsy.
2. The participant will get insights into current problems of false-positive and false-negative prostate cancer diagnostic results and learn to utilize possibilities in avoiding these clinical drawbacks.

4:15 PM
[090] INFERTILITY: A NOVEL AEROMEDICAL POLICY
M.J. Hessert[1,2] and M.T. Acromite[2]
[1]North Island Clinic, U.S. Navy, Pensacola, FL; [2]Naval Aerospace Medical Institute, Navy Medicine Operational Training Center, Pensacola, FL

(EDUCATION - PROCESS)

MOTIVATION: Female infertility affects 10% of women. It is associated with increased ectopic risk and underlying disqualifying conditions and treatments. Advanced reproductive technology (ART) has its own risks that can be mitigated and managed by the local flight surgeon with temporary grounding. In order to meet the needs of female aviators and their families, the Navy developed an aeromedical policy for fertility treatment. **OVERVIEW:** ART increases medical risks, entails financial and emotional investment, requires critical timing of procedures, and triggers adverse side effects. Infertility medications are given monthly in constant, single, sequential, and/or cyclic dosing and include hormones, clomiphene, gonadotropins, metformin, and others which can cause distracting, variable, and unpredictable mood and physical changes during the cycle. ART procedures can also have side effects and complications. Single or several months of a treatment "holiday" may occur during which aviators can fly. Infertility treatments and use of ART are disqualifying for Naval aviation and require local grounding – up to 120 days – during the entire cycle within which any treatment has occurred. Waivers to continue flight duties are generally not recommended. An aviator may return to flying in the first cycle without treatment if she is symptom-free and pregnancy/ectopic precautions are employed. **SIGNIFICANCE:** The Navy is the first among military services and the Federal Aviation Administration to develop a comprehensive aeromedical policy to address female infertility. The use of ART continues to grow worldwide. All U.S. Military, civilian, and international aviation are affected by infertility treatments and their potential consequences. Aeromedical and non-aeromedical cross-disciplinary uncertainties lead to inconsistent management adversely affecting flying opportunities and aviation risk. This leads to inappropriate risk tolerance, excessive grounding, or inadvertently accepting unnecessary aeromedical risk. Infertility treatment is a commonly unrecognized or ignored aeromedical circumstance due to its private and emotional nature, uncertainties of risk, and lack of interdisciplinary understanding. This risk-focused approach to policy creates a consistent, appropriate strategy to maximize the aviator's opportunity to fly safely and accomplish conception, while mitigating risk and providing a foundation for constructive, interdisciplinary communication.

Learning Objectives:
1. Attendees will learn a risk-focused approach to infertility policy and a consistent mitigation strategy that maximizes the aviator's opportunity to fly safely and accomplish conception, while providing a foundation for constructive, interdisciplinary risk communication and reduction.
2. Attendees will learn the aeromedical risks of infertility medications, procedures and psychosocial stressors that accompany these advanced reproductive technologies.
3. Attendees will learn about the underlying disorders that contribute to infertility and their aeromedical risk, especially as it pertains to infertility.

4:30 PM
[091] AN ANALYSIS OF MEDICAL CONDITIONS IMPACTING FITNESS IN FEMALE AIRCREW OF THE INDIAN AIR FORCE (IAF)
S.S. Nair[1] and P. Renjhen[2]
[1]Medical Training Centre, Indian Air Force, Bangalore, India; [2]Medical, Indian Air Force, Delhi , India

(ORIGINAL RESEARCH)

INTRODUCTION: Studies providing data and analysis of health issues effecting female military aircrew especially in developing countries, are practically nonexistent. The aim of this study was to analyze various medical conditions impacting fitness in serving women aircrew of the IAF and compare these trends with those in female Ground Duty and male aircrew officers. **METHODS:** This cross-sectional study involved analysis of medical data in respect of all serving women aircrew of the IAF. Currently, women are employed only as officers in the Indian Air force. Records of a total of 108 serving women aircrew in the age group of 23 to 40 yrs, were reviewed and analyzed between Oct 2015 and Jan 2016. Of these, 93 were from the Transport and Helicopter stream and 15 from the Navigator stream. These were then compared with trends in female ground duty and male aircrew officers, who

ranged between 21 to 60 yrs of age. The data was statistically analyzed. **RESULTS:** Higher percentage of female aircrew were in low medical category (classification) when compared to male aircrew officers of similar age group, i.e., 20 to 40 yrs. The difference was statistically significant (p=0.0015). However, when compared to low medical category trends in female ground duty and male aircrew officers across all age groups, this difference was statistically not significant. The leading cause of medical unfitness in women aircrew was pregnancy (35%), followed by diseases due to Endocrine causes and PIVD (17.4% each), Injuries and Anemia. **DISCUSSION:** Important differences exist between men and women in their susceptibility to various diseases. In a highly male dominated aviation industry, little is known about specific health issues impacting women aircrew. This study highlights a significant difference in medical fitness of female aircrew viz a viz male aircrew in the age group of 20 to 40 yrs. Pregnancy was the leading cause of medical unfitness in female aircrew followed by diseases due to Endocrine causes and PIVD. Given that the reproductive age group in females largely coincides with the peak flying phase of military aircrew, it is surprising that more studies have not reflected this aspect. Continuing trend analysis is therefore essential to understand health issues effecting female military pilots so as to enable formulation of suitable Human Resource and training policies, for achieving the right balance between gender aspirations and operational requirements of any Air force.

Learning Objectives:

1. To understand prevalence of significant medical conditions impacting fitness in female aircrew of the Indian Air force.
2. To compare and analyze low medical category/classification trends in female aircrew with similar trends in female ground duty personnel and male aircrew of the Indian Air force.

4:45 PM

[092] BENIGN PAROXYSMAL POSITIONAL VERTIGO AS A COMPLICATION OF SINUS LIFT AUGMENTATION WITH OSTEOTOMES: CLINICAL IMPLICATIONS

D. Robles[2], J.L. Dominguez-Mompell[1,2] and J. Lara Chao[1,2]
[1]DL Cirugia Oral, Aranjuez. Madrid, Spain; [2]Universidad Rey Juan Carlos, Madrid, Spain

(EDUCATION - CASE STUDY CLINICAL)

The osteotome is a commonly used technique in patients with maxillary bone atrophy. This method however, has been associated with the provocation of benign paroxysmal positional vertigo (BPPV). This condition can occur as a consequence of working the implant bed with a mallet and osteotome for sinus membrane elevation. When placing maxillary dental implants using this technique, the patients neck is hyperextended for accessibility and visualization. With the neck hyperextended, the percussion from the surgical mallet against the osteotome produces a vibration. This vibration can have the potential to displace the otoliths and induce BPPV. The vertigo induced, can occur immediately, after a few days, or even up to a week away, making diagnosis more challenging. Although the symptoms dissipate over time, the condition can incapacitate the afflicted patient and prevent them from performing their daily activities or duties.

Learning Objectives:

1. To gain a general understanding of how to diagnose and treat BPPV.
2. To become aware of alternative surgical procedures that can minimize the chances of BPPV.

5:00 PM

[093] NEEDS FOR DENTAL TREATMENT IN CONDITIONS OF ISOLATION

V. Lloro
Oral and Forensic Dentistry, Centro Dental Sant Andreu, Barcelona, Spain

(EDUCATION - PROCESS)

Dental emergencies in isolated groups have always been difficult to solve. Especially in people or groups who cannot be evacuated and who need urgent dental assistance (long spaceship trips and long submarine missions). The dental and evacuation problems could put at risk the successful of the mission, with relevant associated economic and strategic costs. Our study summarizes current evidence about dental problems in isolated people.

Learning Objectives:

1. Assess the need of specific dental equipment in special long-term isolation situations.

5:15 PM

[094] DIAGNOSING ORO-FACIAL PAIN RELATED TO BAROMETRIC CHANGES IN ATMOSPHERIC PRESSURE

M.H. Hodapp
Private practice, Houston, TX

(EDUCATION - TUTORIAL)

Physicians and dentists alike, were dealt a new set of challenges with the advent of flight, the development of self-contained underwater breathing apparatus (SCUBA), and with the dawn of spaceflight. Barometrically related events amongst pilots, divers, and crewmembers, affected mission performance, and compromised crew safety. Barodontalgia, odontocrexis, and barosinusitis are some of the anomalies that can affect a crew-member in the oro-facial complex. Barodontalgia, dental pain related to barometric changes in atmospheric pressure, can become so severe that the afflicted individual experiences visual disturbance, loss of focus and vertigo, and has been known to cause early cessation of flights or missions. Studies initiated during the World War II era gave insight into the severity of pain, statistical analysis, as well as some of the causes and recommended treatments to minimize the number of occurrences. Since that era, numerous other studies and publications, described cases, discussed causes, and recommended treatments, as well as preventive measures needed to prevent barodontalgia to avoid its wrath, but with limited success. It is often considered that with all the research related to barometrically related oro-facial pain, the pressurization of modern day aircraft, and the latest advances in dentistry, that barodontalgia is no-longer an issue. However, this does not take in consideration that the number of flights, dives, and spaceflights have grown exponentially, and recent studies still reveal that number of in-flight barodontalgia cases (10 % on average) is as prominent today as it was in the 1940's. In-fact, this figure may be quite conservative since the subject is currently not listed on the curriculum any nationally based dental school, and very few dentists are even aware of the term "Barodontalgia", much less how to diagnose it. This presentation will cover some of the challenges faced by practitioners in diagnosing oro-facial pain, caused by barometric changes in atmospheric pressure, give an approach to simplify the diagnostic process, and discuss recommendations for the prevention and treatment.

Learning Objectives:

1. Gain an understanding of why Barodontalgia is still as prominent today as it was during the World War II era.
2. To learn a simplified approach to diagnosing pain in the oro-facial complex, caused by by barometric changes in atmospheric pressure.

Monday, May 07 ***4:00 PM***
Wedgewood

S-021: PANEL: DESIGNING A ROADMAP FOR MOON MEDICAL CAPABILITIES

Sponsored by Space Medicine Association

Chair: Peter Hodkinson
Hitchin, Bedfordshire, United Kingdom

Chair: Casey Pruett
Cologne, NRW, Germany

PANEL OVERVIEW: The challenges of human spaceflight are numerous and complex. Space faring nations have been evolving their human support capabilities to focus on Low Earth Orbital (LEO)

spaceflight given the existing boundary conditions. However, returning to the Moon will revive support concepts created for the Apollo program. Many new factors including, but not limited to partial gravity, inability for 'relatively' quick return to Earth, and remote medical support capabilities present new challenges compared to LEO. This panel is designed to stimulate thought and discussion about the next steps that are needed to develop medical support programs necessary for lunar missions. The panel will present potential medical scenarios, current research analyzing partial gravity locomotion biomechanics, an ESA initiative tasked with researching possible technologies and concepts to support lunar exploration missions, and a lunar analogue to test possible support scenarios to refine operations. The first presentation describes the ESA "Moon Village" concept to establish the background parameters for the following presentations. It will lay the foundation by describing design mission scenarios, a subset of medical concerns to address, and describe the LUNA analogue facility developed at the ESA European Astronaut Centre (EAC). The second presentation outlines a subset of possible medical challenges that could occur in a short duration (days to a few weeks) lunar exploration mission with up to 4 crew members. The third presentation describes a subset of possible medical challenges that a multinational crew up of to 10 astronauts and commercial crewmembers could face in an established lunar base with a mission duration of up to several months. The fourth presentation describes research involving a weight offloading treadmill to assess biomechanics of locomotion in various partial gravity configurations. The final presentation outlines the "Spaceship EAC" initiative that is a multi-disciplinary innovation-driven team within EAC and beyond which aims to utilize the spaceflight experience of EAC to develop and validate operational concepts and low-TRL level technologies in support of lunar human exploration scenarios. These presentations will provide basis for the panel discussion and encourage action in the field of medical support needed for human exploration of the Moon.

[095] MEDICAL CHALLENGES AND CONSIDERATIONS FOR A SHORT DURATION LUNAR EXPLORATION MISSION

R.A. Anderton[1], B. Posselt[4], M. Komorowski[2], R.S. Whittle[6], K. Fong[5] and P.D. Hodkinson[3]
[1]Medical Department, UK Civil Aviation Authority, Gatwick, United Kingdom; [2]Intensive Care Unit, Imperial College London, London, United Kingdom; [3]RAF Centre of Aviation Medicine, Hitchin, United Kingdom; [4]Royal Air Force, Bedfordshire, United Kingdom; [5]University College London, London, United Kingdom; [6]Cranfield University, Cranfield, United Kingdom

(EDUCATION - PROCESS)

MOTIVATION: As we near the 50th anniversary of the first human mission to the Moon there is significant international interest in returning. This may be as a proving ground for future exploration of Mars, to establish a permanent research base on the Moon or commercial opportunities from the exploitation of lunar resources. The initial missions, however, are likely to be exploratory, temporary and short duration (days-weeks) in nature, likely consisting of 3-4 crewmembers. As with the Apollo missions, conditions will be austere with limited support available except for that able to be provided by remote communications, carried on-board or provisioned in advance. This places increased emphasis on appropriate mission planning and, as an integral part of this, medical planning and risk assessment. This will need to incorporate the likely activities to be undertaken and the specific challenges to be faced in light of the stringent limitations on resources, support and medical skills. A dedicated physician may not be part of the crew; instead members will need to undergo focused medical training based on the most probable medical occurrences. **OVERVIEW:** Lunar exploration missions are likely to involve multiple extravehicular activities (EVAs) for exploration in the lunar partial gravity environment and be associated with different medical challenges to those of established ISS operations in low Earth orbit and spaceflight analogue environments. Three particular medical scenarios of concern that will be discussed are the management of severe trauma, loss of spacesuit pressurization during lunar EVA and management of acute radiation sickness. For each of these scenarios, we will discuss the possible impact on crew health and mission objectives and the options for optimal management in light of the severe constraints aforementioned. For the management of injuries occurring during EVAs, the European Space Agency has developed and tested the Lunar Evacuation System Assembly (LESA), a foldable rescue device on wheels that opens above a fallen astronaut to lift and transport them. **SIGNIFICANCE:** Achieving a successful return to the Moon, in preparation for the establishment of a permanent base, will require a thorough assessment of the medical risks involved and extensive medical preparation focusing on the medical scenarios posing the highest threat to crew health and mission objectives.

Learning Objectives:

1. To gain an understanding of the anticipated medical challenges to support lunar exploration missions and areas that require further investigation and consideration to support such missions.

[096] MEDICAL CHALLENGES AND CONSIDERATIONS FOR AN ESTABLISHED LUNAR BASE

B. Posselt[1], R.A. Anderton[2], M. Komorowski[3], B. Healey[4], T.G. Smith[5], R.S. Whittle[6], K. Fong[7] and P.D. Hodkinson[1]
[1]RAF Centre of Aviation Medicine, Hitchin, United Kingdom; [2]Authority Medical Section, Civil Aviation Authority, Kingston upon Thames, United Kingdom; [3]Intensive Care Unit, Imperial College London, London, United Kingdom; [4]European Space Agency, Cologne, Germany; [5]King's College London, London, United Kingdom; [6]Cranfield University, Cranfield, United Kingdom; [7]University College London, London, United Kingdom

(EDUCATION - PROCESS)

MOTIVATION: An established base on the lunar surface, perhaps akin to Antarctic research station operations, offers great potential for lunar exploration, science and would act as a stepping-stone for future missions to Mars. A permanent habitat is likely to have more personnel (>6-10) and still be of a multinational nature but perhaps with more regular commercial crewmembers. It is an exciting challenge to build and progress from the lessons learned and international relationships developed during operation of the ISS. However, an established lunar base will pose a number of different medical considerations. **OVERVIEW:** This talk highlights some key requirements for maintenance of crew physical and mental health and performance, as well as several expected medical challenges associated with an established lunar base, some of which are informed by established operation of Antarctic bases. For the larger group of astronauts a designated medical facility and staff may be deemed necessary although this will need to be informed by consideration of the likely activities and associated risks. For example, a lunar launch and landing facility may introduce risk of mass casualty events. As with long duration spaceflight in low Earth orbit consideration must be given to how astronauts will adapt but this time to living in partial gravity and thought must be given to an appropriate physical conditioning program to maintain health and performance. Additionally novel medical conditions may develop; the Apollo crewmembers reported some irritation symptoms of the skin, eyes and upper airways raising concern that exposure to respirable lunar dust could be detrimental to human health. The potential health effects of chronic exposure are unknown. Finally, to allow more rapid extravehicular activity it is likely that a lunar habitat will be operated at a reduced barometric pressure, partially countered by an increase in the percentage of oxygen, and that the overall atmosphere will be mildly hypoxic compared with Earth at sea level, introducing chronic hypoxia as an additional physiological challenge in this setting. **SIGNIFICANCE:** Significant progress is being made to address the potential medical challenges of lunar missions. Efforts will need to be multinational in their approach, to address the needs of all nations involved. This presentation reviews current knowledge to highlight gaps and direct future research to support the establishment of a lunar base.

Learning Objectives:

1. To gain an understanding of the anticipated medical challenges to support an established lunar base and areas that require further investigation and consideration to support such missions.

[097] WALKING ON THE MOON: KNOWN UNKNOWNS

D.A. Green[1,2], A. Suess[1], J. Attias[2] and K. Mileva[3]
[1]*European Astronaut Centre, KBRwyle GmbH , Cologne, Germany;* [2]*Centre of Human & Aerospace Physiological Sciences, King's College London , London, United Kingdom;* [3]*School of Applied Sciences, London South Bank University, London, United Kingdom*

(ORIGINAL RESEARCH)

INTRODUCTION: Whilst humankind has ambulated on the lunar surface, the gait pattern and 'ground reaction' forces were not quantified. Furthermore, whilst ground-based studies at specific simulated Gz levels have shown that the gait pattern and forces are modulated (Richter *et al.*, 2017), standardized determination of their relationship with Gz has yet to be performed. Thus, this study evaluated the relationship between variable simulated Gz, and both gait pattern and plantar forces during walking. **METHODS:** Eight male subjects (31.9±4.7 yrs; 178.4±5.7 cm and 73.5±7.3 kg) gave written informed consent to participate in the study that received ethical approval. Subjects walked at 25% below their estimated preferred walk-to-run transition speed in five 30s counter-balanced trials: at 1Gz (F320 AlterG treadmill; CONTROL), and at 0.7, 0.38, 0.27 and 0.16Gz on ESA's Verticalised Treadmill Facility in gym clothing. Ground (plantar) reaction forces were measured continuously (100Hz) by pressure-sensitive foot insoles (PedoPed) from which gait duration and peak heel strike and toe-off forces were derived, in addition to vertical displacement. One-way repeated measures ANOVA determined the effect of simulated Gz with regression analysis used to define inter-relationships. **RESULTS:** A prolongation of stride duration indicative of gait velocity slowing and an increase in 'vertical' displacement were observed as simulated Gz was reduced. In contrast, plantar force during heal strike and toe off tended to decrease. However, the relationship between Gz and stride duration, 'vertical' displacement in addition to plantar force were non-linear. **DISCUSSION:** Gait pattern parameters and plantar force were non-linearly related to Gz at low gravity levels, during 'standardised' walking, resulting in higher than previously predicted forces. These data have implications for the definition of optimal partial gravity ambulation and the forces applied to the musculoskeletal system associated with it. Suit, habitat, and mission design in addition to 'Moon Gym' exercise device requirements should be mindful of such findings. However, investigation of the effect of variable Gz upon the 'preferred' gait biomechanics (strategies, and speed), in addition to determining whether plantar and internal forces acting upon the musculoskeletal system possess similar non-linear relationships with Gz is warranted.

Learning Objectives:

1. The participant will be able to understand the relationship between, plantar forces and gait patterns associated with simulated low gravity and potential implications upon Lunar mission scenarios.

[098] HUMAN EXPLORATION AT THE EUROPEAN ASTRONAUT CENTRE

A. Cowley
European Astronaut Centre, European Space Agency, Cologne, Germany

(ORIGINAL RESEARCH)

The operational capabilities of the European Astronaut Centre (EAC) in terms of training and support for human spaceflight operations on the ISS are well known. With increasing attention now being given to post-ISS human spaceflight and potential lunar exploration missions, the future projects team at EAC and the broader ESA stakeholders are collaborating on projects that will leverage the capabilities and experience available at EAC to advance these exploration objectives. Within the future projects team currently there exists an initiative named "Spaceship EAC", which has been running since 2012. This high level objectives for this initiative are: Enhance, the capabilities of the EAC to address future exploration challenges; Enable, via demonstration of concepts, operations and technology, developments which advance European human spaceflight capability for exploration; and Inspire, using the center and its image to advocate for human exploration of the lunar vicinity. This initiative encompasses a multidisciplinary innovation-driven team crossing divisions within the center and aims to utilize the spaceflight experience of the center to develop and validate operational concepts and low-TRL-level technologies in support of lunar human exploration scenarios. The individual concept/technology development and demonstration projects within this initiative are coordinated with ESA centers (mission scenarios, technology roadmaps) and exploit synergies with EAC facilities and operational competencies as well as with the surrounding DLR campus and European research groups. The future projects team is also supporting the development of the LUNA analogue facility. Here the team provides project management, technical and administrative support during the construction phase in 2018, and it is planned that the team will use the Spaceship initiative to support the facility once it is operational and available for use. The LUNA facility and attendant analogue elements (such as the FlexHab habitat module) will be used by the team to demonstrate technologies and concepts (e.g. human-robotic interaction for exploration) to support ESA exploration activities, but the facilities will also be open to external research groups to use with no cost barriers in a collaborative environment.

Learning Objectives:

1. Understand the activities of the EAC in preparation for potential human exploration of the lunar vicinity.

Monday, May 07 ***4:00 PM***
Ballroom B

S-022: PANEL: FAILURE TO FOLLOW PROCEDURES IN AVIATION AND MEDICINE

Sponsored by the AsMA Aerospace Human Performance Committee

Chair: Immanuel Barshi
Moffett Field, CA

Chair: David Schroeder
Oklahoma City, OK

PANEL OVERVIEW: Despite the recent emphasis on the importance of safety culture in both aviation and healthcare, failure to follow procedures (FFP) remains a persistent problem. However, FFPs are evident in virtually all occupational settings: a case is dismissed in court because an officer's FFP; an employee dismissal is voided due to the employer's FFP; a cyber security attack was successful when an employee FFP. Many of the major accidents in high risk safety occupations occurred as a result of employee FFPs. While the emphasis on establishing an effective safety management system has improved safety, FFPs continue. In aviation, pilots fail to complete safety checklists, pilots continue to land following an unstabilized approach, maintenance personnel omit procedural steps and air traffic controllers fail to follow established procedures. In surgery we find that surgeons and anesthetists have not complied with established policies and procedures. In nursing medical administration errors often involve FFPs. While a majority of these incidents do not present significant safety concerns they can result in accidents/incidents where lives are lost. While attention is often focused on the individual, research clearly demonstrates that the reasons are complex and frequently involve organizational issues. Causal factors often include the organizational culture, design of the equipment, working conditions (time pressure, workload, lighting, distractions) and the employee (fatigue, illness, etc.). This panel is designed to address many of these issues in aviation and medicine. We will hear about efforts at NASA to address FFPs on the flight deck. Within the FAA research has been focused on identifying factors associated with FFPs in aircraft maintenance and air traffic control. Research at Embry Riddle University has been directed toward understanding and mitigating FFPs in medicine. An opportunity will be provided for a panel discussion.

[099] FAILURE TO FOLLOW PROCEDURES: A CLASSIFICATION SYSTEM FOR THE MITIGATION OF FFP EVENTS

M. Bryant and K. Avers
FAA, Oklahoma City, OK

(EDUCATION - PROCESS)

MOTIVATION: Identifying and mitigating Failure to Follow Procedure events can have a direct positive impact in occupations such

as aviation and medicine. **OVERVIEW:** When an aviation incident or accident occurs as a result of mistakes made by maintenance technicians, supervisors, or managers, investigators will often cite 'failure to follow procedures' as the cause. This phrase is used all too often as the ending point of an investigation (Drury, Barnes, & Bryant, *Under Review*). However, we know that there are underlying root causes that go beyond simply failing to follow procedures (Johnson & Avers, 2014; Johnson & Watson, 2001; Rankin, 2008). In fact, when we use this phrase, we preclude any further understanding of *why* actions/inactions of maintenance personnel occurred. Researchers in the Human Factors Research Division at the Civil Aerospace Medical Institute have examined over 100 literature sources as well as 154 Aviation Safety Reporting System (ASRS) reports, and 94 National Transportation Safety Board reports to derive an aviation maintenance-specific classification system that categorizes contributing factors (the "why") for accidents that qualify as Failure to Follow Procedures (FFP) events. This classification system outlines 5 key areas of a FFP event that must be addressed within an organization to adequately mitigate FFP events. One unique criterion included in this system is its inclusion of organizational factors that contribute to an increased risk of FFP events including (among others) time pressure, task interruption and distraction tolerance. Results showed that the academic literature and ASRS reports identified the procedure documentation as the primary contributing factor in FFP events. However, NTSB reports often did not provide enough detail to classify events, resulting in many cases that were considered "unexplained". **SIGNIFICANCE:** It is expected that through the use of this new classification system, root causes (contributing factors) of FFP events may be more easily identifiable. It is also expected that such a system can benefit multiple domains in addition to aviation maintenance including healthcare and flight deck operations.

Learning Objectives:

1. Recognize the pitfalls of the current "failure to follow procedures" classification code across domains.
2. Identify how the TAPES classification system can address short-comings of the current classification across multiple domains including aviation maintenance, pilot, as well as the healthcare profession.

[100] RISK ASSESSMENT IN AEROMEDICAL DECISION MAKING

A. Jordaan
Aviation Medicine, ICAO, Montreal, QC, Canada

(EDUCATION - TUTORIAL)

Following procedures is considered to be essential to promote safety in various operational environments. Aviation Medicine connects the fields of aviation and healthcare with the desired outcome being both operational safety and health preservation (or in some cases, preservation of life). Failure to follow procedures (FFP) can result in disastrous consequences, but sometimes FFP can have a desired outcome or a positive effect. The standard action for everybody involved in an operation is to follow procedures, but sometimes circumstances dictate that procedures must be set aside in the interest of higher priorities. The key in knowingly deciding not to follow accepted procedures or when to amend existing procedures relies on knowledge, consultation with subject matter experts, risk assessment and good judgment. These principles form the basis of "accredited medical conclusion" in the aviation medicine context. Three cases will be discussed: two in relation to the emergency evacuation environment where FFP resulted in a positive outcome, and the other where the failure to follow aviation medical examination procedures resulted in a negative outcome.

Learning Objectives:

1. To understand the application of risk assessment and "accredited medical conclusion" in the aeromedical decision making process.

[101] FAILURES OF PROCEDURES

A. Miranda
Naval Safety Center, Norfolk, VA

(EDUCATION - TUTORIAL)

In the aftermath of accidents, it is a common reaction as outsiders looking in to second guess the actions and decisions made by the individuals involved in the accident. A subtle yet profound attitude outsiders can embrace, however, to better understand the conditions surrounding the accident is to recognize that the individuals involved did what is rational to them as the event was unfolding. Given their knowledge, goals, and resources available, individuals behaved in a way that made sense to them at the moment of action or inaction. This mindset is known as the Local Rationality Principle and it helps provide insight into the problem of "failure to follow procedures." The Local Rationality Principle, alongside human factors research and practice in safety, allows us to see that individuals tend to deviate from procedures not because they are bad apples who see themselves as above the law, but because they must adapt and improvise their work to keep up with the demands of the chaotic and oftentimes goal-conflicted work environment. When work is completed successfully, even when procedures are not followed, individuals earn short-term rewards by getting the job done, thus reinforcing procedural deviation. The slow creep into normalization of deviance makes individuals unintentionally blind to unknown hazards and increased risks occurring in dynamic and often complex work settings. This evolution of how work is actually performed may continue unabated over weeks, months, or even years. People are then placed in unsafe situations partly because they are unaware of the circumstances that have emerged over time. When accidents occur during what has become normal work, the individuals involved often get blamed for failing to follow procedures. Future efforts in organizational safety should look beyond explanations like "failure to follow procedures" and other human error excuses as reasonable conclusions for how and why accidents occur.

Learning Objectives:

1. Describe a psychological perspective to better understand how "failure to follow procedures" is commonly determined as a causal factor in accidents and mishaps.

[102] FAILURES OF PROCEDURES

I. Barshi
Human Systems Integration Division, NASA Ames Research Center, Moffett Field, CA

(EDUCATION - TUTORIAL)

We see procedures as the tool for coordinating the interactions between the Technology, the Human, and the operational Environment (THE Model). When procedure designers fail to take all two-ways and three-ways interactions into account, procedures are bound to fail at some point. We can easily see such failures when there is a conflict between procedural demands and operational demands (e.g., taxi checklist), and between procedural demands and human limitations (e.g., concurrent tasks and the need for deferred intentions). To design good procedures, we must take all the interactions within THE Model into account. Another source of failures is inconsistencies within the system of procedures. We see procedures as part of what we call a 4Ps framework. This framework includes the Philosophy, Policy, Procedures, and Practice levels of an operation If the full framework is not in place, there are likely to be inconsistencies which can lead to "selective noncompliance." Again, procedure designers are often focused on a single procedure, and when they fail to take the whole system of procedures and the whole 4Ps framework into account – procedures are bound to fail at some point.

Learning Objectives:

1. To understand the complexity of the operational context within which procedures have to be followed.
2. To understand the complexity of the task of designing procedures.

[103] ATC MANDATORY AND DISCRETIONARY PROCEDURES

P. Krois
NextGen Human Factors Division, FAA, Washington, DC

(EDUCATION - TUTORIAL)

Air traffic controllers routinely manage a highly complex air traffic control (ATC) system. Their operations are established by FAA Order 7110.65 Air Traffic Control. These procedures are of two types, either mandatory or discretionary. Mandatory procedures establish requirements using terms like "must" or "shall not" that air traffic controllers are expected to strictly adhere to. In contrast, discretionary procedures use terms like "should" or "may not" that give controllers an option on what to do. Version W of Order 7110.65 contains 1,096 instances of mandatory

procedures and 1,251 instances of discretionary procedures. Variation from mandatory and discretionary procedures can be intended or unintended. Intended variation is shown for example, in discretionary procedures that are written to allow the controller a choice on what action to take or not take. Unintended variation reflects operations that are different from organizational expectations, procedures, training, and other operational parameters. Unintended variation can occur such as when human performance drifts from organizational expectations. An analysis of voluntary safety reports in the NASA Aviation Safety Reporting System submitted by pilots and controllers for North Atlantic operations shows trends for unintended variation from procedures.

Learning Objectives:

1. Learn about challenges with how the design of operational procedures in air traffic control poses risk from unintended variation.

Monday, May 07 ***4:00 PM***
Topaz

S-023: PANEL: NEUROLOGIC EFFECTS OF HYPOBARIC EXPOSURE

Chair: John Sladky
San Antonio, TX

PANEL OVERVIEW: This panel presents the results of ongoing international collaborative human and animal research to enhance our understanding regarding the effects of hypobaric exposure on the human brain. A strong relationship has been established between subcortical white matter injury and U.S. Air Force operational exposure to non-hypoxic hypobaric conditions. The first presentation highlights updated neuroimaging and metabolic findings on human single exposure model to hypobaric conditions. The second presentation demonstrates the effect of high-altitude exposure on brain magnetic resonance imaging sequences in 10 healthy mountain climbers while the third presentation reviews magnetic resonance imaging findings in United Kingdom altitude chamber trainees. The fourth talk discusses the effects of extreme hypobaria in a rat model. The fifth and final presentation examines the operational implications that have ensued in several North Atlantic Treaty Organization countries as a direct result of international collaborative research on the effects of hypobaria. The goal of our multi-national research is to elucidate the underlying pathophysiology of hypobaric exposure-related white matter injury changes to optimally protect our aircrew during mission performance.

[104] RESULTS OF THE SINGLE EXPOSURE TRIAL - MRI ASSESSMENT OF AIRCREW IN THE HYPOBARIC ENVIRONMENT

P.M. Sherman[2,1], J.H. Sladky[2] and S. McGuire[2]
[1]Human Performance/Radiology, USAF School of Aerospace Medicine; Wilford Hall ASC, Boerne, TX; [2]USAFSAM, San Antonio, TX

(ORIGINAL RESEARCH)

INTRODUCTION: Subcortical white matter (WM) injury and global decreased fractional anisotropy are associated with repetitive exposure to non-hypoxic hypobaric conditions. A single hypobaric hypoxic occupational exposure induces magnetic resonance imaging (MRI) changes that reflect transient brain injury. **METHODS:** There were 96 U.S. Air Force aircrew trainees and 14 aerospace physiology inside observers undergoing occupational altitude chamber training exposure to 7,620 m (5.45 psi) and 65 age-matched control subjects who were evaluated. Subjects underwent MRI brain examinations (Siemens 3 Tesla Verio magnet) 24 h pre-exposure and 24 and 72 h post-exposure with quantitative analysis. MRI protocol included fluid-attenuated inversion recovery (FLAIR) images, magnetic resonance spectroscopy (MRS) within the frontal WM and anterior cingulate gyrus, diffusion weighted imaging, and arterial spin labeling (ASL) perfusion imaging. Statistical analysis was performed with a generalized additive model (GAM) corrected for age and sex, and with paired two-tailed *t*-tests. **RESULTS:** ASL showed an upregulation of white and gray matter cerebral blood flow at both 24 h and 72 h in the exposed subjects (white matter $p = 0.003/0.020$; gray matter $p = 0.053/0.041$). Group comparison using a GAM adjusted for age and gender demonstrated significant increased WM and GM cerebral blood flow (CBF) at 24 h and 72 h post-exposure compared to controls ($p<0.001$ and $p=0.048$ respectively). There is no statistical difference in CBF between the 24-h and 72-h MRIs. No significant change in CBF was observed in the control subjects. Significant group differences across the three MRS scans were noted for frontal glutathione and for anterior cingulate choline, acetylaspartate, myoinositol, creatine, and glutamate/glutamine. All frontal and anterior cingulate neurometabolites were significant independent variables for CBF change. No WM FLAIR changes. **DISCUSSION:** There is an upregulation of both GM and WM CBF following exposure to occupational hypobaric training that persists up to 72 h following exposure, which reflects an increased metabolic demand and suggests a transient cerebral injury has occurred. Neurometabolite changes suggest an acute glial and neuronal cell response, which may be responsible for the change in CBF. Repetitive injury with repetitive hypobaric exposure, without adequate time for healing, may represent an underlying basis for previously reported subcortical WM injury.

Learning Objectives:

1. Understand that MRI changes occur after a single exposure to hypobaria and hypoxia for routine altitude chamber training which suggest transient brain injury.
2. Understand cerebral blood flow changes and basic neurometabolite changes that occur during routine altitude chamber training.
3. Review current human and animal hypobaric research results and their implications for aircrew.

[105] HUMAN ALTITUDE CHAMBER RESEARCH AND WHITE MATTER INTEGRITY: STUDY ENTRY AND EXIT SCREENING WITH BRAIN MRI

D.M. Connolly and H. Lupa
Aircrew Systems, QinetiQ plc, Farnborough, United Kingdom

(ORIGINAL RESEARCH)

INTRODUCTION: Manned altitude chamber assessment of a contemporary aircraft oxygen system began in March 2017 and is nearing completion. Participants will complete up to 24 decompressions ranging up to a maximum 40,000 ft equivalent pressure altitude (PA). Consideration of the risk of decompression-related white matter injury, as evidenced by white matter hyperintensities (WMH) on magnetic resonance imaging (MRI) brain scans, was required to inform ethical review of the study protocol, as relevant exposure limits are unavailable. **METHODS:** Investigators are required to establish participants' MRI status on study 'entry' and 'exit', to document absence of harm or record any changes that occur. MRI 'entry' criteria were derived to determine eligibility of volunteers with pre-existing WMH. Candidates underwent 3-D 'FLAIR' MRI screening at the University of Nottingham, UK, according to the published USAF method, and data were reanalyzed at the University of Maryland, Baltimore, USA, to validate comparison with USAF normative data. Those with ≤ 5 WMH of total volume ≤ 0.08 ml (80 mm^3) were eligible to participate, anticipated to exclude up to 20% of 'normals.' Exit MRI scans are scheduled at least four weeks after participants' final altitude exposures above 15,000 ft PA. **RESULTS:** Only one of 13 volunteers screened with 'entry' MRI was ineligible, having 63 subcortical WMH of total volume 2.31 ml. Eleven participants (five experimental subjects and six inside observers) undertook decompressions above 15,000 ft PA. At 'entry' six had zero subcortical WMH, three had a single lesion, one had two (total volume 0.018 ml) and one had three (total volume 0.038 ml). At abstract submission 'exit' MRI scans are being scheduled for December 2017. **DISCUSSION:** The ineligible volunteer's excess WMH may be explained by past mild traumatic brain injury (MTBI), consistent with a recent survey of 20 UK participants in past hypobaric research and training, of which three with past MTBI had excess (>15) WMH. By historical standards the current study imposes modest decompression stress, comprising relatively few, brief and infrequent exposures (maximum two per week with three days 'down time'). Thus, any change in participants' MRI status will be unexpected. The outcome will be known early in 2018 and will inform the requirement for MRI screening for future UK altitude studies.

Learning Objectives:

1. To understand the ethical basis of MRI screening for human altitude chamber research programs.
2. To begin to understand safe parameters for repetitive hypobaric exposures that do not promote permanent white matter change.

[106] OPERATIONAL IMPACT OF WHITE MATTER HYPER-INTENSITIES

H. Wittenberg[3], T. Meeuwsen[3], P.D. Hodkinson[2] and J. Saary[1]
[1]Canadian Forces Environmental Medicine Establishment, Toronto, ON, Canada; [2]RAF Centre of Aviation Medicine, Hitchin, United Kingdom; [3]Center for Man in Aviation, Royal Netherlands Air Force, Soesterberg, Netherlands

(ORIGINAL RESEARCH)

INTRODUCTION: Neurologic decompression sickness (NDCS) can occur as a result of high altitude exposure and thus could affect military personnel such as U2 pilots, Special Forces, altitude chamber personnel etc. Such exposure has also been associated with white matter hyper-intensities (WMH). A NATO research work group has been created to examine WMH in greater depth, and to identify the operational impact of WMH. **PURPOSE:** the purpose of this presentation is to describe the changes that have been made in operational and training environments in various nations, particularly since the identification of white matter hyper intensities in U2 pilots. In addition, the rationale for either making, or not making changes will be summarized. Method: A qualitative survey of the nine participating members / Subject Matter Experts of the NATO WMH working group was undertaken. Members were requested to answer questions related to 2 key issues: 1) to identify and report any changes in national Standard Operating Procedures, training protocols and regulations, and 2) provide rationale for changes of lack thereof. **RESULTS:** The results from 6 participating countries are currently available. Key changes relate to maximum allowable cabin altitudes, and intervals between exposures. The U.S. Air-Force has changed the cabin altitude for single U2 pilots to 15,000 feet, dual seats remain unchanged an altitude up to 28-30,000 feet but crews are restricted to exposures with at least 72 hours between exposures. All countries have limited their altitude chamber runs to a maximum of 25,000 feet and have introduced 72 hours restrictions between exposures to 25.000 feet. For NATO STANAG 7046 HAHO/HALO operations a proposal has been made to limit the exposure to or above 25,000 feet to one in every 72 hours. **DISCUSSION:** Except for U2 pilots no known restrictions apply for flight crew. Some countries have made changes to limit hypobaric flight exposures presumably then reducing the risk of WMH. Such changes could impact training for HAHO/HALO personnel.

Learning Objectives:

1. Operational- and training impact of white matter hyper-intensities.

[107] BRAIN MRI SHOWS (SUB)CLINICAL EDEMA FORMATION AFTER ACCLIMATIZATION TO GENUINE HYPOBARIC HYPOXIA

S. Kuehn[1], D. Gerlach[2], H. Noblé[1] and U. Limper[2]
[1]Zentrum für Luft- und Raumfahrtmedizin der Luftwaffe, Bundeswehr, München, Germany; [2]Cardiovascular Aerospace Medicine, German Aerospace Center, Institute of Aerospace Medicine, Cologne, Germany

(ORIGINAL RESEARCH)

INTRODUCTION: From pilots and astronauts to mountaineers - in several occupations people are exposed to a hypoxic and/or hypobaric environment (HH) and thus research on brain effects has been conducted for decades. While acute effects of HH on the brain are well studied, like intracranial volume increase or micro-bleedings, there is a lack of knowledge about brain changes directly after acclimatization. To investigate the acute and chronic brain responses of acclimatized subjects exposed to the severe HH environment at Europe's highest alpine hut, this study applied brain MRI after adaption and regression of symptoms. **METHODS:** 10 subjects (5f) ascended within 48h to an alpine hut in 4554 m. They stayed for 7 days and descended within 1 day. Before the ascent a MRI of the brain was performed at sea level. Within 12h after their descent and again after 108 days the subjects underwent follow up MRI. The MRI sequence protocol was designed for detection of changes in intracranial volumes (ICV) and diffusion values, brain edema, cerebral micro-bleedings and structural lesions. **RESULTS:** Significant volume increases of white (WM) (p=0.026) and gray matter (GM) (p=0.004) combined with a non-significant compensatory decrease of cerebrospinal fluid (CSF) (p=0.08) could be observed. Furthermore subjects with larger total ICV seem to be more susceptible for altitude induced changes (p=0.025). Focal volume increases demonstrate an unequal distribution of the GM and WM volume changes. Significant increases in water diffusion suggest edema formation as the underlying mechanism. Beside these group effects individual brain anomalies where visible in two subjects. One presented an edematous exacerbation of pre-existing WM lesions. A second subject showed a local cytotoxic edema in the splenium. Both vanished within few days. **DISCUSSION:** There is a certain vulnerability of the human brain exposed to extreme environments. Even after 7 days exposed to a HH environment and complete regression of any symptoms, group and individual effects on the brain integrity could still be observed. Edema formation, as the underlying mechanism with subsequent volume increases of brain compartments, seem to play a central role in the physiological brain response. Since the human brain is affected by HH triggered susceptibility further research should cover occupational fields. **FUNDING:** By the German Aerospace Center (DLR) and the German Mountain and Expedition Medicine Society (BExMed).

Learning Objectives:

1. The participant will be able to understand the effects of an hypobaric and hypoxic environment on the human brain.

[108] A TRANSLATIONAL APPROACH TO THE PATHOPHYSIOLOGY OF WHITE MATTER HYPERINTENSITIES IN HIGH ALTITUDE AIR PILOTS

M.B. Havnes[1], M. Widerøe[1], S.H. Torp[2], B.H. Munkeby[3] and A. Møllerløkken[1,3]
[1]Department of Circulation and Medical Imaging, NTNU, Norwegian University of Science and Technology, Trondheim, Norway; [2]Department of Clinical and Molecular Medicine, NTNU, Norwegian University of Science and Technology, Trondheim, Norway; [3]Institute of Aviation Medicine, Norwegian Defence Medical Services, Oslo, Norway

(ORIGINAL RESEARCH)

INTRODUCTION: Efforts throughout recent years studying the pathophysiology of white matter hyperintensities, have mostly involved clinical examinations of personnel exposed to hypobaric environments. Our contribution is to offer a translational approach through animal models to study the pathophysiology in more detail. We have developed two animal models, one using pig and one using rat, which are demonstrated valid. Recent findings from these animal models will be highlighted. **METHODS:** Anaesthetized pigs (sus scrofa domestica), spontaneously breathing, underwent a simulated flight to 30.000 feet, breathing 100% oxygen, for 120 min with continuous ultrasound investigation of the pulmonary artery. The ascent and decent rates were 5000 feet/min. The rats (Sprague Dawley) underwent 14 exposures to 30.000 feet breathing 100% oxygen, with similar compression and decompression rates as the pigs. The rats flew six at a time, all awake in the chamber. Before the first simulated flight, and after the last flight, the rats underwent MRI scanning using a 7T small animal MRI scanner. Following the last MRI scan, the animals were euthanized, and the brains were preserved in paraformaldehyde and then paraffin embedded for histological analyses. **RESULTS:** All animals survived the simulated flights. In pigs, vascular gas bubbles could be detected during the decompression and at altitude. In rats, we found hyperintensities on the MRI but mostly located to hippocampal and cortical areas. Preliminary histological examinations reviled dilated vessels in the same brain areas. However, most hyperintesities were also present on MRIs before the simulated flights began. **DISCUSSION:** We demonstrate the potential of using animal models to study the pathophysiology of WMH. We were able to demonstrate vascular gas bubble formation during the decompression to altitude and at altitude. Hence, the large animal model is suited for investigations involving hypothesis related to formation of vascular gas bubbles. Our small animal model is also an important tool in longitudinal studies. The model permits repeated exposures to the hypobaric environment with possibility of both performing high end MRI investigations and histological evaluations of the experimental animals.

Learning Objectives:

1. The participant will be able to understand how one can use a translational approach to address challenges related to white matter hyperintensities in high altitude pilots.

Monday, May 07 ***4:00 PM***
Sapphire

S-024: SLIDE: IS THERE A DOCTOR IN THE HOUSE? UNIQUE AEROMEDICAL RESPONSES

Chair: James Cushman
Oakland, CA

Chair: Michael Gallagher
Edmonton , Alberta, Canada

4:00 PM
[109] PREVALENCE AND IMPLICATIONS OF LASER ATTACKS ON AIRCRAFT IN EUROPE: RESULTS OF A GEOGRAPHICAL SURVEY
F.M. Jakobs[2,3], J. Franklin[4], M.A. Hoffmann[1] and J. Frischmuth[5]
[1]Supervisory Center for Medical Radiation Protection, Bundeswehr Medical Service Headquarters, Mainz, Germany; [2]Epidemiology, GAF Centre of Aerospace Medicine, Fuerstenfeldbruck, Germany; [3]Ophthalmology, GAF Centre of Aerospace Medicine, Fuerstenfeldbruck, Germany; [4]Safety Analysis and Performance Section, European Aviation Safety Agency, Cologne, Germany; [5]Clinical Aviation Medicine, GAF Centre of Aerospace Medicine, Fuerstenfeldbruck, Germany

(ORIGINAL RESEARCH)

INTRODUCTION: Laser attacks on aircraft using standard or high-powered diode lasers remain to be a major concern for the environmental health of pilots and flight safety from the passengers' point of view. While in the United States, data are collected and published on a regular base as of the year 2000, respective data in Europe are scarce and difficult to obtain. As a result, the delayed and reduced prevalence reported in Europe have been interpreted as a copy-cat reaction to the events reported for the USA. Recent data suggest that this perception has to be revised. **METHODS:** An international survey was initiated by the German Air Force Centre of Aerospace Medicine, covering a total of 44 nations across geographical Europe. In detail, civil aviation authorities were contacted and asked to provide information on frequencies, circumstances, and official handling of laser events as nationally recorded. Response data were stratified according to target-related and environmental topics, statistically analyzed, and compared to the respective database entries of the European Aviation Safety Agency (EASA). **RESULTS:** At a response rate of 52.3%, data from 19 nations were available at time of evaluation, while 4 authorities refused to provide any information. Pooled results showed an increase to >4500 events/year beginning from 2010, which was one year following introduction of a central reporting system, and lasted in this range at least until 2015. EASA database entries confirmed this rate for the European member nations. The preferred laser wavelength was green (532 nm), primarily targeted at slowly moving aircraft at low altitude. No physical damage of a pilot's eye was reported so far. **DISCUSSION:** Our results indicate that prevalence of laser attacks on aircraft in Europe have been underestimated. Based on the data currently available it can be stated that the public burden of laser strikes in Europe tends to exceed the events reported by the United States. We conclude that the reduced rates of laser attacks recorded in Europe is the result of a considerable reporting bias caused by the delayed installation of a mandatory reporting system due to diverging public health/security policies within the European Union.

Learning Objectives:
1. The participant will learn about the incidences and prevalence of laser attacks on aircraft and the impairment of flight safety induced by such laser strikes. The participant will be able to differentiate between pilot incapacitation by functional organic failure and sensory impairment on different levels.
2. The participant will be able to understand the need of harmonized public health policies in order to provide safety and security in aviation.

4:15 PM
[110] MASS CASUALTY DISASTER RESPONSE: EMERGENCY AEROMEDICINE IMPROVES GLOBAL HEALTHCARE
R.J. Andrews[1,2], L. Quintana[3,2] and T. Khan[4,2]
[1]Nanotechnology, NASA Ames Research Center, Los Gatos, CA; [2]World Federation of Neurosurgical Societies, Nyon, Switzerland; [3]Neurosurgery, Valparaiso University Medical Center, Valparaiso, Chile; [4]Neurosurgery, Northwest Hospital and Medical School, Peshawar, Pakistan

(EDUCATION - PROCESS)

MOTIVATION: The UN and World Bank estimate that natural disasters cost over U.S.$500B and 100,000 lives yearly; "unnatural" disasters (industrial accidents, terrorism) add to mass casualties. An estimated 20,000 people died each day from lack of surgical facilities after the 2010 Haiti earthquake. Disaster response (DR) agencies (e.g., UN, Red Cross) are not on site until days to weeks after a disaster strikes. To improve survival, DR must be on-site within 24 hours. **OVERVIEW:** Trauma and stroke centers (TSCs) evolved with evidence that "24/7" immediate treatment dramatically improved morbidity/mortality. TSC equipment/personnel are seamlessly integrated into local healthcare delivery/training systems. We propose that DR - like TSCs - be integrated into healthcare systems worldwide as Disaster Response Centers (DRCs). A DRC includes a mobile trauma center (operating room with a car battery-powered CT, portable by helicopter) that can be operational at a disaster anywhere worldwide within hours. Remote-control camera telemedicine systems allow immediate on-site subspecialty guidance; drones can optimize utilization (eg, identify the living buried in rubble, triage medical resources for maximal benefit). The DRC concept has been presented at emergency/trauma/DR conferences worldwide and benefits from input/support by the World Federation of Neurosurgical Societies, the American College of Surgeons, UN disaster relief agencies, WHO emergency response, Chilean Health Ministry, etc. Initial DRC sites are planned for Iquique (northern Chile) and Peshawar (northwest Pakistan). Interestingly, the U.S. National Academy of Sciences has recently proposed a National Trauma System that integrates the military resources available for mass casualty response with the civilian TSC system – a national concept similar to our proposal for worldwide DR. **SIGNIFICANCE:** Disasters evoke a humanitarian response that suspends political, cultural and socioeconomic barriers that hinder collaboration on other global crises. This global "mega TSC system" would improve DR, establish global standards for emergency aeromedicine and medical/surgical training, and provide an unmatched universal platform for aeromedical/trauma research. DRCs, with multinational staff, would advance healthcare in developing countries. There are political, cultural, and socioeconomic benefits - beyond the aeromedical and healthcare benefits - of integrating DR into the ongoing global healthcare system.

Learning Objectives:
1. The participant will learn about the healthcare impact of disasters (both natural and man-made) worldwide, and the limitations of the current disaster response systems.
2. The participant will learn about the aeromedical resources available for immediate medical/surgical care in disasters.
3. The participant will learn about the benefits - both for disaster response and for global healthcare - of integrating disaster response into ongoing healthcare systems using the trauma/stroke center model.

4:30 PM
[111] TACTICAL COMBAT CASUALTY CARE FOR ARMY AVIATORS
S. Scott[1,2], N. True[3], M. Carman[4], M. Shapiro[5] and M. Zychowicz[1]
[1]School of Nursing, Duke University , Durham, NC; [2]Army National Guard, Raleigh, NC; [3]Army National Guard, Morrisville, NC; [4]Georgetown University, Washington, DC; [5]Trauma/Surgical Critical Care, Grady Health System, Atlanta, GA

(EDUCATION - PROCESS)

MOTIVATION: Preventable death on the battlefield has been a tragic and costly burden on the U.S. military. Most of these battlefield casualties died of their injuries before ever reaching a surgeon. Common battlefield injuries and injury patterns in survivable

helicopter crashes create a high risk for preventable death for rotator-wing aircrews, and there have been many historical difficulties for aircrews to provide point-of-injury care for casualties related to military rotatory-wing operations. This presentation will help military and civilian aerospace medical professionals gain an understanding of the importance of Tactical Combat Casualty Care (TCCC) in mitigating the risk of preventable death, and familiarize themselves with the unique challenges faced by non-medical trained rotatory-wing aircrews in caring for casualties both on and off the battlefield. **OVERVIEW:** TCCC is a set of best-practice prehospital trauma care guidelines customized for use on the battlefield shown to improve outcomes for combat casualties. This systematic approach makes it well suited for use in this setting. Army rotatory-wing aviators are at high risk for causalities because they operate at low altitudes to engage in direct action against enemy forces. Additionally, they often engage far away from medical facilities, typically do not have any medical personnel onboard, and can have longer wait times for medical evacuation services. Army aviators do not receive any standardized immediate life-saving care training and have significant limitations in rendering pre-hospital care in the austere environment related to helicopter operations. This presentation will review an education project implementing a TCCC for All Combatants course tailored specifically for rotatory-wing operations in a population of Army aviators who are current and qualified in the AH-64D Apache Longbow. **SIGNIFICANCE:** Army aviators currently do not receive any standardized pre-hospital care training and have distinctive challenges rendering pre-hospital care in the austere environment related to helicopter operations. A TCCC program tailored to the specific needs of rotatory-wing operations has potential to decrease the number of preventable deaths. This education program is of broad interest to any military and civilian aerospace medical provider in a position to provide training to military aviators.

Learning Objectives:

1. To understand the role of Tactical Combat Casualty Care in decreasing preventable death on the battlefield.
2. To recognize the unique challenges faced by military rotatory-wing aviators in treating casualties with injuries sustained in rotatory-wing operations.
3. To understand the need for TCCC training for military rotatory-wing aviators and aircrews and the importance of tailoring the training to helicopter operations.

4:45 PM
[112] THE IMPACT A MULTIDISCIPLINARY MEDICAL TEAM HAD ON FLIGHT OPERATIONS DUE TO LONG-TERM SICKNESS AS A RESULT OF MSK CONDITIONS

R.J. Pieterse
Group Medical, Emirates Airline, Dubai, United Arab Emirates

(EDUCATION - PROCESS)

MOTIVATION: The MSK unit managed work place injuries in flight attendants for many years. It was found that the majority of commercial airline pilots that were off work for an extended period were due to musculoskeletal conditions. The MSK-Unit got involved with the case management of these individuals. **OVERVIEW:** I have conducted a number of analyses in the past on the profiles and costs associated with work place injuries in flight attendants and demonstrated positive results of a multidisciplinary team in this group of patients. It was decided to get the MSK team involved in the case management of these pilots in order to standardise the approach to medical care and try and find solutions for specific problems, like the delay when a simulator assessment is required to determine fitness to fly. **SIGNIFICANCE:** The protocols put in place resulted in a significant reduction in lost productivity and positive impact on flight operations. A functional return to work assessment was developed to replace SIM assessment where possible, as a cheaper and faster means to determine fitness to resume normal flying duties. **DISCUSSION:** I will discuss the functional return to work assessment we have developed and the logic behind it. Benefits include cost reduction, reduction in time off work, improving regulator and pilot confidence that the individual is indeed fit to resume normal flying duties.

Learning Objectives:

1. There are benefits to working with different stakeholders and fostering relationships with them for the individual workers, the group as a whole, the medical team as well as the different departments.
2. The MDT need to understand the work environment and requirements of the individual to be able to identify high value areas for the different stakeholders.
3. The MDT need to collect data to analyse the effectiveness of protocols and procedures that were developed to address these high value areas.

5:00 PM
[113] THE ROLE AND SIGNIFICANCE OF AN AVIATION MEDICINE FLIGHT

M.E. Lewis
AIHF, RAF CAM, Baldock, United Kingdom

(EDUCATION - PROCESS)

MOTIVATION: Aviation medicine flight trails units deliver the interactions between aerospace medicine professionals and the Test and Evaluation (T&E) flight test world. The aim of these units is to understand the importance of airborne assessments to evaluate both separate items of aircrew equipment and complete life support systems, to provide on-aircraft high onset G training for pilots and to provide clinical support to aircrew, including motion sickness and flying phobias desensitization programs. **OVERVIEW:** The RAF has developed a unique Aviation Medicine Flight (AMF) which combines aviation medicine specialists with T&E aircrew. In a world of increasing regulation, governance and assurance the training and qualifications specialist need have had to be developed. Test Pilots or Flight Test Engineers have recognized formalized qualifications, but for aeromedical personnel (AMP) there are few if any courses specifically on T& E. Consequently, the RAF has proposed a qualifications protocol which will provide newly appointed AMP with skills to conduct flight trials. The aims are to provide: sound academic backgrounds, a philosophy that can be applied to any type of flight testing, the skills to analyze and present flight test results including data recording for real time monitoring of equipment and subject performance, and to develop a broad knowledge of aviation. The AMF has: utilized the medical and aircrew skills to deliver improved capabilities of integrated helmet mounted systems for the Typhoon and F35 programs, including neck injury mitigations, provided inflight clinical evaluations to return aircrew to flying duties with treated arrhythmias and respiratory diseases, and demonstrated how it has been instrumental in identifying the sequences of events which were involved in aircraft accident investigations. **SIGNIFICANCE:** AMF must have input at all stages equipment procurement from the initial specification requirements through to the design, test and evaluation, and introduction into service phases and continuing with the investigation of in service modifications, issues, incidents or accidents. The medical and T&E communities can learn from each other to better understand the of Risk-to-Life considerations, and to field better equipment and systems to improve air safety and deliver greater operational effectiveness.

Learning Objectives:

1. To understand the significance of aviation medicine qualifications in the T&E environment.
2. How aviation medicine flight can be used to improve flight safety and deliver enhancements to operational performance.

5:15 PM
[114] OBJECTIVE FATIGUE ASSESSMENT: FLYING, WORK AND REST ON EXERCISE GREEN FLAG WEST 04-17

I.A. Mollan, V. Cutler and A.C. Timperley
Aviation Medicine Wing, RAF Centre of Aviation Medicine, RAF Henlow, United Kingdom

(ORIGINAL RESEARCH)

INTRODUCTION: Fatigue reduction is a force preserver; higher levels of performance with increased productivity, fewer errors and incidents can be achieved with active fatigue risk mitigation. Aerospace medicine guidance and validated tools are available to inform flight schedule decision-making to achieve effective and safe programing.

METHODS: Data from reported sleep and scheduled work/flight programs were collected from all fast jet bomber crews over the 2-week duration Exercise. These were corroborated with actual tasks undertaken in the Exercise Flying Programme. Individual aircrew data from the 2-waves of sorties was categorized (simulated/live weapons release) and analysis undertaken using the Fatigue Assessment Scheduling Tool. **RESULTS:** 100% of pilots (n=18) participated. A total of 224 tasks were scheduled, comprising 129 (58%) flying including simulated weapons release, 12 (5%) live weapons release and 83 (37%) ground tasks. All weapons tasks were completed successfully; no accidents or incidents occurred. However, 18 (13%) flying tasks were undertaken with a retrospectively calculated effectiveness (FAST score) of less than 70%, with an average of 55% of these tasks being conducted below the '70% effectiveness' criterion. A total of 37 shift changes were conducted with 15 (41%) shift changes occurring after a programmed rest day and 22 (59%) occurring on a working day. On working day shift changes, 11 (50%) occurred immediately prior to ground tasks, 11 (50%) occurred immediately prior to flying tasks, 3 (17%) of which were immediately prior to live weapons release (2 on the last day of the exercise). Shift changing from late to early was associated with subsequent worse calculated effectiveness in 7 subsequent tasks. **DISCUSSION:** Existing fatigue mitigation policies were being used and were effective. However, a small number of flying tasks (18 (13%) of all flying tasks) were undertaken with sub-optimal effectiveness; this may represent a risk to mission and flight safety. Further research should be undertaken to enhance data quality and capture by the objective measurement of sleep and rest using actigraphy or polysomnography. Examination of the widely-used Operational Risk Matrices should be studied to determine their usefulness.

Learning Objectives:

1. Recognize that fatigue mitigation is relevant as a force multiplier to air operations.

Monday, May 07 ***4:00 PM***
Ballroom A

S-025: SLIDE: PHYSIOLOGICAL RESPONSES TO FLIGHT

Chair: Brent Haskell
Georgetown, KY

Chair: Scott Shappell
Daytona Beach, FL

4:00 PM
[115] HELMET SYSTEMS ASSESSMENT RESULTS TOWARDS AIRCREW NECK PAIN MITIGATION

P.S. Farrell[1], E. Maceda[1], A. Niri[2], C. Apostoli[3], C. McGuinness[4], J. Vallikanthan[4] and T. Karakolis[4]
[1]Human Effectiveness Section, Defence Research and Development Canada, Toronto, ON, Canada; [2]Canadian Forces Experimentation Centre, Department of National Defence, Toronto, ON, Canada; [3]Engineering, University of Toronto, Toronto, ON, Canada; [4]Operational Health and Performance Section, DRDC, Toronto, ON, Canada

(ORIGINAL RESEARCH)

INTRODUCTION: Over the past four years, Defence Research and Development Canada (DRDC) and Canadian Forces Environmental Medicine Establishment (CFEME) have been assessing potential solutions to CH 146 Helicopter aircrew neck trouble prevalence rates of 75% (Chafé & Farrell, 2016). The Helmet System Assessment (HSA) study involved comparing the in-service (IS) HGU 56/P helmet system to the Improved HGU 56/P (IH) and the Alpha Eagle (AE), both of which claim to have better mass properties and helmet fitting capability than IS. (The 'helmet system' includes helmet plus night vision goggles, battery pack and counterweights.) The metrics used to compare the helmet systems were external neck loading, neck cumulative muscle activation (CMA), perceived neck muscle exertion, and perceived neck trouble after a typical mission. The overarching premise is that if IH and/or AE fares better than IS with respect to these metrics, then it is likely that the risk of neck pain would be reduced for IH and AE helmet systems. **METHODS:** Thirty-nine pilots and Flight Engineers (FEs) ran through three 10-minute scenarios; one for each helmet. Motion capture, electromyography, and two questions were collected for each helmet condition. Within subject statistical tests were conducted to determine any significant differences amongst helmet system pairwise comparisons. **RESULTS:** CMA with AE was significantly less than IH and IS. CMA was consistently higher for FEs than pilots. While there were no significant differences in neck loads amongst the three helmets, the data shows that IH affords more head and neck movements than AE and IS afforded the least movements. Perceived muscle exertion for pilots with IH was significantly less than IS, while FEs did not perceive any difference between the three helmet conditions. Finally, pilots anticipated the smallest impact on neck trouble during a typical mission with AE, followed by IH and then IS. **DISCUSSION:** We conclude that both IH and AE fared better than IS, and therefore have the potential to reduce the risk of aircrew neck trouble. The HSA trial results have been provided to the Royal Canadian Air Force, along with several other solutions, and have been part of their decision to implement various solutions into operations. Researchers will have an opportunity to track aircrew neck pain over the next few years, and see if, in fact, the solutions reduce aircrew neck pain prevalence rates.

Learning Objectives:

1. Electromyography and motion capture data can be used to generate muscle activity and neck load metrics, respectively. These metrics can be used to distinguish between helmet systems.
2. Participants seem to have a kinesthetic sense of how much mass is on their heads, and they are willing to move faster for a lighter helmet (and vice versa), thus the neck loads remain constant regardless of the helmet system.
3. Subjective data can be used to confirm objective data results.

4:15 PM
[116] PHYSIOLOGICAL RESEARCH CHALLENGES IN EJECTION SEAT TEST AIRCRAFT

D. Carroll
Technical Support, USAF Test Pilot School, Palmdale, CA

(EDUCATION - TUTORIAL)

PROBLEM STATEMENT: The challenges of monitoring and recording aircrew physiological parameters, synchronizing them with the aero environment, repeating and balancing the tests among a statistically significant number of subjects are just the beginning of the technical considerations. There are significant operational, logistic and safety challenges as well. **TOPIC:** Monitoring recording and transmitting the blood pressure, SpO_2, heart rate, respiration rate as well as inhalation and exhalation flows and any other physical parameters of a pilot in an ejection seat while airborne is not straightforward. Knowing the partial pressure of gasses in the cockpit and the breathing mixture requires special & costly installations. Synchronizing these with aircraft accelerations and other state data requires a dedicated data system. Having a subject execute cognitive tests in flight requires preparation and practice. Much of the test may be rehearsed in a flight simulator to whittle down the time it takes to complete. Compared to a laboratory, very few data runs are available on any particular flight. Extremely few subjects (usually one or two) will be providing data on any particular sortie. A methodic test plan is required to maximize defendable data in flight test research involving ejection seat aircraft. The scientist will appreciate the basic additional considerations when preparing an experiment for flight test in a high performance aircraft. How does one get data from the test subject in an ejection seat to a recorder? Why would wind blast be a factor in sensor selection? After the IRB who else must review the test, the installation and the process? **APPLICATIONS:** A well designed physiology based flight test must consider the technical and operational constraints, of obtaining each parameter from the aircraft and environment as well as the subject. The scientist must work with the flight test plan developers in an iterative way to achieve maximum success while possibly constrained by regulations, flight safety considerations and logistics.

Learning Objectives:

1. Understand the basic scope of preparing a physiologic experiment for flight test.

4:30 PM

[117] SPINAL INJURY RISK ASSOCIATED WITH MIL-S-58095 AIRCREW SEAT PERFORMANCE REQUIREMENTS

J. McEntire[2], K. Logsdon[2], F. Brozoski[2], G. Lidl[2], R. Daniel[1,2], A.S. Dargie[1,2] and E.L. Mazuchowski[3]
[1]Laulima Government Solutions, LLC, Orlando, FL; [2]US Army Aeromedical Research Laboratory, Fort Rucker, AL; [3]Joint Trauma System, San Antonio Military Medical Center, Ft Sam Houston, TX

(ORIGINAL RESEARCH)

INTRODUCTION: Military specification MIL-S-58095 was used for procurement of pilot seats for the H-60 Blackhawk helicopters. MIL-S-58095 compliant seats employ energy attenuation devices to limit crash-induced vertical force transmission to the occupant. This capability is intended to mitigate spinal injury risk by reducing the peak vertical acceleration levels. MIL-S-58095 prescribes dynamic test conditions and the acceptable performance limits for compliance. No validation studies have been performed to demonstrate the appropriateness of the standard. **METHODS:** The USAARL Vertical Acceleration Tower (VAT) was used to expose post mortem human specimens (PMHS) to seat bucket accelerations consistent with MIL-S-58095 (i.e., peak vertical acceleration of 20 +/- 1 G, 12.8 +/- 0.5 meters per second velocity change, 950 +/- 50 G per second acceleration onset rate). Sensors were affixed to the acceleration carriage and test specimens to capture exposure levels and specimen response. Specimen displacement was recorded on high-speed video. To document sensor locations and injury, pre- and post-exposure CT images were captured and specimen dissection performed. The protocol requires male specimens to be positioned on a rigid seat, restrained with a 5-point restraint system, and lightly clothed in a body suit. This research study and the acquisition of PMHS specimens are in compliance with the Army Policy for Use of Human Cadavers. **RESULTS:** Data has been collected from three PMHS specimens (63-73 yrs, 170-193 cm, 77-93 kg). High-speed video analysis of specimen response during the acceleration phase reveals vertical compression of the specimen thorax to be substantially greater than the observed response of automotive anthropometric tests devices. All three specimens received multiple thoraco-lumbar spine fractures, to include anterior wedge and burst fracture types. One specimen also sustained multiple pelvic fractures. All specimens exhibited multiple rib fractures. **DISCUSSION:** The observed injuries suggest that MIL-S-58095 requirement may need to be revised. Confounding variables for application to the military population include: specimen age adjustment, absence of a seat pan cushion, the 90 degree seat pan to back angle, general specimen condition, and absence of ALSE gear. Additional data collection and analysis are required to address these limitations.

Learning Objectives:

1. To understand the injury types possible to be sustained during seated whole-body exposure to vertical accelerations and how human tolerance impact crashworthy seating system design requirements.

4:45 PM

[118] BIOMARKERS, CO-MORBIDITIES, AND NEURO-COGNITIVE EVALUATION, IN THE AEROMEDICAL ASSESSMENT OF THREE HIV-POSITIVE PILOTS

E.M. Ricaurte
Safety Risk Management-AAM-3, Venesco, LLC/FAA-CAMI, Oklahoma, OK

(EDUCATION - CASE STUDY CLINICAL)

INTRODUCTION: HIV-positive pilots without Acquired Immunodeficiency Syndrome (AIDS) may be considered for any class medical certificate. A current viral load, CD4 and lymphocyte count, and current assessment of CogScreen-AE or other test battery with a neuropsychological evaluation are required. HIV-associated neurocognitive disorders (HANDs) are common, frequently undetected, and can impact aviation safety. Lower CD4 count has been identified as a risk factor for neurocognitive impairment. Comorbidities such as major depressive disorder (MDD) are a predictor of poorer treatment outcomes, reduced medication adherence, and increased cognitive complaints. Also, individuals with HIV-Hepatitis C Virus Co-Infection may be vulnerable to neurocognitive impairment. The benefits of routine cognitive screening to detect impairment in HIV-positive patients remain unclear. This case presentation highlights the assessment of CD4, viral load (VL), and neurocognitive function in asymptomatic applicants. **METHODS:** Three asymptomatic cases were selected from a random list of HIV-positive pilots extracted from the FAA Document Imaging Workflow System. **RESULTS:** ***Case 1:*** 36 yo CL3 pilot, diagnosed HIV+ 5 years before his last physical exam (PE), with medical history of Hepatitis-C, polysubstance abuse, and arrest. Prescribed Atripla and Harvoni. Cogscreen-AE LRPV=1.00, CD4 count: 706 and VL: Undetected (<20). ***Case 2:*** 64 yo CL1 pilot, diagnosed HIV+ 21 years before his last PE, medical history of MDD and cardiovascular disease, with nine consecutive abnormal Cogscreen-AE LRPV scores (>0.600) since 2002. Prescribed Atripla. ***Case 3:*** 67 yo CL3 pilot, diagnosed HIV+ 17 years before his last PE, with medical history of AIDS defining illness (pneumocystis carinii pneumonia), abnormal CogScreen-AE, and CD4 count of 128. Prescribed Viracept and Combivir. **DISCUSSION:** Aerospace Medical Certification Division Decision (AMCD) general requirements and individual considerations of multiple factors for a complete aeromedical assessment will be discussed. Ongoing AMCD efforts to evaluate the current risk of neurocognitive impairment will be supported by data analysis from larger pilot population.

Learning Objectives:

1. To emphasize the value of biomarkers, co-morbidities, and neurocognitive evaluations in HIV-Positive pilots, from an aeromedical certification standpoint.

5:00 PM

[119] ESTIMATED DOSE OF IONIZING COSMIC RADIATION IN AIR ROUTES OF COLOMBIAN OPERATORS

J.C. Camacho and H. Fajardo
Universidad Nacional de Colombia, Bogota, Colombia

(ORIGINAL RESEARCH)

INTRODUCTION: Flight workers are constantly exposed to different hazards, one of those is Galactic Cosmic Radiation (GCR). This kind of radiation is about 40% of all natural radiation and it is increased at high altitudes and polar regions. In 1994, the International Commission on Radiological Protection (ICRP) recognized aircrews as an occupationally exposed population and because of this, it is important to follow the recommended limits for radiation exposure. There are many studies about this problem as it occurs in polar regions, but in equatorial regions the evidence is low, and there is not studies that address Colombia. The aim of this research was to estimate the GCR dose in different national and international routes of commercial aviation in Colombia, with the aim to know the level of occupational risk present in this population. **METHODS:** This was a descriptive cross-sectional study in national and international flight routes in Colombia, taking a maximum amount of pilot duty hours of 1000 hours/yr. This value was established by the civil aeronautics authority in Colombia. Other variables considered were: the International Civil Aviation Organization (ICAO) codes for each airport, type of aircraft, airport altitude, distance between airports, cruising altitude and time, ascent and descent rate. The effective dose was calculated using three solar radiation software: EPCARD, PCAIRE and CARI-6. **RESULTS:** In international flights the highest exposure routes were from Bogota to London with a dose of 5.82 mSv/yr and from Bogota to New York with 5.27 mSv/yr. The lowest were to Panama City with 1.78 mSv/yr and Guayaquil with 1.94 mSv/yr. For national flights the highest exposure routes were to San Andrés with 2.7 mSv/yr and Leticia with 2.16 mSv/yr. The lowest to Ibague 0.34 mSv/yr and Armenia 0.2 mSv/yr. **DISCUSSION:** An estimated dose exceeding 1 mSv/yr was found in all international routes, while in the national flight scenarios this value was reached as measured with PCAIRE and CARI-6 in almost a half of the routes. The data found agree with what was expected, since the majority of the members of a crew with 750 hours of flight are expected to receive exposures above 1 mSv/yr. Is important to carry out new studies taking into account the exact duty hours for each pilot and the different routes in which they fly in their real situation as well as studies through the use of dosimetry.

Learning Objectives:

1. An overview of galactic cosmic radiation in aviation as it relates to occupational health in Colombia.

5:15 PM

[120] ASSESSMENT OF FINGER TAPPING TEST FOR HUMAN FATIGUE AND EFFECTIVENESS OF GLUTAMIC ACID SUPPLEMENTATION AT HIGH ALTITUDE

M. Khan[1], A.K. Salhan[2] and S.K. Sharma[2]
[1]*Electrical Engineering, Jamia Millia Islamia, New Delhi, India;* [2]*Defence Institute of Physiology and Allied Sciences, Defence Research and Development Organisation, Timarpur, India*

(ORIGINAL RESEARCH)

BACKGROUND: Finger Tapping Test (FTT) has a long history in the field of neuropsychology and called as a standalone test. Aim of the study is to see how a short duration finger tapping test is affected (i) at high altitude and (ii) with supplementation of glutamic acid. **METHODS:** Data was acquired from 30 healthy young volunteers aged between 24 to 28 years on sea level (SL) and high altitude (HA) of 10700 feet. All subjects were right hand dominant. The signal was acquired for movement of index finger tapping for 30 seconds of all the subjects. 30 subjects were randomly divided into two groups. 15 subjects were administered oral glutamic acid as supplementation group (SG) and rest was designated as the control group (CG). Tapping was recorded for 30 seconds on ppg probe of Biopac System and time noted for first 10 taps and last 10 taps from the recordings. At SL, the CG took 1.99 secs for first 10 taps and 2.27 secs for last 10 taps. The corresponding values for SG were 2.13 and 2.37 secs respectively. At HA, average δT for start and end taps was 2.12 and 2.49 secs for CG and 2.31 and 2.63 secs for SG. Corresponding average area was 66.15 and 77.87 for CG and 81.27 and 93.69 for SG. Tap Index for start was 31.28 for CG and 30.38 for last 10 taps. Corresponding values for SG were 34.60 and 35.38. **RESULTS:** Area under curve signifying extent of up-down movement of the finger found as 67.51 for start and 87.34 for end taps for CG and 77.48 for start and 95.85 for CG. The δT for start and end 10 taps for both groups was highly significantly increased in 30 secs ($p<0.00001$) signifying slowing of finger taps. Tap Index was created by dividing the area by δT and found significantly different ($p<0.05$) in both groups at SL. **DISCUSSION:** Comparing SL and HA values shown significant increase in δT in both CG ($p<0.05$) and SG ($p<0.005$) for first 10 taps however δT for end taps was significantly increased ($p<0.005$) for CG but a non-significant increase was seen in SG ($p=0.476$). There is a highly significant slowing of tapping speed by 30 seconds in both the groups ($p<0.00001$). The significance of slowing was more at HA ($p<0.000001$) in both the groups. **CONCLUSION:** Short time FTT for 30 secs may be effectively used as a simple and quick test for assessment of effect of HA on neuromuscular performance and also to study effect of supplements.

Learning Objectives:

1. How supplementation of glutamic acid affects small muscle performances?
2. How supplementation of glutamic acid affects small muscle performances at high altitude?
3. How short duration Finger Tapping Test can be utilized at high altitude?

TUESDAY, MAY 8, 2018

Tuesday, May 08 ***8:30 AM***
Chantilly East

5th MEMORIAL REINARTZ LECTURE

Ronald Przygodzki, M.D.

"Genomic Medicine: What, How and Where?"

Tuesday, May 08 ***10:30 AM***
Ballroom D

S-026: SLIDE: GZ ACCELERATION

Chair: Alden Hilton
Dayton, OH

Chair: Deborah White
Poulsbo, WA

10:30 AM

[121] CUMULATIVE +GZ EXPOSURE AND ITS EFFECT ON ACCELERATION ATELECTASIS

R.D. Pollock, H.D. Tank, F.L. Edwards and A.T. Stevenson
QinetiQ, Farnborough, United Kingdom

(ORIGINAL RESEARCH)

INTRODUCTION: Recently there has been an increased reporting of acceleration atelectasis by fast jet aircrew. In the majority of individuals >60s exposure to +Gz is required for its development while it is believed that breathing gas mixtures containing <60% O_2 prevent it. However, the effects of cumulative exposure to +Gz acceleration have not been investigated and, given reports of acceleration atelectasis, the assumed protection from breathing <60% O_2 may no longer be valid. **METHODS:** Fifteen subjects, wearing full coverage anti-G trousers, completed four centrifuge exposures to 1, 2, 3 or 4 peaks of +5Gz, lasting 30s, separated by 15s nadirs at +1.4Gz. Exposures were performed twice with subjects breathing gas mixtures containing either 94% or 60% O_2 under Gz. Acceleration atelectasis was assessed after each exposure by measurement of forced inspiratory vital capacity (FIVC) and regional lung (basal) FIVC (rFIVC - by electrical impedance tomography). Pulmonary shunt was estimated from breath-by-breath measures of end-tidal O_2 concentration and peripheral oxygen saturation (SpO_2) obtained during a switch of the breathing gas to one containing 14% O_2. The minimum SpO_2 during this period was also recorded. **RESULTS:** Compared to baseline FIVC and rFIVC were significantly lower after all peaks in Gz breathing 94% O_2 ($P=0.012$). FIVC significantly declined after 4 peaks of Gz while breathing 60% O_2 ($P=0.015$) while there was a tendency for rFIVC to be lower after all Gz exposures when breathing 60 % O_2. There was a tendency for a greater number of peaks in Gz to cause a larger pulmonary shunt ($P=0.125$) which was more exaggerated when breathing 94% O_2 ($P=0.087$). The hypoxaemia during a hypoxic exposure post Gz was significantly lower after breathing 94% O_2 ($P=0.007$) and when a greater number of Gz peaks were performed ($P=0.003$). **DISCUSSION:** This is the first study to show that cumulative exposure to +Gz is capable of eliciting increasing levels of acceleration atelectasis, with >30s cumulative exposure sufficient to cause this when breathing high O_2 concentrations. With sufficient cumulative +Gz exposure, 60% O_2 is not capable of preventing acceleration atelectasis indicating a lower inspired O_2 concentration may be required to prevent acceleration atelectasis. The increased reporting of acceleration atelectasis may be due to the inspired O_2 concentrations not being sufficiently low to prevent it along with its gradual development over an entire sortie.

Learning Objectives:

1. To understand how cumulative exposure to +Gz acceleration influences acceleration atelectasis.
2. Recognize the importance of inspired O2 concentration on the development of acceleration atelectasis.

10:45 AM

[122] VARIATION OF CARDIAC PARAMETERS BEFORE THE TERMINATION OF G FORCE DURING OPERATING ANTI-G STRAINING MANEUVER

C. Lai[1], H. Chu[2], C. Liu[3] and M. Tu[1]
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(ORIGINAL RESEARCH)

INTRODUCTION: When pilots are exposed to high G environment, blood will be impelled toward the lower body. Without proper protection, visual disturbance such as grayout, blackout, tunnel vision and G force induced loss of consciousness (G-LOC) may ensue. Anti-G straining maneuver (AGSM), which increases preload of the heart, is the most important guard against acceleration force and prevent fighter pilots from G-LOC. An objective evaluation of cardiac performance during AGSM would provide insight into acceleration training effectiveness. **AIMS:** To describe the cardiac indices characteristics of subjects while performing AGSM in the centrifuge and to compare these data between