TUESDAY, May 2, 2017

Tuesday, May 2 ***8:30 AM***
Grand Ballroom

4th ANNUAL REINARTZ LECTURE

Michael A. Berry, M.D., M.S.
"Have Flight Surgeons and Aerospace Medicine Made Aviation Safer?"

Tuesday, May 02 ***10:30 AM***
Plaza A/B

S-030: PANEL: SEX AND THE NAVAL AVIATOR, THE SEQUEL: HPV DISEASE BURDEN

Chair: Charles Reese
Pensacola, FL

Chair: Georgia Stoker
Pensacola, FL

PANEL OVERVIEW: This panel presents a discussion of the burden of disease represented by Human Papilloma Virus (HPV), the most common sexually transmitted infection in the United States. Persistent HPV infection is a significant risk factor for anogenital and oropharyngeal cancers. Globally, half a million cancer cases are associated with HPV, with over 295,000 HPV-associated cancer deaths each year. Effective screening and prevention strategies exist that can significantly reduce the nearly 39,000 cases of newly diagnosed HPV-associated cancers and associated mortality within the US. The first presentation will introduce HPV's association with oropharyngeal squamous cell carcinoma and how HPV has changed the face of this disease process, including a shift in risk factors. Our second presentation will review the virology of HPV, and elucidate how this viral infection has developed its oncogenic potential. Our third panel presentation will review the extensive list of HPV-associated malignancies, which will help underscore the broad scope of disease represented by this virus. Finally, a review of the current vaccine options available, the recommended vaccination schedule proposed by the Advisory Committee on Immunization Practices (ACIP), and current screening options available will be presented. It is hoped that this panel will provide the audience with a better understanding of HPV-associated disease and arm the clinician with the tools to advocate for and counsel patients on recommended screening and preventive strategies.

[149] SEX AND THE NAVAL AVIATOR, THE SEQUEL: HPV ASSOCIATED OROPHARYNGEAL CANCER

C.A. Reese
Otolaryngology, Naval Aerospace Medical Institute, Pensacola, FL

MOTIVATION: There has been a dramatic increase in the incidence of Human Papilloma Virus (HPV) associated oropharyngeal carcinoma. It can justifiably be considered a "Sexually Transmitted Disease." Educating healthcare providers as well as our patient population regarding this "epidemic" will hopefully have an impact on its occurrence. Recognizing associated risk factors, clinical behavior and treatment outcomes of this cancer will lead to more effective planning for a potential return to a career in aviation in aviation personnel who develop this cancer. **OVERVIEW:** HPV is associated with the development of a number of cancers, to include cervical, vaginal, vulvar, penile, anal, and oropharyngeal cancers. Based on CDC data from 2008-2012, nearly 40,000 HPV-associated cancers were diagnosed annually within the US. Among men, oropharyngeal squamous cell carcinoma is the most commonly diagnosed HPV-associated malignancy. In the US, the broader category of head and neck squamous cell carcinoma just misses the "Top 10" of cancer sites, falling just behind thyroid cancer. Globally, head and neck cancer ranks sixth overall, and accounts for almost half of cancer cases in India/Southeast Asia. As tobacco use has decreased in the US, the overall incidence of head and neck squamous cell carcinoma has also decreased, but there has been a disturbing increase in the rate of oropharyngeal squamous cell carcinoma since 1995. This increase has been shown to be due to infection with high risk HPV, in particular, HPV-16. There is a new face to oropharyngeal cancer, occurring at a younger age, in non-smokers and social drinkers, presenting at a higher stage at the time of diagnosis, and 70-90% of cases are associated with HPV-16. This presentation discusses the changing demographics of oropharyngeal cancer, as well as the diagnosis, treatment, and prognosis for a return to a career in aviation for individuals who are diagnosed with this cancer. **SIGNIFICANCE:** As clinicians and leaders in public health, having an understanding of the disease process and current intervention strategies available can lead to a reduction in HPV- related disease burden, reduce lost man-hours due to disease or caring for a loved-one, keep a ready force, and most importantly save lives. Approved for public release; distribution is unlimited. The views expressed herein are those of the authors and do not necessarily reflect the official position of the Department of Defense or its components.

Learning Objectives:

1. Develop an awareness of the role of high risk HPV infection, primarily HPV 16, in the development of oropharyngeal squamous cell carcinoma in order to provide meaningful information to our patient population.
2. Recognize the potential differences in the behavior of HPV-associated oropharyngeal cancer compared to "classical" oropharyngeal cancer and therefore potential differences in treatment and outcomes for individuals who develop HPV associated oropharyngeal squamous cell carcinoma versus those whose cancer is HPV negative in order to more effectively participate in the care and counseling of our patients.
3. Recognize the changing demographics of "throat cancer." The typical patient with HPV-associate oropharyngeal carcinoma is not a heavy drinker and smoker, it is a younger urban professional white male. Develop a higher level of suspicion regarding the potentially subtle presentation of HPV-associated oropharyngeal carcinoma which more commonly presents with a neck mass rather than an ulcerated lesion in the oropharynx.

[150] SEX AND THE NAVAL AVIATOR, THE SEQUEL: HPV-ASSOCIATED MALIGNANCIES OTHER THAN CERVICAL CANCER

J. Kiser
479 OSS, Pensacola, FL

MOTIVATION: Most physicians are acutely aware of the links between Human Papilloma Virus (HPV), PAP smear abnormalities, and ultimately cervical cancer. However, less attention is devoted to other non-cervical malignancies related to persistent high risk HPV infections. Although lower in incidence in the United States; vaginal, vulvar, penile, and anal malignancies also share a link with HPV. Our goal is to increase the awareness of these less discussed malignancies in the primary care setting and identify risk factors and behaviors associated with these diseases. **OVERVIEW:** HPV is associated with the development of a number of cancers, to include cervical, vaginal, vulvar, penile, anal, and oropharyngeal cancers. Less commonly discussed than cervical cancer; vaginal, vulvar, penile, and anal malignancies still represent a significant disease burden associated with HPV. In the United States from 2004-2007, there occurred on average 11,845 annual cases of cervical cancer. For females, this number eclipses the lower incidence of the 714 vaginal, 3,062 vulva, and 2,977 anal malignancies, and for males the 1,000 penile and 1,618 anal malignancies. Despite the lower prevalence, it is imperative for the primary care provider, such as the flight surgeon, to be aware of these HPV related malignancies as they can share similar risk factors to that of cervical cancer such as number of sexual partners, history of genital warts, smoking, and risky sexual behavior. **SIGNIFICANCE:** As clinicians and leaders in public health, having an understanding of the disease process and current intervention strategies available can lead to a reduction in HPV-related disease burden, reduce lost man-hours due to disease or caring for a loved-one, keep a ready force, and most importantly save lives. Approved for public release; distribution is unlimited. The views expressed herein are those of the authors and do

not necessarily reflect the official position of the Department of Defense or its components.

Learning Objectives:

1. Describe the epidemiology and risk factors of vaginal, vulvar, penile, anal malignancies and the role that HPV plays in each of these.
2. Discuss the findings at the time of presentation for these malignancies.
3. Evaluate clinical or laboratory tests if any for these conditions.

[151] SEX AND THE NAVAL AVIATOR, THE SEQUEL- HPV PREVENTION STRATEGIES

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

MOTIVATION: Human Papilloma Virus is a ubiquitous pathogen, and one that infects millions of individuals each year. Though only a fraction of these cases will develop HPV-associated cancer, the number of lives lost is sobering. Effective and safe vaccinations exist that can protect the population and reduce the number of lives lost each year to HPV-associated cancers. **OVERVIEW:** As the most common sexually transmitted infection in the US, HPV causes a significant clinical disease burden. Given the availability of a vaccine that has been shown to be effective in preventing the very HPV infections that lead to HPV-associated carcinomas, it is disheartening to realize HPV vaccine uptake in the US is less than half of the goal set by Healthy People 2020, with only 40% of US female adolescents and 22% of male adolescents having completed the series. There are currently three versions of the HPV vaccine available in the US. The vaccines should be used to fulfill the ACIP's recommendation to vaccinate children of both genders, ideally between 11-12 years of age, with an opportunity to catch up between ages 13-26. Sadly, inadequate provider recommendation has been listed as one of several barriers to reaching vaccination goals and represents a missed opportunity to potentially save over 295,000 lives around the world each year. **SIGNIFICANCE:** As clinicians and leaders in public health, having an understanding of the disease process and current intervention strategies available can lead to a reduction in disease burden, reduce lost man-hours due to disease or caring for a loved-one, keep a ready force, and most importantly save lives. Approved for public release; distribution is unlimited. The views expressed herein are those of the authors and do not necessarily reflect the official position of the Department of Defense or its components.

Learning Objectives:

1. To enable recognition of the currently available vaccinations series against Human Papilloma Virus.
2. To demonstrate an understanding of Advisory Committee on Immunization Practices (ACIP) recommendations for HPV vaccination.
3. To demonstrate an understanding of current cervical cytology screening recommendations.

[152] SEX AND THE NAVAL AVIATOR, THE SEQUEL: VIROLOGY AND ONCOGENIC POTENTIAL OF HPV

I.M. Porter
Residency in Aerospace Medicine, Naval Aerospace Medical Institute, Pensacola, FL

MOTIVATION: Understanding how the Human Papilloma Virus (HPV) functions, replicates and infects the human body is part of our fundamental knowledgebase as clinicians. Virology research has led to an understanding of the oncogenic potential, the development of effective immunizations, and the identification of high risk strains of HPV. Continued efforts to study this virus have the potential to improve patient treatment and also to identify new therapeutic targets in the future leading to both direct and indirect benefits for the aviator. **OVERVIEW:** HPV is the most common sexually transmitted infection in the U.S., with 79 million Americans currently infected, and 14 million new infections predicted each year. Of these 14 million HPV infections, an estimated 40,000 HPV-associated cancers will result. Understanding how a virus can lead to the malignant transformation of cells is essential to understanding the disease process of HPV-associated cancers. There are more than 150 genotypes of HPV. Based on specific characteristics, they are divided into multiple genera. The alpha genus includes those HPV strains that affect human cutaneous and mucosal surfaces. These strains are further characterized as high risk (HR-HPV) and low risk (LR-HPV). The majority of HPV infections, both high risk and low risk, resolve spontaneously. Nearly all sexually active men and women will acquire an HPV infection at some point in their lifetime. For this reason, HPV can be considered "the URI of the genital tract." Only a small percentage develops a persistent infection and these are the individuals with the potential to develop cancer as a result. The importance of continued efforts to better understand this virus is highlighted by the potential to develop new therapeutic targets as well as the ability to perhaps improve clinical outcomes for these patients. **SIGNIFICANCE:** As clinicians and leaders in public health, having an understanding of the disease process and current intervention strategies available can lead to a reduction in HPV-related disease burden, reduce lost man-hours due to disease or caring for a loved-one, keep a ready force, and most importantly save lives.

Learning Objectives:

1. To enable identification of low and high risk HPV strains and associated cancers.
2. To demonstrate understanding of the gene structure and resulting translational protein products of HPV.
3. To be able to identify specific cell targets and the oncogenic potential of HPV.

Tuesday, May 02 ***10:30 AM***
Plaza D/E

S-031: PANEL: NEUROLOGIC EFFECTS OF HYPOBARIC EXPOSURE

Chair: Paul Sherman
Boerne, TX

PANEL OVERVIEW: This panel presents the results of ongoing international collaborative human and animal research regarding the effects of hypobaric exposure on the human brain. A strong association has been demonstrated between subcortical white matter injury and exposure to U.S. Air Force operational non-hypoxic hypobaric conditions. The first presentation reviews evidence of both diffuse axonal injury in normal-appearing white matter in U-2 pilots as well as subcortical white matter lesions and describes transient cerebral blood flow changes after a single exposure to hypobaric hypoxic conditions in an altitude chamber. The second presentation describes cellular metabolic changes in the brain associated with occupational altitude chamber exposure. The third presentation reviews white matter hyperintensity findings in United Kingdom altitude chamber trainers and research volunteers. The fourth presentation describes the association of white matter hyperintensities and neurocognitive decrements in decompression-exposed trades. The final presentation reviews screening MRI findings and functional consequences in German altitude chamber instructors. The goal of our multinational research is to understand the pathophysiology of hypobaric exposure-related white matter injury changes and optimally protect our aircrew during mission performance.

[153] TRANSIENT BRAIN INJURY DURING ROUTINE AIRCREW TRAINING HYPOBARIC EXPOSURE – SINGLE EXPOSURE TRIAL AT 2 YEARS

P.M. Sherman
Human Performance/Radiology, USAF School of Aerospace Medicine; Wilford Hall ASC, Boerne, TX

INTRODUCTION: We previously reported increased subcortical white matter (WM) injury and global decreased fractional anisotropy associated with repetitive occupational exposure to non-hypoxic hypobaric conditions in both aerospace physiology inside observers and high-altitude U-2 pilots. A single hypobaric hypoxic occupational exposure to 7,620 m induces transient magnetic resonance imaging (MRI) changes. **METHODS:** This study was approved by the 59th Medical Wing Institutional Review Board. Subjects underwent advanced MRI brain examinations (Siemens 3-T Verio magnet) 24 h pre-exposure and 24 and 72 h post-exposure with quantification of findings. No subject

experienced decompression sickness symptoms. Eighty U.S. Air Force aircrew trainees and 15 aerospace physiology inside observers undergoing standard occupational altitude chamber training exposure to 7,620 m (5.45 psi) and 45 age-matched control subjects not exposed to hypobaria were evaluated. MRI protocol included fluid-attenuated inversion recovery images, magnetization-prepared rapid gradient-echo sequences, magnetic resonance spectroscopy within the frontal WM and anterior cingulate gyrus, diffusion tensor and Q-space imaging, and arterial spin labeling perfusion imaging. Statistical analysis was performed with a two-tailed t-test. **RESULTS:** WM cerebral blood flow (CBF) at 24 h post-exposure increased by 6% (p=0.004) while gray matter (GM) CBF increased by 5% (p=0.065). At 72 h post-exposure, CBF remained significantly elevated (WM 6%, p=0.021; GM 6%, p=0.037), with no statistical difference in CBF between the 24-h and 72-h MRI. No significant change in CBF was observed in the control subjects. Diffusion tensor imaging, magnetic resonance spectroscopy, and Q-space analyses demonstrate observable trends between MRI #1 and MRI #2 that return to baseline on MRI #3. There were no WM fluid-attenuated inversion recovery changes. **DISCUSSION:** These results demonstrate an upregulation of both GM and WM CBF following exposure to occupational hypobaric training that persists up to 72 h following exposure. This reflects an increased metabolic demand and suggests a transient cerebral injury has occurred. Findings lend additional support for a diffuse process inciting cerebral injury following hypobaric exposure. Repetitive injury with repetitive hypobaric exposure may represent an underlying basis for previously reported subcortical WM injury.

Learning Objectives:

1. Review the current research regarding the effects of recurren hypobaric exposure upon the brain.
2. Understand the effects of a single hypobaric exposure upon the brain with quantitative MRI findings.

[154] WHITE MATTER MRI SURVEY OF UK PARTICIPANTS IN ALTITUDE CHAMBER RESEARCH AND TRAINING

D.M. Connolly[1] and P.D. Hodkinson[2]
[1]Aircrew Systems, QinetiQ plc, Farnborough, United Kingdom; [2]RAF Centre of Aviation Medicine, Hitchin, United Kingdom

INTRODUCTION: Increased white matter hyperintensities (WMH) have been reported in USAF U-2 pilots and aerospace operational physiologists. A brain magnetic resonance imaging (MRI) survey of UK participants in altitude chamber research and training (UKP) is being conducted to further inform the association between occurrence of WMH and intensity of exposure to decompression stress. **METHODS:** Eligible candidates, aged 26 to 50 years with at least 10 past exposures above 15,000 ft pressure altitude (PA) in a hypobaric chamber, are undergoing 3-D volumetric 'FLAIR' MRI at the Sir Peter Mansfield Imaging Centre, University of Nottingham, UK, reproducing USAF scan sequences. To validate comparison with USAF cohorts, anonymised MRI data are being reanalysed at the University of Maryland, Baltimore, USA. Detailed metrics of altitude chamber hypobaria encompass exposure frequency, rapid decompressions, pressure breathing, hypoxia experience, extended duration exposures (>1 h) and occurrences of decompression sickness (DCS). **RESULTS:** The UKP cohort currently comprises 17 participants with over 1200 hypobaric exposures (including over 500 rapid decompressions with more than 300 involving pressure breathing above 40,000 ft PA) and 40 hypoxia experiences. Overall exposure frequency is low and only 90 exposures lasted longer than one hour. Six participants have experienced DCS. Notwithstanding numerous confounds predisposing to WMH, preliminary analysis indicates that UKP have fewer WMH even than the normative USAF control cohort (Mann-Whitney two-tailed test, $P = 0.0049$). No associations are evident with metrics of altitude exposure. Some participants have extensive experience of high 'G' on the Farnborough centrifuge. Eleven have been screened previously for presence of patent foramen ovale (PFO). The data do not support an association between WMH and either PFO or high G exposure in this cohort. Multiple WMH in two outliers may be attributable to mild traumatic brain injury and competitive contact sports over many years. **DISCUSSION:** The data indicate that brief, infrequent ('low intensity') hypobaric exposure is not associated with development of WMH in UKP. Recent UK altitude chamber procedures appear not to have promoted WMH. Occasional, infrequent hypoxia experiences or episodes of non-neurological DCS are not associated with WMH in UKP. The study will complete in November 2016 with final data validation at the University of Maryland anticipated in early 2017.

Learning Objectives:

1. To better understand the association between occurrence of white matter hyperintensities and intensity of decompression stress.
2. To consider the proposition that there are 'safe' (sub-threshold) levels of hypobaric exposure that do not promote white matter change.
3. To consider the factors that might differentiate the prevalence of white matter changes in discrete cohorts.

[155] SCREENING EXAMINATIONS INTO FUNCTIONAL CONSEQUENCES OF REPETITIVE HYPOBARIC EXPOSURES IN ALTITUDE CHAMBER INSTRUCTORS – PRELIMINARY FINDINGS

C. Ledderhos, C. Gammel, A. Gens and F. Weber
German Air Force Center of Aerospace Medicine, Fürstenfeldbruck, Germany

INTRODUCTION: A variety of recent studies revealed subcortical white matter hyperintensities (WMH) occurring after repetitive hypobaric exposures in both humans and animals. The resulting functional consequences, however, are unknown so far. It must be assumed that the appearance of WMH especially in young individuals like pilots or inside observers of altitude chambers who have undergone special health screening and lack further risk entails a potential risk for neurological long-term damage/impairment. In this context, a study of inside observers of altitude chambers is in progress at the GAFCAMed in Fürstenfeldbruck, including multiple functional screening examinations to generate evidence-based data. **Methods:** Subjects of interest are chamber personnel of high-altitude simulation facilities repeatedly exposed to the relevant altitudes. A control group that has not undergone exposure will be used for comparison. To recruit a sufficient number of participants, a multinational approach is intended involving Norway, the Netherlands, France and Germany, that have already agreed to participate. Further nations are welcome. The tests focus on the sensory pathways with recordings of visual and auditory evoked potentials. In addition, balance regulation using posturography will be examined and psychometric tests will be conducted. There is evidence of impaired performance in divers who have experienced decompression sickness. When available in adequate numbers, laboratory data on the cardiovascular risk and inflammation parameters collected during regular routine examinations to establish fitness for military flying duties throughout the respective personnel's professional career will be systematically analyzed and compared retrospectively over time. **RESULTS:** All findings will be evaluated in relation to the morphological findings comprising 3 T MRI scans of both the skull and spinal cord. First examinations started in the German group of inside observers. Data evaluation is in progress. **DISCUSSION:** As the findings of the MRI scans described so far mainly concern white matter, they are most likely indicative of impairments of the functions of sensory and motor pathways as well as limitations of balance and coordination functions. The study is intended to focus on this aspect.

Learning Objectives:

1. Understand the functional consequences of structural changes of white matter due to repetitive hypobaric exposures.
2. Learn something about psychometric testing.

[156] WHITE MATTER HYPERINTENSITIES AND NEUROCOGNITIVE DECREMENTS IN DECOMPRESSION-EXPOSED TRADES

J. Saary[1,3], G. Gray[1] and A.S. Louis[2,3]
[1]CAF- CFEME, Toronto, ON, Canada; [2]Queen's University School of Medicine, Kingston, ON, Canada; [3]University of Toronto, Toronto, ON, Canada

INTRODUCTION: White matter hyperintense lesions have been identified in the brains of individuals with exposure to decompression stress, the clinical significance of which is currently unclear. Occupational exposure to decompression occurs either in training for, or during the duties of various trades including pilots, hypobaric chamber personnel, divers, and astronauts. Clinical decompression illness resulting from exposure to decompression stress is rare as a result of prudent countermeasures and safety regulations in

occupational settings. However, there may be subclinical effects of decompression stress not previously appreciated. As well, those exposed to decompression may also have other confounding exposures. **METHODS:** The literature published up to October 2015 was reviewed to identify the extent of evidence for a relationship between occupational exposure to decompression stress, white matter hyperintense lesions and possible neurocognitive impacts of these lesions in various populations. **RESULTS:** Initial synthesis revealed a higher burden of lesions in several populations including U2 pilots. These were sometimes associated with subtle neurocognitive deficits in reasoning, memory, information processing accuracy and general cognitive functioning compared to controls. **DISCUSSION:** Despite initial assessment of lesion burden, several factors such as other exposures, and measurement variation (e.g., lesion measurement, imaging techniques, cognitive assessment) may be relevant confounders warranting further consideration.

Learning Objectives:

1. Be aware of decompression-exposed trades in which white matter hyperintensities have been identified, possible associated neurocognitive deficits, and the challenges in making comparisons between these trades.

[157] CELLULAR METABOLIC CHANGES IN HUMANS FOLLOWING HYPOBARIC EXPOSURE - POSSIBLE EXPLANATION FOR WHITE MATTER INJURY WITH HYPOBARIA

S. McGuire
USAFSAM, San Antonio, TX

INTRODUCTION: Exposure to hypobaric conditions is associated with both focal and diffuse subcortical brain injury. A single exposure is associated with an upregulation of cerebral blood flow suggesting acute injury. This on-going human study examines the metabolic changes associated with single occupational exposure. **METHODS:** Magnetic resonance spectroscopy (MRS) was performed on 75 exposed subjects and 34 controls with MRS obtained 1 d before and 1 d and 3 d after exposure. Metabolites were measured in the frontal lobe white matter and the anterior cingulate gray matter. A two-tailed paired t-test was used for comparison. **RESULTS:** Exposed subjects had a significant decrease on MRS#2 in frontal lobe white matter n-acetylaspartate (p=0.039) and mylo-inositol (p=0.019) with a trend in creatine (p=0.076) and glutathione (p=0.063). Control subjects had no significant change. **DISCUSSION:** These metabolite changes are consistent with acute oxidative stress affecting the glial and neuronal components of white matter, possibly reflecting a decrease in mitochondrial function. This would be consistent with the changes noted in cerebral blood flow suggesting acute injury. Additional study is warranted.

Learning Objectives:

1. Understand the cellular metabolic changes occurring in cerebral white matter following routine occupational aircrew altitude chamber training.
2. Understand how these cellular metabolic changes might potentially explain the changes noted on MRI following repetitive exposure to hypobaria.

Tuesday, May 02 ***10:30 AM***
Plaza F

S-032: PANEL: CENTRIFUGE-SIMULATED SUBORBITAL SPACEFLIGHT: THE ROLE OF TRAINING AND THE IMPACT OF ANXIETY

Chair: James Pavela
Houston, TX

Chair: James Vanderploeg
Galveston, TX

PANEL OVERVIEW: In commercial suborbital spaceflight, anxiousness could become mission impacting, causing negative experiences or endangering the flight itself. It is important to identify and mitigate anxiety in spaceflight participants (SFPs) before it becomes problematic. Similarly, it is crucial to identify the best training methods available to prepare laypersons for exposure to the hypergravitational environment and the stressors of suborbital spaceflight. However, there are currently no known effective methods to best train laypersons for such an experience, or to successfully identify or mitigate significant SFP anxiety in commercial spaceflight. To address this issue, a study was conducted under funding from the FAA Center of Excellence for Commercial Space Transportation in which 157 layperson volunteers were exposed to various training methods prior to experiencing centrifuge-simulated suborbital spaceflight. This panel will review key findings from this study, addressing training techniques, anxiety identification and mitigation strategies, and various cardiovascular and hemodynamic trends observed.

[158] EVALUATION OF TRAINING EFFECTS ON ANXIETY AND TASK PERFORMANCE IN SIMULATED SUBORBITAL SPACEFLIGHT

R.S. Blue[3], F. Bonato[1], K. Seaton[2], J. Vardiman[3], A. Bubka[4], C. Mathers[3], T. Castleberry[3] and J. Vanderploeg[3]
[1]Montclair State University, NJ, Belleville, NJ; [2]UTMB/Wyle, Houston, TX; [3]Preventive Medicine and Community Health, University of Texas Medical Branch, Galveston, TX; [4]Psychology, Saint Peter's University, Jersey City, NJ

INTRODUCTION: In commercial suborbital spaceflight, anxiousness could become mission-impacting, causing negative experiences or endangering the flight itself. It is important to identify and mitigate anxiety in spaceflight participants (SFPs) before it becomes problematic. We studied layperson response to four varied-length training programs (ranging from 1hr-2days of preparation) prior to centrifuge-simulated suborbital spaceflight. We examined subject task execution, evaluating performance in high-stress conditions. We sought to identify any trends in demographics, hemodynamics, or similar factors in subjects with the highest anxiety or poorest tolerance of the experience. **METHODS:** Volunteers participated in varied-length centrifuge training programs culminating in two simulated suborbital spaceflights. At most, subjects underwent seven centrifuge runs over 2d, including two $+G_z$ runs (peak $+3.5G_z$, Run 2) and two $+G_x$ runs (peak $+6.0G_x$, Run 4) followed three runs approximating suborbital spaceflight profiles (combined $+G_x$ and $+G_z$, peak $+6.0G_x$ and $+4.0G_z$). Two cohorts also received dedicated anxiety-mitigation training. Subjects were evaluated on their performance on various tasks, including a simulated emergency. **RESULTS:** 148 subjects participated in centrifuge trials ranging from 0.5-2days and 2-7 centrifuge exposures. 10 subjects withdrew or limited their G-exposure; history of motion sickness was associated with subject withdrawal. Shorter-length training programs were associated with elevated hemodynamic responses but no adverse events or increase in withdrawal rates. Single-directional G-training did not significantly improve tolerance or reduce withdrawal. **DISCUSSION:** Training programs appear best when high fidelity, and sequential exposures may improve tolerance of physical/psychological flight stressors. Few factors predict an individual's ability to tolerate the psychological stress of suborbital flight.

Learning Objectives:

1. Discuss the physiological and psychological tolerance in laypersons exposed to centrifuge-simulated suborbital spaceflight.

[159] MOTION SICKNESS SYMPTOMS, TRAINING BENEFITS, AND ADAPTATION DURING SIMULATED COMMERCIAL SPACE FLIGHT

F. Bonato[1], A. Bubka[5], K. Seaton[4], R.S. Blue[2], J. Vardiman[2], C. Mathers[3], T. Castleberry[2] and J. Vanderploeg[2]
[1]Montclair State University, Belleville, NJ; [2]Preventive Medicine & Community Health, UTMB, Galveston, TX; [3]Clinical Preventive Medicine, UTMB Health, Galveston, TX; [4]UTMB/Wyle, Houston, TX; [5]Saint Peter's University, Jersey City, NJ

INTRODUCTION: As the realization of commercial spaceflight approaches, questions about how spaceflight participants (SFPs) with limited training will tolerate flights are valid. Planned flights will entail

acceleration forces during ascent and decent and an intervening 4-6 minutes of weightlessness. It is unknown how provocative this environment will be in terms of motion sickness (MS). If present, can MS symptoms be reduced or eliminated by using some specific training protocols? Methods: Volunteer subjects (n=99, mean age=40, 70 men, 29 women) participated in two simulated spaceflight in a sustained-G centrifuge simulator. Prior to participation, subjects received: 1) minimal training (MT) (n=35), 2) one day of cognitive/psychological training (CP) (n=32), or 3) two days of cognitive/psychological/acceleration training (CPAT) (n=32). After each simulated flight, subjects rated the severity of MS symptoms (none, mild, moderate, severe) using the Simulator Sickness Questionnaire (SSQ), a well-established instrument that yields a total score and sub-scores for nausea, oculomotor symptoms, and disorientation. **RESULTS:** Overall, mean total SSQ scores were low (5.8 – 11.5) compared to a score (20+) that would indicate a 'problem' simulator. Two-way ANOVAs and Tukey's post hoc analyses indicated that SSQ total scores and nausea, oculomotor, and disorientation sub-scores, were all significantly higher in the MT condition compared to the CPAT condition. SSQ total scores and oculomotor and disorientation sub-scores were also significantly higher for the first simulated spaceflight compared to the second. **DISCUSSION:** Results suggest that MS is not a serious problem for most subjects during simulated spaceflights. Moreover, preparation in the form of psychological and acceleration training may lead to an increased resistance to MS. It should be noted, that even though the simulation methods used were the most advanced available, head movements during centrifugation about an axis other than that of the planetary arm can produce a stimulus to the semicircular canals about a third axis that can often be nauseogenic. This Coriolis cross-coupling effect does not occur during actual spaceflight. Also of interest is the apparent benefit derived from the first simulated flight to the second—a possible adaptation effect that developed despite the two flights being separated by only a few hours.

Learning Objectives:

1. The participant will be able to understand how training may provide some resistance to motion sickness during a simulated spaceflight in a sustained-G centrifuge simulator.
2. An understanding will be gained as to why actual spaceflight may result in less motion sickness than simulated flight that could be accompanied by Coriolis effects.

[160] INCIDENCE AND SIGNIFICANCE OF BRADYCARDIA DURING HUMAN CENTRIFUGATION

R. Suresh, C. Mathers, R.S. Blue, T. Castleberry and J. Vanderploeg
Preventive Medicine & Community Health, UTMB, Galveston, TX

INTRODUCTION: Abnormal cardiac rhythms are frequently noted during human centrifugation. Episodes of anomalous bradycardia have been known to occur, and on occasion have even led to early termination of centrifuge trials secondary to concerns regarding hemodynamic tolerance if heart rate (HR) is too low. During a larger study of laypersons exposed to centrifuge, we sought to identify the frequency of bradycardia and whether bradycardia is associated with intolerance to acceleration. **METHODS:** Volunteers participated in varied-length centrifuge training programs of 2-7 centrifuge runs over 0.5-2d, culminating in two simulated suborbital spaceflights. Suborbital spaceflight profiles included combined $+G_x$ and $+G_z$ (peak $+6.0G_x$ and $+4.0G_z$). Hemodynamic data collected included blood pressure, HR, and continuous 3-lead electrocardiogram. **RESULTS:** Significant bradycardia (HR<60 during dynamic phases of flight) was observed in 14% of subjects, all during +6Gx exposure, and more commonly during single directional runs than combined profiles. Bradycardia was significantly more common in men (P=0.04), and was more frequently observed in subjects participating in longer centrifuge training (2d training vs. 0.5-1d training, P=0.03). Younger subjects are more likely to experience bradycardia than older individuals (P=0.04). **DISCUSSION:** Bradycardia is a frequent occurrence during high +Gx exposure, particularly in young men. While subjects denied symptoms associated with the rhythm, it is worth noting that shorter training programs were associated with less incidence of the rhythm. It is possible that adrenaline or stress-response blunts the bradycardic events, and that bradycardia may be a sign that subjects are more comfortable with the experience rather than an indicator of hemodynamic intolerance.

Learning Objectives:

1. Describe the incidence of bradycardia during human centrifugation.
2. List risk factors for bradycardia during human centrifugation.
3. Describe the clinical and operational consequences of bradycardia during human centrifugation.

[161] SUSTAINED ACCELERATED IDIOVENTRICULAR RHYTHM IN CENTRIFUGE-SIMULATED SUBORBITAL SPACEFLIGHT

C. Mathers[3], R. Suresh[1], R.S. Blue[2], T. Castleberry[2] and J. Vanderploeg[2]
[1]Internal Medicine, UTMB, Galveston, TX; [2]Preventive Medicine & Community Health, UTMB, Galveston, TX; [3]Clinical Preventive Medicine, UTMB Health, Galveston, TX

INTRODUCTION: Hypergravitational exposures during human centrifugation have been known to provoke dysrhythmic events. Sinus dysrhythmias, premature atrial or ventricular contractions, supraventricular tachycardias, and even short-lived atrial fibrillations or flutter patterns have been reported. However, events are generally short lived and resolve rapidly after cessation of acceleration. This case report describes a prolonged cardiac dysrhythmia in response to high G force exposure. **CASE REPORT:** A previously healthy 30 yr man voluntarily participated in centrifuge trials as a part of the larger study described in this panel, experiencing a total of 7 centrifuge runs over 48h. Day 1 consisted of two +Gz runs (peak 5 +3.5Gz, run 2) and two +Gx runs (peak 5 +6.0Gx, run 4). Day 2 consisted of three runs approximating suborbital spaceflight profiles (combined +Gx and +Gz). Hemodynamic data collected included blood pressure, heart rate, and continuous 3-lead electrocardiogram. Pre-spin EKG demonstrated normal sinus rhythm with normal intervals, otherwise normal EKG. Following the final acceleration exposure of the last Day 2 run (combined G-exposure, peak +4.5Gx and +4.0Gz, resultant +6.0G), during a period of idle resting centrifuge activity (resultant vector +1.4G), the patient demonstrated a marked change in his 3-lead EKG from normal sinus rhythm to a wide-complex ectopic ventricular rhythm at a rate of 91-95bpm, consistent with an accelerated idioventricular rhythm (AIVR). This rhythm was sustained for 2m24s before reversion to normal sinus. The subject reported no adverse symptoms during this time. **DISCUSSION:** Potential physiological etiologies and consequences of the dysrhythmic event will be discussed.

Learning Objectives:

1. Understand possible etiologies for accelerated idioventricular rythym during centrifuge-simulated suborbital spaceflight.

[162] IDENTIFICATION OF SUBJECT ANXIETY AND RISK OF WITHDRAWAL DURING SIMULATED SUBORBITAL SPACEFLIGHT

J. Vardiman[2], R.S. Blue[2], F. Bonato[1], K. Seaton[3], A. Bubka[4], C. Mathers[2], T. Castleberry[2] and J. Vanderploeg[2]
[1]Montclair State University, Belleville, NJ; [2]PMCH, UTMB, Galveston, TX; [3]UTMB/Wyle, Houston, TX; [4]Saint Peter's University, Jersey City, NJ

INTRODUCTION: Anxiety or panic during commercial spaceflight have the potential to significantly detract from the flight experience, cause disruption during flight, or even put the mission, vehicle, or crew at risk. This study was designed to evaluate layperson tolerance of centrifuge-simulated spaceflight and identify the most successful means of predicting anxiety or poor tolerance in commercial spaceflight participants prior to mission-impacting events. **METHODS:** Volunteers participated in varied-length centrifuge training programs of 2-7 centrifuge runs over 0.5-2d, culminating in two simulated suborbital spaceflights. Suborbital spaceflight profiles included combined $+G_x$ and $+G_z$ (peak $+6.0G_x$ and $+4.0G_z$). Two cohorts received dedicated anxiety-mitigation training. Psychological batteries were evaluated for any predisposing factors that might increase risk for poor tolerance. Subjects were observed by multiple monitors for any signs of anxiety during their experience. **RESULTS:** 148 subjects participated in centrifuge trials. 29 subjects were identified by monitors as concerning for anxiousness; 10 subjects withdrew or limited their G-exposure. Training length did not predispose subjects to withdrawing from participation. Motion sickness

was significantly associated with withdrawal. Subjects were most likely to report anxiety-related symptoms in private, written format. **DISCUSSION:** It is unclear whether the correlation between motion sickness, anxiety, and withdrawal from further centrifuge participation will hold true in commercial spaceflight. Private reporting may be a means of identifying issues during training and before a flight. Close observation, trainer and monitor experience, and strong trust relationships will likely improve an observer's ability to identify participants at risk before anxiety becomes detrimental to the experience.

Learning Objectives:

1. Participants will gain an understanding of the factors that contribute to test subject withdrawal from this research study and the implications for commercial human spaceflight.

Tuesday, May 02 ***10:30 AM***
Governor's Square 14

S-033: PANEL: CHARACTERIZING THE NAVAL BIODYNAMICS LABORATORY LEGACY IMPACT RESPONSE COLLECTION IN THE BIODYNAMICS DATA RESOURCE

Sponsored by Life Sciences and Biomedical Engineering Branch

Chair: Carol Chancey
Fort Rucker, AL

Chair: Barry Shender
Patuxent River, MD

PANEL OVERVIEW: The Biodynamics Data Resource (BDR) houses one of the most dynamic and robust collections of data for human and human surrogate non-contact inertial loading. The BDR is a collaborative effort of the US Army Aeromedical Research Laboratory and the Naval Air Warfare Center Aircraft Division. This material was generated over the course of 25 years at the Naval Biodynamics Laboratory (NBDL) from several thousand acceleration exposures, involving 200+ human research volunteers (HRV), 10+ anthropomorphic test dummies (ATD), and 100+ non-human primates (NHP). These data formed the foundation for the understanding of head and neck impact response. Its value has been demonstrated by its contributions to biomechanical advancements, such as being the basis for both the Hybrid III's mechanical neck and the biofidelity requirements for ATD side impact performance (ISO TR9700). Over the past few years, the BDR has focused research efforts on digitizing the material and developing a relational database, accessible to outside researchers. Working with such an extensive collection of legacy data includes a variety of problems and pitfalls that the BDR has elucidated on previously. This experience has given the BDR an in-depth look at the collection; it is evident that vast amounts of data were collected to monitor the HRVs and NHPs over the course of their time in the impact acceleration program, and that much of this data has not yet made it out to the scientific community. This panel gives an overview of the NHP database, examples of the exposure and outcome NHP responses, symptomology of HRV, and a comparison of HRV response to +Gz loading, including when the input vector is aligned upright vs. horizontally. The BDR gives insight into the aeromedicine research gaps the legacy collection can potentially address.

[163] AN OVERVIEW OF THE NON-HUMAN PRIMATE LEGACY COLLECTION IN THE BIODYNAMICS DATA RESOURCE

A.V. Olszko[1,2], C.M. Beltran[1,2], K.B. Vasquez[1] and C. Chancey[1]
[1]Injury Biomechanics Division, US Army Aeromedical Research Laboratory, Fort Rucker, AL; [2]Laulima Government Solutions, LLC, Orlando, FL

INTRODUCTION: In the impact acceleration program at the Naval Biodynamics Laboratory (NBDL), non-human primates (NHP) were used as a human surrogate. The NHP collection includes three different species of primates and data for over 400 impact exposures of varying direction and acceleration. Much of the NHP data remain unpublished. The Biodynamics Data Resource (BDR) exists, in part, to catalog, organize, digitize, and modernize this research collection and to make it available for research. A multifaceted effort was initiated to discern what data exist, in what amount, and to what degree of usefulness. **METHODS:** The NHP collection, complex with a variety of physical and digital items, was organized and an inventory developed. Usability of physical material as a diagnostic tool was reviewed. Physical items of the collection are being digitized into archival formats. Data are being modernized from obsolete media and formats. Metadata, for use in the relational database of the BDR, are being applied and digital files reviewed. **RESULTS:** The majority of impact acceleration research at NBDL was conducted on a horizontal accelerator, including 366 NHP runs. Frontal impacts were the most numerous with the highest peak accelerations (up to 193 G). Rear, lateral, and axial runs were also conducted. On the vertical accelerator, 34 NHP axial runs were completed (up to 70 G). Sources of time series data acquired during impact included: 1) sensor, 2) photo, and 3) electrophysiology. Additional data were collected from anthropometry and diagnostic tests (e.g., X-rays). Evaluation of NHPs immediately post-run and at regular intervals until sacrifice was documented, analgesic medications were logged, and necropsies and tissue samples taken were recorded. These samples, in the form of slides and paraffin blocks, remain in usable condition. Ultimately, this collection will reside in digital form within the BDR relational database and will be accessible to researchers by use of metadata terms applied to each item. **DISCUSSION:** The work done by the NBDL impact acceleration program will never be repeated. The BDR strives to provide these data to researchers in a way that it may be used to address research gaps, supported by a firm understanding of what NBDL accomplished in the 25 years of the program. Through scaling with human volunteer data, the NHP collection is one facet of the complex program with immediate application to acceleration injuries evident in aeromedicine.

Learning Objectives:

1. A robust collection of non-human primate data exists and can be used to understand human tolerance to high level acceleration; the Biodynamics Data Resource is making the collection accessible for research.

[164] OUTCOME-BY-EXPOSURE COMPARISONS OF NON-HUMAN PRIMATE IMPACT ACCELERATION

A.V. Olszko[1,2], C.M. Beltran[1,2], K.B. Vasquez[1] and C. Chancey[1]
[1]Injury Biomechanics Division, US Army Aeromedical Research Laboratory, Fort Rucker, AL; [2]Laulima Government Solutions, LLC, Fort Rucker, AL

INTRODUCTION: The Naval Biodynamics Laboratory (NBDL) used non-human primates (NHP) as a human surrogate for higher, injurious accelerations, to which human volunteers cannot be safely exposed. NHP run outcomes are characterized by electrophysiology, blood chemistry, macroscopic imaging, necropsy, and histology. Comparing outcomes (i.e., non-injurious, injurious, or fatal) and exposures (e.g., direction, peak acceleration, number of runs, etc.) can give insight into effects on humans undergoing injurious accelerations. **METHODS:** The Biodynamics Data Resource (BDR) classified runs of the NHP collection according to outcome. This was according to documentation of medical examinations and laboratory tests that occurred at regular intervals after exposure up until necropsy, as well as veterinary records, and pathology reports. Time to necropsy was also recorded. Outcomes were characterized by exposure using a run index table, constructed to provide a reliable listing of the parameters of each run and to quantify the content in the BDR collection. Relationships were derived according to outcome for several parameters. **RESULTS:** Over 60% of the runs conducted on the horizontal and vertical accelerator occurred at peak accelerations greater than 20 G. The range of peak accelerations over which runs were classified as non-injurious, injurious, or fatal differed for each direction (axial, lateral, frontal, and rear). The majority of injurious runs were between 60 and 100 G. Fatal runs occurred between 67 G and 163 G. Recovery time between final run and necropsy varied, from within an hour following the run until 40 days after, depending on research hypotheses. Necropsies were done after runs with peak accelerations greater than 20 G. **DISCUSSION:** The relationships

presented can be developed into future outcome comparisons, extrapolating effects of direction, peak acceleration, repeated runs, recovery time between exposures, etc. Histology samples provide a microscopic evaluation of effects of acceleration on the body. These samples remain in usable condition within the NHP collection. Combined with the head dynamic response of the NHP, these data in the BDR can be used to develop scaling procedures to examine similar exposure effects in humans.
Learning Objectives:
1. Defining injurious and fatal thresholds to high level acceleration is complicated by numerous covariates; previously collected non-human primate data demonstrate relationships that can be scaled to humans undergoing similar loading.

[165] EFFECT OF POSTURE ON HEAD KINEMATIC RESPONSE TO RAPID +Z ACCELERATION

G.R. Paskoff[1], K. Chiu[1], A.V. Olszko[2], C.M. Beltran[2], K.B. Vasquez[3], C. Chancey[2] and B.S. Shender[1]
[1]Human Systems, NAVAIR, Patuxent River, MD; [2]Injury Biomechanics Division, US Army Aeromedical Research Laboratory, Fort Rucker, AL

INTRODUCTION: Development of ejection and crashworthy seating systems and neck injury mitigation technologies requires understanding the kinematics of head motion during aircraft emergencies. Vertical acceleration (foot to head) can be applied in a seated upright (UP) or supine (SP) position, depending on the type of accelerator or decelerator test device. An analysis was run to determine if the response kinematics were the same. **METHODS:** Three datasets from studies conducted at the former Naval Biodynamics Laboratory were analyzed (all healthy unhelmeted males). A total of twenty-three subjects were exposed to 190 vertical impact pulses (Gz) ranging from +3 to +10Gz in 1Gz increments. Note that not all subjects completed runs at all G-levels. Volunteers were fitted with custom restraints to minimize torso movement. Sensors attached to mounts at the mouth (bite bar) and base of neck (T1) provided linear and rotational head and neck responses. Data analysis included sled acceleration, head angular acceleration (A) and head angular velocity in flexion (V) and time to peak A and V. Two-tailed t-test (assuming unequal variance) were performed using G-level, body weight, and load vector as factors (p=0.05). **RESULTS:** Volunteers were divided into three weight groups: 61-72.6kg (W1 (n=7)), 72.7-82kg (W2 (n=8)), 83-108kg (W3 (n=8)). Analysis focused on +3, 5, 7, 10Gz to include the most exposures. For W1 at 7 and 10G, Peak A (pA) and V (pV) were greater (7G: 35464 deg/s^2 & 662 deg/s vs. 22456 deg/s^2 & 385 deg/s; 10G: 134361 deg/s^2 & 970 deg/s vs. 43017 deg/s^2 & 392 deg/s) and time to 7G pA pV (111 vs. 175ms) and pV was shorter when volunteers were in SP vs. UP position. For W2 (5G: 550 vs. 343 deg/s; 7G: 709 vs. 472 deg/s) and W3 (5G: 521 vs. 308 deg/s; 7G: 702 vs. 465 deg/s), 5 and 7G pV were greater and W3 time to pV (172 vs. 161 ms) and pA at 7G (145 vs. 127 ms) shorter for the SP vs. UP position. **DISCUSSION:** These data quantify how male dynamic response to impact varies with load vector and weight and provide a validation dataset for spinal musculoskeletal modeling. These responses also imply that care should be taken when comparing the same responses to the same G vector based on occupant posture.
Learning Objectives:
1. To investigate whether anatomic factors such as weight and posture relative to loading vector are significant variables in predicting and understanding head kinematic response to +Z axis acceleration.

[166] AN INITIAL CHARACTERIZATION OF THE SYMPTOMS EXHIBITED BY HUMAN VOLUNTEERS IN THE IMPACT ACCELERATION PROGRAM AT NAVAL BIODYNAMICS LABORATORY

A.V. Olszko[2,3], C.M. Beltran[2,3], J.S. McGhee[2], A.S. Dargie[2,3], A.L. Burke[2,3], K.B. Vasquez[2], B.S. Shender[1] and C. Chancey[2]
[1]Human Systems, NAVAIR, Patuxent River, MD; [2]Injury Biomechanics Division, US Army Aeromedical Research Laboratory, Fort Rucker, AL; [3]Laulima Government Solutions, LLC, Orlando, FL

INTRODUCTION: The impact acceleration program of the Naval Biodynamics Laboratory (NBDL) was supported by nearly 300 human research volunteers (HRVs). For each run, pre- and post-run physicals were collected; an additional extensive qualifying physical was required. The physicals, now part of the digitized Biodynamics Data Resource (BDR) collections of subject and run records, offer a rich dataset that may elucidate trends in kinematic response and can apply to relevant research questions. Though HRV runs were non-injurious, transient symptoms were reported in post-run physicals. This initial characterization provides an overview of the BDR symptoms database and presents relationships between symptoms and exposure. **METHODS:** Physicals from the digitized records were reviewed and symptoms recorded into a digital matrix for incorporation into the BDR database. Queries were performed for pre- and post-run differences in symptoms. Relationships between particular symptoms and exposure parameters, such as direction and peak sled acceleration, were derived. Physicals from the highest G runs were considered in more detail by a medical professional. **RESULTS:** Symptoms reported include headaches, visual issues (e.g., blurred vision), vestibular issues (e.g., dizziness), backaches, muscle soreness, stiffness, and others. Examinations also include elapsed time post-run that symptoms were present (up to 24 hours). In general, the overall number of symptoms present increased with an increase in acceleration; other symptoms followed a similar trend. The majority of symptoms were reported with at least one other symptom. The 10 highest G runs (all frontal impacts of approximately 16 G) showed no lasting, injurious effects, but in addition to symptoms reported (e.g., headache, neck pain), abnormalities in electrocardiograms were also reported. **DISCUSSION:** Analyzing HRV symptoms in combination with other datasets available in the BDR (e.g., kinematic and electrophysiology data for both HRV and non-human primates) has clinical relevance in various avenues of impact research. For example, while HRV runs were non-injurious because there were no known lasting effects, reports of headache from high accelerations may be symptomatic of mild concussion and, though temporary, electrocardiographic activity may indicate possible cardiac injury. Overall, relationships between symptoms and exposure parameters can give insight into more complex research questions.
Learning Objectives:
1. The NBDL legacy collection can provide multifaceted data for human volunteer exposures to high levels of acceleration; these data can be applied to relevant research questions regarding injurious thresholds under inertial loading.

Tuesday, May 02 ***10:30 AM***
Governor's Square 15

S-034: PANEL: NAVIGATING THE FUTURE OF AEROSPACE MEDICINE WITH ADVANCING LEADERSHIP DEVELOPMENT VIA INNOVATIVE TEACHING & LEARNING FRAMEWORKS

Sponsored by Aerospace Human Factors Association, the AsMA Aerospace Human Performance Committee, and Aerospace Medicine Student and Resident Organization

Chair: Philippe Souvestre
Vancouver, British Columbia, Canada

PANEL OVERVIEW: MOTIVATION: Established leadership styles in the past have tended to value leaders with a strong personality who could deliver a clear top down authority. Challenges in personality based leadership have been found to foster unreviewed faults in leaders, and lack of team development. The current workplace has changed to a more dynamic model, which has changed the expectations and demands on leaders for organizations to stay competitive by leveraging the best of their team. New leadership skills include self-awareness, continuous development and learning, coaching and listening skills in order to create a more productive and engaged team. **OVERVIEW:** This Panel features leading military and civilian academic biomedical, scientific, technical, and operational educators peer-recognized as experts in Aerospace Medicine and Human Performance as well as contributing to Leadership Development in diverse other settings. Reviews of current Leadership Development (LD) strategies highlight novel pedagogical methodologies such as Scholarship in Teaching and Learning (SoTL) as an effective tool towards developing leaders. *(Kouzes, J.M., & Posner, B.Z. (2011). Leadership Practices Inventory*

(LPI); New Norms, November, 2012. Retrieved March 6, 2013). Exemplary leadership modeling includes several archetypes not limited to the Five Essential Practices, Myers-Briggs Indicator, Seven habits of Highly Effective People, Emotional Intelligence, Ethical Leadership, Servant Leadership, Talents and Strengths. **SIGNIFICANCE:** Presenters share specific situational LD failure experiences along with their own analysis and introspection, what they did at that time to countermeasure it, and what they now think could have been done to better mitigate or prevent it. From sharing a personal experience to specifically modelling reported SoTL related fundamental issues, they reflect on the complex dimension of this distinctive unresolved debate and the magnitude of its impact on LD, a broad range of ways of learning leadership is demonstrated through combining all presenters' invaluable experiences and uniquely refined approaches.

[167] INITIATION TO LEADERSHIP DEVELOPMENT IN AEROSPACE MEDICINE – AN AMSRO STUDENT'S EXPERIENCE

A. Mantri (postumously)[2] and P.A. Souvestre[1]
[1]NeuroKinetics Health Services, Inc., Vancouver, BC, Canada; [2]College of Medicine, Texas A&M, Bryan, TX

MOTIVATION: Mentorship is often an invaluable essential component in the development of future leaders in any expertise. Throughout my membership, AsMA has provided a wealth of mentors to me. Often, one or two comments or pieces of advice I received from each of them often made a huge impact on my success and put me in a leadership position. Many often think that mentorship takes a lot of time investment. However, it appears to be more about vested interest in the mentees themselves along with the mere encouragement to pursue opportunities. This support alone has been shown to be very inspiring and essential in many instances. Through AMSRO, students aim to add to the culture of mentorship within AsMA with providing our own mentorship opportunities and aim to cater to different leadership styles and personality types, allowing for both individual and team success. **OVERVIEW:** This presentation will outline AMSRO's current efforts to develop effective, time-sensitive mentor-mentee relationships within AMSRO itself and within AsMA. Many feel that establishing an effective mentor-mentee relationship requires a great time investment and expertise. However, the most valuable experiences in mentorship are more dependent on invested interest in the mentee's success and encouragement and support to successfully pursue and meet opportunities of achievement in one's domain of expertise to be learned and earned. **SIGNIFICANCE:** The advancement and effectiveness of Aerospace Medicine experts throughout generations depends on the investment in future young professionals. Dedicated and multidisciplinary mentors who take a vested interest in developing the leadership potential of mentees are key and essential to the growth and the Future of values, and necessary to the successful contribution of Aerospace Medicine to human kind.

Learning Objectives:

1. Consider ways to make mentor-mentee relationships effective and time-sensitive
2. Provide examples of peer mentorship that enable individual and team success

[168] LEADERSHIP DEVELOPMENT AS A COMPLEX SYSTEM IN AEROSPACE MEDICINE

A. Sobel
Medical Education, TTUHSC, Lubbock, TX

MOTIVATION: This presentation will address some specific examples of Leadership challenges throughout the author's extensive, inter-disciplinary civilian and military career. **OVERVIEW:** Specifically, throughout this journey of discovery, examples of experiential learning curricula that were designed and implemented to address real world problems and objectively measure outcomes will be described. The paradigm addresses multiple system inputs, challenges, solution vulnerabilities and end-user applications. In many ways, this process parallels a course of innovation and self-guided discovery, but with the rigor of continuous objective feedback and 'fine tuning' of the student's analytical acumen with time and experience. Uniquely, with "Generation Y" learners, the active learning process becomes a human-in-the-loop system with considerable inputs from the categories of interactive technology, professionalism, mentoring or parenting, and bidirectional communication or feedback. (Eckleberry-Hunt J and J Tucciarone, The Challenges and Opportunities of Teaching "Generation Y", Journal of Graduate Medical Education, December 2011, 458-460). Additionally, although traditional lecture methods have remained popular with many professional medical educators, active learning techniques result in improvements in retention, implementation, and assimilation of skills. (Wolff M, MJ Wagner, et. al., Not Another Boring Lecture: Engaging Learners with Active Learning Techniques, Journal of Emergency Medicine, Vol. 48: 1 85-93.) **SIGNIFICANCE:** This presenter will also describe the learning paradigm as a complex system with critical components that closely parallel a SWOT analysis. The author believes this process is unique not only in its multidimensionality, but also in the intertwined thread of 'human factors' challenges and opportunities throughout the process. The student learns to optimize his/her own learning style as a dynamic process with continuous real-world input.

Learning Objectives:

1. Recognize the value of using a complex systems approach in development of ASM leadership skills.
2. Identify essential elements of SWOT analysis in the context of experiential learning in leadership development.

[169] AIR UNIVERSITY CONSENSUS MEDICAL FORCE DEVELOPMENT STATEMENT - IMPLICATIONS FOR AEROSPACE AND OPERATIONAL MEDICINE

P. Nelson
Department of International Security Studies, Air War College Surgeon General's Chair to Air University, University Maxwell AFB, Maxwell AFB, AL

MOTIVATION: The practice of medicine, emergence of civilian aerospace initiatives, rapid evolution of military ConOps, and the way we educate medical professionals have dramatically changed over the past 15 years. These shifts represent both risk and opportunity for the specialties that encompass the disciplines of Aerospace Medicine. Improperly managed, they have the potential to threaten the viability of our specialties. However, these dramatic changes simultaneously present opportunities for us to deliberately refocus our education and training experiences, positioning us for continued relevance thru human performance effects. With this mindset, we can develop the Aerospace and Operational medicine professionals and teams that will reimagine our specialty in the future. **OVERVIEW:** Air University has partnered with the Air Force Medical Service and others in charting a course towards deliberate development of medical forces to support Air Force missions. This presentation will review consensus results from the Air University Force Development Summit (Oct 2016), and apply them to the specialties of Aerospace and Operational medicine. Participants agreed on a holistic framework for professional development, focusing on deliberate pathways of both leadership and technical expertise through training, education and experiential learning. A special focus was placed on onboarding and enculturation which could be used to better connect AsMA constituent organizations with each other. Additionally, the summit supported distance and technology based learning along with collaborative teaming, all to enhance shared experiences and mutual understanding across medical and non-medical disciplines. **SIGNIFICANCE:** We must ensure an adequate pipeline for individuals to join the team of Aerospace and Operational Medical professionals, continuously revitalizing our specialties. To do this we will should partner with the best civilian, military, interagency and international institutions, engaging both our supported population and their emerging mission sets to realize our full potential.

Learning Objectives:

1. Consider the challenges and opportunities that the current simultaneous revolutions in medical and military affairs represents to our specialty of Aerospace and Operational Medicine.
2. Recognize the opportunity that partnerships and distance learning present to develop the Aerospace and Operational Medical teams of the future.

[170] LEADERSHIP DEVELOPMENT - A PERSONAL JOURNEY

J. Sventek
Aerospace Medical Association, Alexandria, VA

MOTIVATION: Leadership skills are difficult to develop and master. Is leadership a genetic trait or can leadership skills be learned and developed over time? This presentation will address some specific examples of leadership challenges throughout the author's extensive military and civilian career. **OVERVIEW:** The debate over whether leadership is a genetically-based trait or a skill set that can be learned and developed over time has occupied scholars and researchers for hundreds of years. There are good arguments on both sides of the debate (Leadersh Q. 2013 February; 24(1): 45–60). In my personal experience, effective leaders develop their leadership skills through a combination of training and experiences. As a follower early in my career, I watched my superiors closely and attempted to emulate the leadership traits of those leaders I found most effective. Leadership traits of the ineffective leaders were also closely scrutinized. The most effective leaders possess the same skills and traits: (1) inspire action, (2) optimistic, (3) have integrity, (4) support and facilitate the team, (5) have confidence, (6) communicate effectively, and (7) are decisive. According to a 2014 Pew Research Center Report, honesty, intelligence, and decisiveness are absolutely essential leadership qualities. **SIGNIFICANCE:** The author will share personal experiences that make a case for honesty and integrity as the most important leadership qualities. Teams will not follow or respect a leader that does not demonstrate honesty and integrity. If the team does not respect the leader, they will not be inspired to take action toward accomplishing the assigned mission.

Learning Objectives:

1. Given a list of list of personality traits, select the seven traits most often associated with effective leaders.
2. Identify whether effective leaders inherited their leadership skills or developed their leadership skills through training and experience.

[171] LEADERSHIP DEVELOPMENT: LESSONS FROM ANALOG ASTRONAUT MISSIONS AT MARS DESERT RESEARCH STATION

P.A. Souvestre[2] and I. Cinelli[1]
[1]Biomedical Engineering, NUIG, Galway, Ireland; [2]NeuroKinetics Health Services, Inc., Vancouver, BC, Canada

MOTIVATION: Living in close quarters for long time persons as on long haul space travel can have similar challenges and issues comparable to those faced by naval aeromedical personnel during military and aerospace operations. Mars Analog Astronaut Simulation (MAAS) missions are full immersion expeditions where crews live and work in isolation and confinement in remote extreme or hostile environments. Such conditions can elicit difficulties among the team which can put the mission at risk if not sufficiently addressed. **OVERVIEW:** A series of studies were conducted from two missions conducted at Mars Desert Research Station (MDRS) operated by Mars Society. The goal was to study various countermeasures for stress including acupuncture, meditation, search & rescue operations, et al. With one crew, the dynamics of the team deteriorated to the point of clear dysfunction as some members of the teams did not stick to the objectives of the mission. Thus, tensions arose and the mission objective became at risk. The situation forced members to spend considerable extra effort to continue the mission, and a member with specific leadership training stepped up to guide the dynamics. Not all members had leadership training so was a strong learning situation. It was necessary to draw on attributes such as servant leadership principles, humility, broadened mindfulness, introspection awareness, emotional intelligence, ethics, and scientific rigor finally restore sufficient team dynamics in order to complete the objectives of the mission. **SIGNIFICANCE:** When working objectives are critical, it is of utmost importance that all members of the team have a leadership skills foundation and essential emotional intelligence. Whether a member is the lead or not, the ability to work together, see the bigger picture, communicate clearly, and confront conflict is a critical factor in the success of such missions.

Learning Objectives:

1. Understand the significance of leadership skills in general for all members regardless of role.
2. Identify specific leadership skills that assist in high pressure working conditions.

Tuesday, May 02 ***10:30 AM***
Governor's Square 12

S-035: SLIDE: DESIGN & AIRCRAFT CONSIDERATIONS FOR PREVENTION

Chair: Kirk Nailling
Grandview, TX

Chair: Marian Sides
Grayslake, Illinois

[172] MEDICAL TRANSPORT OF PASSENGERS WITH LEG INJURY: OPERATIONAL, MEDICAL, AND ERGONOMICS ISSUES

H. DeRee and B. Veldhuijzen van Zanten
Health Services, KLM, Schiphol, Netherlands

INTRODUCTION: In one year about 600 passengers fly in KLM aircraft on European routes for medical reasons with an extended leg rest. In these cases the back of seat in front is folded down and a pouf is used to support the leg. However, this service was discontinued because of operational issues. It was decided to evaluate whether it was possible to continue offering an extended leg rest, but without a pouf. **METHODS:** A sample was analyzed from 2014/2015 of 390 medical transport cases that needed an extended leg rest. The aim was to find out whether the injuries involved would merit using a pouf or could do without. Seats in the aircraft types that fly European routes were measured to assess the posture of the passenger and estimate possible discomfort. **RESULTS:** The sample showed a large variation in types of injuries, but for most it was evident that a pouf is not absolutely necessary. Travelling with an injured leg will undoubtedly result in less than optimal comfort. However, when several basic ergonomical requirements are met, adequate comfort can be offered, and the risk of adverse effects is minimal. **CONCLUSION:** Most passengers who need an extended leg rest involved will enjoy adequate comfort during their flight even if no pouf is provided.

Learning Objectives:

1. The participant will be able to understand compromises have to be made when transporting passengers with leg injury.

[173] U.S. ARMY HELICOPTER MEDICAL INTERIOR DESIGN CONSIDERATIONS

K. Barazanji[1], G. Hildebrandt[2], B. Bowers[1], R. Kinsler[1] and S. Conti[1]
[1]U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL; [2]MEDEVAC Proponency Directorate, Fort Rucker, AL

INTRODUCTION: Physical limitations to rendering critical care caused by space constraints in the medical interiors of current U.S. Army MEDEVAC helicopters are unknown. These limitations are affected by the number of patients to which a U.S. Army Critical Care Flight Paramedic (CCFP) can reasonably be expected to provide enroute medical care. The objectives of this study were to (1) evaluate the adequacy of space available for CCFP to perform advanced medical treatment on simulated critical care patients (manikins) in existing MEDEVAC aircraft - the UH-60 and HH-60, and (2) to identify the CCFP clinical tasks failure occurrences while completing medical scenarios on 2-3 simulated patients with various wounds and injuries. **METHODS:** There are 3 phases for this study. During Phase 1, three flight medics (test participants or TPs) wore motion capture suits while performing 43 critical flight paramedic-level medical tasks that were determined to be space-consuming. In stature, the TPs varied from a 2nd percentile female to a 99th percentile male. During Phase 2, 17 TPs (ranging from 35th percentile female to 99th percentile male in stature) were tested to determine the vertical litter spacing required to accomplish the medical tasks adequately. For Phase 3, 17-20 TPs will be tested to determine number of trauma patients that can reasonably be treated by each TP. **RESULTS:** Approximately 75 percent of the medical tasks were successfully accomplished by TPs working in the UH-60 Interim Medical Mission Support System (IMMSS), while 91 percent of the tasks were successfully completed in the HH-60M medical interior. Problems completing the medical tasks were due to structural physical limitations of the aircraft interior, primarily vertical clearance. Neck

and back bend angles were calculated from the motion data. The 2nd percentile TP's neck angle was 66 degrees, on average, for 94% of the time during all tasks and scenarios. Surprisingly, the 99th percentile TP's neck angle was much lower (by 28 degrees), and the back angle was slightly higher than the 2nd percentile TP, suggesting that TPs assumed complex postures to accomplish patient care tasks. **DISCUSSION:** It is recommended that an improved IMMSS should have a vertical clearance of 28 in. between the litters, with more urgent patients loaded in the lower litter position and less urgent patients in the upper litter position. Ergonomic specifications should be considered when designing vehicle medical interiors.

Learning Objectives:

1. The audience will learn the vertical, lateral, and longitudinal clearances needed to render enroute care to a patient aboard a medical evacuation helicopter.
2. The audience will learn about the flight medic postures (specifically neck and back angles) while performing critical care tasks.
3. The audience will learn initial findings of ability of flight paramedic rendering critical care for more than one patient aboard a medical evacuation helicopter.

[174] ANTISTAPHYLOCOCCAL EFFECTIVENESS OF SURFACE TREATMENTS IN A SIMULATED AIRCRAFT ENVIRONMENT

T.J. Oh[3], A. Kreitenberg[1] and L.A. Mermel[2]
[1]Orthopedic Surgery, UC Irvine School of Medicine, Irvine, CA; [2]Infectious Disease, Brown University, Providence, RI; [3]Cadet, United States Military Academy, West Point, NY

INTRODUCTION: Reducing the bioburden on commercial aircraft could reduce post flight passenger illness. There are no standards or requirements for disinfection of commercial aircraft and interiors are rarely, if ever, disinfected. Studies have shown viral and bacterial survival for days to weeks. Passive antimicrobial surface-coatings used in healthcare have been proposed for the aircraft environment. International and Japanese standards specify an undisturbed interval after treatment of 24 h 35°C, and >90% Relative Humidity (RH). Such conditions are never available on commercial aircraft. This study describes a reproducible protocol with high fidelity, real world commercial aircraft simulation of time, temperatures, RH, materials, and use. **METHODS:** Pieces of aircraft metal, leather, and plastic were coated with a variety of antimicrobial surface treatments. Each test material was rubbed with gauze to simulate passenger use then disinfected with alcohol. An aliquot of *S. aureus* was applied to a swatch which was then pressed against the test material to simulate human skin touch. Test materials were then left undisturbed for 1 h or 8 h to simulate a short turn or an overnight airline stop. Temperature was set at 20°C and RH at 20%. D/E contact culture plates were touched against the test surface and incubated 36hr at 35°C. CFU's were then enumerated independently by two of the investigators and tabulated. **RESULTS:** *S. aureus*-contaminated test material made of stainless steel with embedded copper showed significant reductions in CFUs at 1h and 8h. Two varieties of stainless steel with embedded silver showed significant reductions in *S. aureus* CFUs at 8h, but not at 1h. Plastic sprayed with a long-acting quaternary ammonium compound showed significant reductions in *S. aureus* CFUs at 8h, but not at 1h. No product tested showed reductions in *S. aureus* CFUs on leather surfaces at 1h or 8h. **DISCUSSION:** Manufacturers' claims of antimicrobial efficacy of surface treatments require testing in a high fidelity aircraft environment simulating real-world conditions before adoption on commercial airliners. These data suggest a role for imbedding copper into stainless steel and possibly aluminum for applications such as seat belt buckles and latches. However, it is unclear how best to safely and effectively prevent contamination of leather and plastic aircraft components. Further studies with other human pathogens, including viruses and fungi, are needed.

Learning Objectives:

1. To gain an understanding of strategies to decrease the bioburden on commercial aircraft as a means of reducing risk of worldwide disease transmission.
2. Passive antimicrobial surface treatments and coatings may possibly reduce viable pathogens, but validation testing must be carried out simulating the unique aircraft environment.

[175] NOISE MEASUREMENT OF CARGO AIRCRAFT AT STAFF RESIDENCE OF AIRBASE

M. Khan and B.B. Sharma
Electrical Engineering, Jamia Millia Islamia, New Delhi, India

BACKGROUND: Noise is undesirable sound and interferes with usual actions during sleep and talk. Noise possibly turns out to be a concern when its intensity surpasses the ambient or background sound pressures. Noise level of aircraft is higher near to airbase and residents living nearby are more prone to aircraft noise. Aircraft generate noise during takeoffs, landings, and level flight (cruise). Higher noise levels affect residents more during takeoff and landing. An attempt has been made to measure cargo aircraft noise for further safety analysis. **METHODS:** A suitable location is identified for the measurement of noise level approximately 1500 m from the air runway. A decibel meter employed in the android mobile phone has been used for noise measurement. Human who recorded the data was protected covering his ear by protective ear plugs. The experiment was performed to record and compare noise generated during takeoff and landing of 10 cargo aircrafts. The decibel meter recorded noise during the taxi stage, takeoff, and landing. Noise level was found uniform and minimum as 80 dB average during taxi stage. Minimum average noise level of 10 takeoffs and 10 landing is 87dB and 80dB respectively. Maximum average noise level of 10 takeoffs and 10 landing is 97dB and 93dB respectively. **RESULTS:** Analysis of data yielded 93 dB average noise levels during takeoff and 86 dB average noise levels while landing. It is found that the noise level during takeoff is more as compared to the landing and above 85 dB. It may be harmful to the residents living nearby to the military airbase without using any protective devices. **CONCLUSION:** Noise levels were measured during takeoff and landing. The research work done could be useful to design and develop counter measures for nearby residents near military airbase.

Learning Objectives:

1. Study will provide awareness of noise safety of cargo aircraft to resident staff of airbase.

[176] CHARACTERIZATION OF PATIENT IMMOBILIZATION AND VIBRATION MITIGATION SYSTEMS DURING SIMULATED TRANSPORT: GROUNDWORK FOR A SAFE TRANSPORT STANDARD

R. Kinsler, R. Khouri, C. Squire and S. Conti
USAARL, Dothan, AL

INTRODUCTION: The efficacy of the long spine board at limiting patient movement has been questioned by civilian emergency medical services. Several commercial-off-the-shelf (COTS) immobilization and vibration mitigation systems are available, but information on the performance of these systems during transport vibration was unknown. This study provides quantitative characterization of the dynamic performance of these COTS technologies using healthy volunteers. **METHODS:** Ten systems were tested: standard
U.S. Army Decontaminable litter, U.S. Army Medical Equipment Set (MES) immobilization kit, U.S. Army MES extrication kit, Vacuum Spine Board (VSB), Emergency Transport Stabilizer (ETS) medical air mattress, Thomas Back Raft, Managed Health Partners (MHP) medical mat, Low-G® standard mattress overlay, RescuePad spineboard, and Techshot mattress. Accelerometers were placed on the head, chest, pelvis, limbs, and system. Motion capture markers were placed alongside the accelerometers. The system was placed onto a litter mounted to a ride simulator. The pressure distribution data between the volunteer and system were collected. The volunteer was then exposed to three vibration profiles: sine dwell, ground vehicle, and rotary-wing aircraft. After each profile, 20 volunteers were given a Ride Comfort Survey (RCS) designed to measure subjective volunteer discomfort or pain perception. **RESULTS:** The majority of systems exacerbated low frequency vibration (1 to 12 Hertz [Hz]), particularly the air bladder systems. Most systems exhibited disproportionate displacement amplitudes between the large body segments of the head, chest, and pelvis when exposed to sinusoidal vibration during frequencies near the resonance frequency of the decontaminable litter (approximately 5 Hz). Systems with hard surfaces, the U.S. Army backboard and deflated VSB, displayed pressure profiles with higher pressure areas at the body contact points. Subjective volunteer perception of discomfort/pain, with higher

scores indicating greater discomfort or pain, scored the U.S. Army MES configuration with the highest mean rating (4.27) and the Low G® mattress with the lowest mean rating (1.4) across all profiles. **DISCUSSION:** A methodology has been established to quantitatively characterize the dynamic performance of immobilization and vibration mitigation technologies. A link to the clinical consequences of this dynamic motion is needed for the development of a safe transport standard for patients.
Learning Objectives:
1. The standard Army immobilization technologies can cause discomfort or pain during dynamic motion, and may also have possible clinical consequences that can affect medical outcomes.

Tuesday, May 02 ***10:30 AM***
Governor's Square 11

S-036: PANEL: RESEARCH AND CLINICAL PRACTICE IN AEROSPACE MEDICINE (GERMAN LANGUAGE)

Sponsored by the German Society of Aerospace Medicine

Chair: Jochen Hinkelbein
Cologne, Germany

Chair: Torsten Pippig
Fuerstenfeldbruck, Germany

PANEL OVERVIEW: This panel is provided by the German Society of Aerospace Medicine. Altogether, five presentations are provided showing different aspects of research and clinical practice in Germany. The presentations are given in German language but with slides in English.

[177] EVALUATING AIRCRAFT ACCIDENT ANALYSIS OF AVIATION PSYCHOLOGISTS OF THE BUNDESWEHR

M.M. Nitzschner[1] and M. Stein[2]
[1]German Air Force Centre of Aerospace Medicine, Cologne, Germany; [2]Applied Military Psychology and Research Group, German Armed Forces Office, Hamburg, Germany

INTRODUCTION: Analyzing accidents clearly is an important method for maintaining and improving safety in aviation. Nevertheless, supervising the procedure of aircraft accident investigation is equally important. Still, such supervising-oriented analyzes seem to be generally neglected, especially in the military domain. The aim of the current study was to shed light on this fact by investigating military aviation psychology accident reports for trends, differences and similarities, as well as interviewing psychological aircraft accident investigators for extracting mental models of the investigation process. **METHODS:** For analyzing the accident reports, a content analysis for 42 reports (pages: Σ=333, M=7.6, SD=7.6, range=1-37) of the Bundeswehr from the years 1994-2014 was conducted. For extracting the mental models of the accident investigators, a semi-structured interview was conducted. **RESULTS:** As a result, various differences in the accident investigation process were found (e.g., concerning differences in the investigation of different human factors as well as differences in level of detail). **DISCUSSION:** Results indicate that it should be aimed for further standardization of the psychological aircraft accident investigation process.
Learning Objectives:
1. The participants will learn about the current process of aircraft accident investigations conducted by aviation psychologists of the Bundeswehr.

[178] THE INFLUENCE OF FUNCTIONAL STRENGTH TRAINING ON NECK MUSCLE ACTIVITY IN FIGHTER PILOTS

M. Rausch
German Airforce Center of Aerospace Medicine, Germering, Germany

INTRODUCTION: Fighter pilot performance is a complex subject related to all areas of aviation medicine. From a sport-scientific perspective there are two main topics: The influence of physical conditioning on enhancing G-tolerance and the influence of physical conditioning on G-related neck and back pain based on the fact that the cervical spine is one of the areas most severely affected by +Gz forces. Many investigations have shown that pilots practicing strength training have a lower risk of neck pain. This underlines the hypothesis that muscular strength might be an important factor in reducing strain and preventing neck pain in fighter pilots (Nagai et al, 2014). There are only few studies which investigate the influence of strength training on muscular strain and activity during +Gz acceleration. In the present study, the influence of a 10-week functional strength training program with the main focus on neck training will be validated. The influence of muscular activity under +Gz exposure and subjective stress parameters on the performance shown in the centrifuge will be investigated. **HYPOTHESIS:** A 10-week functional strength training program with the main focus on neck training reduces neck muscle activity under +Gz exposure. **METHODS:** Pre- and post-training tests with centrifuge test and a 10-week neck strengthening program three times a week. The pre- and post-training tests consist of a maximum muscular strength test and a test in a human centrifuge with accelerations of up to +3 Gz. Furthermore anthropometric data and a questionnaire about subjective stress parameters and neck discomfort related to +Gz exposure will be collected from the subjects. During the centrifuge tests, the subjects have to perform head rotations with and without helmet, and electromyographic (EMG) activity will be measured from neck and trunk muscles. After 10 weeks of functional strength training, the test will be repeated. The available centrifuge capacity will allow 20 male subjects to participate in the study (fighter pilots and pilot candidates). **RESULTS:** This is an ongoing study, results can be presented only at the meeting.
Learning Objectives:
1. Muscular strength might be an important factor in reducing strain and preventing neck pain in fighter pilots.

[179] P300 AS INDICATOR OF MENTAL LOAD UNDER 12 DEGREE HEAD DOWN TILT

B.W. Johannes[1], A.W. Gaillard[2], S.V. Bronnikov[3], Y.A. Bubeev[4], T.I. Kotrovskaya[4] and J. Rittweger[1]
[1]Institute of Aerospace Medicin, German Aerospace Center (DLR), Cologne, Germany; [2]Psychology, Tilburg University, Soest, Netherlands; [3]Crew activities and simulators design, S.P. Korolev Rocket and Space Corporation "Energia", Korolev, Russian Federation; [4]Psychophysiology, Institute of Biomedical Problems (IBMP), Moscow, Russian Federation

INTRODUCTION: Eighteen hours lasting -12 degree head down tilt (HDT) was used to investigate neurocognitive changes under simulated weightlessness. The P300 component of evoked EEG potentials in response to acoustic stimuli as negative feedback was examined in a classic and robust experimental design. The study aimed to address the question whether magnitude, latency or slope of the P300 were impacted by the overnight stay under -12° HDT. **METHODS:** The -12° HDT night stay was compared to a horizontal night stay. The data of six participants could be assessed completely. Four subjects were excluded from the study by different reasons. The subjects took part in two familiarization sessions in horizontal supine position prior the experiment. A cognitive test battery was applied to assess cognitive performance in arithmetic, short term memory, decision making and information processing speed. EEG was registered continuously using the space equipment foreseen for an application on the ISS. Acoustic stimuli of similar physical properties but different frequency were applied as positive or negative feedback. **RESULTS:** There were significant changes found between baseline, horizontal night stay and -12° HDT night stay for all three parameters of the P300 component. Surprisingly, for negative feedback (relevant stimulus) the latency became shorter after -12° HDT but slope and magnitude decreased. Latency showed additionally different changes for P300 on positive and negative feedback. **DISCUSSION:** The P300 application is planned for an ISS experiment. The results confirm the assumption that P300 might be a useful tool to investigate neurocognitive changes under simulated and real weightlessness.
Learning Objectives:
1. Feasibility of certain P300 application to assess neurocognitive changes under simulated and real weightlessness.

[180] THE RELEVANCE OF SOLAR ULTRAVIOLET IRRADIATION - A SPECIAL VIEW ON APRON WORKERS

J.F. Hedtmann[1], G. Meyer[3], M. Wittlich[4] and C. Felten[2]
[1]OSH Division, BG Verkehr, Hamburg, Germany; [2]Occupational Health & Industrial Hygiene, BG-Verkehr.de, Hamburg, Germany; [3]BG Verkehr, Hamburg, Germany; [4]DGUV - IFA, Sankt Augustin, Germany

PROBLEM: For years the number of skin cancer diseases in Germany increases considerably. The main reason for this disease is the ultraviolet irradiation (UV-irradiation), which impacts on the skin at intensive sunlight. The exposure against the solar UV-irradiation can be effected on the one hand during leisure time and on the other hand outdoors during a professional activity. According to evaluations approx. 2 - 3 million employees in Germany work regularly outdoors. But reliable evaluations about the level of the UV-irradiation exposure, to which specific occupational groups are exposed to, are missing. In the research project "skin cancer induced by UV-irradiation", initialized and realized by the German social accident insurance, the actual exposure should be identified under realistic working conditions. The objective is to build up an activity specific hazard cadastre for the occupational UV-exposition. **METHOD:** As a part of this project from April till October 2015, UV-irradiation measurements were implemented in different groups of occupational activities at the airport ramp. Concerned were aircraft handlers, aircraft cargo handlers, loadmasters and gardeners. During their daily working hours they wore an electronic dosimeter, which is fixed at an arm mount and measures the UV-irradiation exposure. The data were anonymously transferred to a server as per working day. UV exposure was expressed as SED (standard erythemal dosis). **RESULTS:** During summer, the UV exposure of occupational groups is as different as their work. Compared to other occupational activities, the measurement results of apron workers can be classified into the mean range. Values between 129 and 322 SED were determined. Aircraft handlers are more exposed to UV-irradiation than loadmasters. Obviously, aircraft handlers stay more often outdoors. Results will be compared with different occupational groups.

Learning Objectives:

1. The participant will be able to understand that ultraviolet irradiation is a common reason for skin cancer.
2. The participant will understand that the risk to develop skin cancer is linked to the degree of uv irradiation exposition and that therefore it is necessary to improve the knowledge of the exposition of different occupational groups.
3. The participant will be able to differentiate the exposition against uv irradiation between different groups of apron workers and to estimate the exposition of apron workers in comparison with other occupational groups.

[181] RHEUMATIC DISEASES - AN INTERDISCIPLINARY CHALLENGE IN CIVILIAN AND MILITARY AVIATION MEDICINE

T.M. Pippig
Clinical aviation medicine, Centre of Aerospace Medicine, Fuerstenfeldbruck, Germany

Rheumatic diseases are autoimmune systemic diseases that causes chronic inflammation of the joints and other areas of the human body. The classification of rheumatic diseases is sometimes difficult due too unknown an etiology and heterogeneity in their clinical presentation, there are above 400 different forms of disease. Rheumatoid arthritis (RA) is the most common rheumatic disease. While the symptoms may vary, as a rule, these conditions target the musculoskeletal system, including the bones, joints, muscles, and tendons that contribute to function: Joint pain, tenderness, swelling, redness, warmth, stiffness, loss of joint range of motion, weakness, instability, limping and joint deformity. There is a high risk for co-morbidity. Pulmonary infection is a major cause of death in RA. RA appears to increase the risk for bacterial, tubercular, fungal, opportunistic, and viral infections, with all infections being more common in more active and severe RA.Although increased in RA, there is currently no evidence to indicate that gastrointestinal ulcers are due to a specific RA process, but there is evidence that they are due to commonly used therapies (medication) in RA. Other common complications are inflammation of the eye, anemia, osteoporosis, skin diseases, and depression. There is no cure for rheumatology diseases! The treatment optimally involves a combination of patient education, rest and exercise, joint protection, medications, and occasionally surgery. Therefore, all civilian and military pilots having well-founded rheumatic diseases are unfit for flying duty. The next step of aeromedical assessment, the waiver process, involves all relevant medical specialist fields, always a case-by-case decision. The key questions of aeromedical assessment are: Activity of the inflammation process and prognosis, medication (efficiency and side effects), functionality of joints involved, co-morbidity, function on the aircraft, work load and risk of sudden incapacitation in flight. In 2014 und 2015 15 pilots and crew members having a rheumatology condition were examined in the orthopedic section of the Centre of Aerospace Medicine of the German Air Force: Rheumatoid arthritis (RA), ankylosing spondylitis (aSp), SAPHO syndrome, psoriasis arthritis, gout and unspecific sacroiliitis. The waiver decision includes periodic review and regular check-up, at least every six months.

Learning Objectives:

1. Aeromedical standards
2. Rheumatic diseases
3. Waiver process

Tuesday, May 02 ***10:30 AM***
Governor's Square 10

S-005A: PANEL: BOARD REVIEW SESSION 1

Sponsored by American Society of Aerospace Medicine Specialists

Chair: Kimberly Toone
Alexandria, VA

PANEL OVERVIEW: This panel is sponsored by American Society of Aerospace Medicine Specialists and is designed to be a review of specific board exam topics. There are three such sessions throughout the annual scientific meeting. This specific panel includes a lecture on Epidemiology, Screening, and Prevention of Cardiovascular Diseases, the Cardiovascular and Pulmonary Effects of Space Flight and Exposure to G Forces, and on Epidemiology, Screening, and Prevention/Intervention of Substance Abuse/Addiction.

[020] BOARD REVIEW SESSION 1: CARDIOVASCULAR DISEASE

M.D. Jacobson and E.D. Davenport
Aerospace Education, 711 HPW/USAFSAM, Wright-Patterson AFB, OH

PROBLEM STATEMENT: Cardiovascular disease is the leading cause of death in the United States. In order to serve well our patient population and reduce morbidity and mortality, physicians must be well-versed on the epidemiology, screening and prevention of cardiovascular disease. **TOPIC:** According to Healthy People 2000, "heart disease is the leading cause of death in the United States… [and] stroke is fifth… [A]long with other cardiovascular disease, are among the most widespread and costly health problems facing the Nation today, accounting [for] approximately $320 billion… annually. Fortunately, they are also among the most preventable." **APPLICATIONS:** The United States Preventive Services Task Force (USPSTF) has published 14 recommendations regarding screening, counseling and prevention and the American Heart Association has added a number of its own. This session will review these guidelines, as well as the current literature, to bring attendees up-to-date on the epidemiology, screening and prevention of cardiovascular disease, prepare them for the American Board of Preventive Medicine (re-)certification examination, and empower physicians to lead aggressively in the 'war' against heart disease and stroke. **RESOURCES:** 1. Office of Disease Prevention and Health Promotion. (2016, 10/27/2016). Heart Disease and Stroke. Healthy People 2000 Retrieved 2016-10-28, 2016, from https://www.healthypeople.gov/2020/topics-objectives/topic/heart-disease-and-stroke. 2. American Heart Association. (2013). New heart disease and stroke prevention guidelines released Retrieved 2016-10-28,2016,fromhttp://news.heart.org/new-heart-disease-and-stroke-prevention-guidelines-released/

Learning Objectives:

1. The participant will comprehend the significant morbidity and mortality of cardiovascular disease.

2. The participant will be able to paraphrase and discuss current generally accepted guidelines for screening and prevention of cardiovascular disease.
3. The participant will be empowered and motivated to reduce the morbidity and mortality of cardiovascular disease within his/her sphere of influence.

[021] BOARD REVIEW SESSION 1: SUBSTANCE USE DISORDERS

M.D. Jacobson
Aerospace Education, 711 HPW/USAFSAM, Wright-Patterson AFB, OH

PROBLEM STATEMENT: Annual national surveys consistently show approximately 10% of the US population use illicit drugs. Similarly, of the nation's 177 million alcohol users, an estimated 10% (17 million) have an alcohol use disorder, and 61 million (23% of respondents) had binged in the 30 days prior to being surveyed. Despite this prevalence, SUDs continue relatively undetected and under-diagnosed, with only a fraction of primary care physicians ever inquiring as to their presence. **TOPIC:** The Centers for Disease Control estimates that excessive alcohol use directly leads to 88,000 deaths per year. Global data confirm that substance use disorders are responsible for a significant percentage of disability-adjusted life years (DALYs) worldwide. **APPLICATIONS:** This session will help prepare the participant for the American Board of Preventive Medicine (ABPM) (re-)certification examination by reviewing SUDs, their epidemiology, risk factors, screening, prevention and treatment of SUDs in both the aerospace community and the larger population. The most recent criteria and terminology from the Diagnostic and Statistical Manual (DSM-5) will be presented, as well as a comprehensive review of the literature, and the latest evidence-based recommendations for screening and brief intervention. **RESOURCES:** 1. Hedden, Sarra L., Kennet, Joel, Lipari, Rachel, Medley, Grace, & Tice, Peter. (2015). Behavioral health trends in the United States: Results from the 2014 National Survey on Drug Use and Health (HHS Publication No. SMA 15-4927, NSDUH Series H-50). Rockville (MD): Center for Behavioral Health Statistics and Quality. 2. Whiteford, Harvey A., Ferrari, Alize J., Degenhardt, Louisa, Feigin, Valery, & Vos, Theo. (2015). The Global Burden of Mental, Neurological and Substance Use Disorders: An Analysis from the Global Burden of Disease Study 2010. *PLoS ONE, 10*(2), 1-14. doi: 10.1371/journal.pone.0116820. 3. SAMHSA. (2015, October 27). Substance Use Disorders Retrieved 10/28/2016, from http://www.samhsa.gov/disorders/substance-use 4.

Learning Objectives:

1. The participant will comprehend the significant morbidity and mortality of substance use disorders (SUDs) and their under-detection in the primary care setting.
2. The participant will be able to discuss and implement screening, brief intervention and referral for treatment (SBIRT) of SUDs.
3. The participant will be empowered and motivated to reduce the morbidity and mortality of SUDs within his/her sphere of influence through early detection and intervention.

[022] BOARD REVIEW SESSION 1: PHYSIOLOGIC EFFECTS OF SPACE FLIGHT

A. Schiemel
Aerospace Medicine, US NAVY, FPO

PROBLEM STATEMENT: Optimal performance on the Aerospace Medicine Board Certification examination requires a clear understanding of the physiologic effects of space flight on crew. **TOPIC:** Cardiovascular and pulmonary effects of space flight and exposure to G forces **APPLICATIONS:** The space environment is dramatically different than that of terrestrial Earth. Altered atmospheric pressure, microgravity, temperature, and background radiation levels are all unsuitable to human existence without significant modification and/or accommodation. Massive changes in velocity, required for orbital entry and the return to Earth's atmosphere, generate significant acceleration and deceleration forces on spacecraft and the persons inhabiting them. At a baseline, safe and effective space operations require that all of these parameters are (or will be) taken into consideration and mitigated before the first steps of mission execution can ever be considered. In this lecture we will focus primarily on the cardiovascular and pulmonary effects of space flight and exposure to G forces. Nonetheless, in an effort to provide a more holistic overview of the topic (and to derive maximal board preparation), we will also touch briefly on other physiologic and environmental factors one must consider in space flight and habitation. **RESOURCES:** Davis, J.R., & Johnson, J., & Stepanek, J., & Fogarty, J.A. (Eds.). (2008) *Fundamentals of Aerospace Medicine, 4th Edition. Philadelphia, PA: Lippincott, Williams, &Wilkins.*

Learning Objectives:

1. At the conclusion of this session participants will gain a better understanding of physiologic decrements associated with spaceflight, the cardiopulmonary effects of G forces, and the countermeasures and rehabilitation required for longer-duration space missions.
2. At the conclusion of this session participants will be better able to correctly answer maintenance of certification questions related to space flight and the space environment.

Tuesday, May 02 ***2:00 PM***
Plaza A/B

S-037: PANEL: MOTIVATION TO FLY

Chair: Teg McBride
Wright-Patterson AFB, OH

PANEL OVERVIEW: In recent times, U.S. Air Force (USAF) pilots have been described as having the legendary "right stuff" and, by and large, have similarly exceptional intelligence and functional capacity (i.e., ability), demonstrated character and emotional composure (i.e., stability), and a consistent desire and proven resolve to become, and remain, a pilot (i.e., motivation and resolve). Pilot candidates must pass through a series of filters that strive to accurately assess their ability, stability, and motivation. USAF Neurological Medical Flight Screening (MFS-N) has historically consisted of measures that objectively assess ability and stability of pilot candidates. However, other than an individual demonstrating a high level of motivation to fly by successfully completing the multitude of steps required to become a pilot, until recently there has not been an objective measure of motivation utilized at MFS-N. This panel will present pilot norms established at the USAF School of Aerospace Medicine's Aeromedical Consultation Service through MFS-N testing and a review of the current literature on motivation as it pertains to pilot training and performance. Also, the panel will discuss the development and findings, as well as future uses, of assessment instruments measuring motivation and resolve recently administered to all pilot candidates during MFS-N. Additionally, the panel will examine how to evaluate candidate integrity during the initial medical flight screening and discuss cases that demonstrate how motivation to fly changes throughout a pilot's career.

[182] MOTIVATIONAL ORIENTATION IN U.S. AIR FORCE PILOT CANDIDATES

R. Walsh[1,2]
[1]Neuropsychiatry, Aeromedical Consultation Division, Wright-Patterson AFB, OH; [2]SSI-STS Systems Integration, Dayton, OH

PROBLEM STATEMENT: Other than an individual demonstrating a high level of motivation to fly by successfully completing the multiple steps of becoming a pilot, to date there has not been a systematic evaluation of motivation at Neuropsychological Medical Flight Screening. While there is a lot of research on different aspects and types of motivation, there is a lack of understanding about pilot motivation and how it changes throughout an aviator's career. **TOPIC:** The presentation will focus on the history of motivational research, highlighting studies on intrinsic and extrinsic variables. Additionally, research will be presented on the concepts of resolve and grit. Finally, the presentation will discuss the latest literature on pilot motivation and resolve. **APPLICATIONS:** Awareness of motivational forces behind aviator behavior is important knowledge for the aeromedical community when evaluating for fitness for duty. This can assist the aeromedical community to better understand what variables influence pilot motivation.

Learning Objectives:
1. Understand what motivates a U.S. Air Force pilot candidate to pursue a career in aviation.
2. Identify motivational factors that influence aviation-directed behavior.

[183] MOTIVATION TO FLY: ASSESSING MOTIVATION DURING THE INITIAL MEDICAL FLIGHT SCREENING INTERVIEW

C. Shurlow
FECM, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH

PROBLEM STATEMENT: Pilot candidates use creative, and often times less that fully truthful, strategies to pass their initial flight physical. **TOPIC:** This presentation will discuss how to evaluate integrity, Adaptability Rating for Military Aviation (ARMA), or the "right stuff" during the initial medical flight screening interview. There is significant variation among pilot candidates who switch college degree programs in order to obtain the grades necessary to maintain ROTC scholarships. In conclusion, the presentation will discuss how pilot candidates use social media sites and other approaches to share their strategies with one another regarding how to pass the initial flight screening process. **APPLICATIONS:** This presentation will educate the attendees about the extent pilot applicants go to become USAF pilots, the techniques used to pass the initial medical flight screening interview, and USAF's techniques to assure flight safety standards are met.
Learning Objectives:
1. Understand the motivational techniques used by USAF pilot applicants to pass their initial flight physical and the flight physical countermeasures used to combat those techniques.

[184] CLINICAL CASE EXAMPLES OF MOTIVATION THROUGHOUT A FLYING CAREER

T.L. Correll
Aerospace Medicine Consultation Division, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH

PROBLEM STATEMENT: A pilot candidate's motivation to fly can surmount enormous obstacles and be at peak levels early on in an aviator's career. However, as they face the challenges associated with a career in aviation (e.g., selection, training, demanding flight schedule, danger), coupled with normal life challenges (e.g., marriage, children, health concerns), they can experience a significant change in their levels of motivation over the course of their career. **TOPIC:** USAF pilots are typically seen as being "cut from a similar cloth." They are routinely viewed as "supranormal" in many ways and demonstrate enormous motivation to fly. They invest a significant part of themselves and their lives to achieve their goal of flying. When "life happens" over the course of a career, there are times when their motivation and dedication to flying may wane. Pilots routinely have a very difficult time raising their hand to share such concerns with their leadership. As such, reduced motivation can show up as somatization, anxiety, phobias, panic attacks, depression, or in a myriad of other ways. On the other end of the spectrum, other aviators remain highly motivated throughout their careers and can demonstrate enormous resolve to continue flying, even to the point of "faking good" (reverse malingering) when ill, or even outright concealment of medical problems in order to maintain their flight status. **APPLICATIONS:** This session will examine clinical cases seen at the USAF School of Aerospace Medicine's Aeromedical Consultation Service (ACS) demonstrating motivational issues as they present in the clinical setting.
Learning Objectives:
1. This session will examine clinical cases seen at the USAF School of Aerospace Medicine's Aeromedical Consultation Service (ACS) demonstrating motivational issues as they present in the clinical setting.

[185] NEW TOOLS ASSESSING MOTIVATION AND RESOLVE OF PILOT CANDIDATES

T. McBride
USAF School of Aerospace Medicine, Wright-Patterson AFB, OH

PROBLEM STATEMENT: A pilot candidate's motivation to fly and accompanied resolve to persist in the face of challenges to become a military aviator are important components of those who go on to become successful pilots. Until recently, however, there have not been objective measures of motivation or resolve utilized during the neuropsychological portion of the medical flight screening (MFS-N) process at the U.S. Air Force School of Aerospace Medicine's Aeromedical Consultation Service. **TOPIC:** Air Force pilots have been described as having the legendary "right stuff" and, by and large, have similarly exceptional intelligence and functional capacity (i.e., ability), demonstrated character and emotional composure (i.e., stability), and a consistent desire and proven resolve to become, and remain, a pilot (motivation). MFS-N consists of measures that objectively assess ability and stability of pilot candidates. However, other than an individual demonstrating a high level of motivation to fly by successfully completing the multiple steps of becoming a pilot (undergraduate college degree; Reserve Officer Training Corps, U.S. Air Force Academy, or Officer Training School; and the multitude of administrative requirements), to date there have not been objective measures of motivation or resolve used at MFS-N. Novel instruments measuring intrinsic and extrinsic motivation, as well as resolve and determination, were developed and integrated into MFS-N. More than 500 pilot candidates have completed the measures. Descriptive statistics and t-test correlations will be presented and interpreted. Future use of the instruments and normative data will be discussed. **APPLICATIONS:** Motivation and resolve are key components of a successful flying career. Baseline normative data allow for pilot candidate comparisons. Additionally, baseline data enable assessment of motivation and resolve changes as pilots become more seasoned aviators.
Learning Objectives:
1. Describe the measures of motivation and resolve now used during MFS-N to assess pilot candidates.
2. Appreciate the initial findings and normative data of the pilot motivation and resolve instruments.
3. Understand future directions of the use of the pilot motivation and resolve assessment tools.

Tuesday, May 02 ***2:00 PM***
Plaza D/E

S-038: PANEL: RISK MANAGEMENT: BIOLOGY, PSYCHOLOGY, AND TRAINING

Sponsored by the AsMA Aerospace Human Performance Committee; Aerospace Human Factors Association

Chair: Keith Ruskin
Chicago, IL

Chair: Joseph Cohn
Washington, DC

PANEL OVERVIEW: Advances in aerospace technology offer the promise of significantly safer and more reliable operations, but human operators will continue to play a critical role in the success of most aerospace activities. Regulatory bodies such as the US Federal Aviation Administration (FAA) and educational groups advocate changes in training in the mechanisms of accidents, how to teach risk management, and understanding cognitive errors. Aerospace manufacturers have spent significant amounts of resources on developing more natural human-machine interactions during operations, while the training community seeks ways to inoculate operators to these types of errors before they can occur. Pilot training now includes a comprehensive curriculum on judgement, decision making, and risk management. The FAA asks questions about aeronautical decision making in both its written and practical examinations. And yet, pilots continue to misjudge the risks associated with a given operation, placing themselves and their passengers at risk. As technology continues to evolve, a better understanding of the neurocognitive basis of performance errors is critical to improving safety. Our evolving understanding of human performance, and the neurocognitive and physiological processes that underlie it, may offer

new ways to help humans understand and manage risks. The increasing reliance upon technology will require the development of advanced human-machine interfaces. This panel seeks to discuss the neurocognitive basis of risk management, explaining how our brains are structured to accept or reject risk and how these structures may be changed through experience; describing the behavioral aspects of risk-taking behavior and how these may be characterized through various cognitive assessments; and, discussing techniques to help manage risk taking behavior. Topics proposed for this panel include the neurobiology of risk perception; linking neurobiology of risk perception to behavior; modifying risk perception through experience; cognitive assessments to classify risk-taking; and models that can be used to characterize and manage risk.

[186] NEUROBIOLOGY OF RISK MANAGEMENT: CAN WE THINK OUR WAY OUT OF TROUBLE?

K. Ruskin
Anesthesia and Critical Care, University of Chicago, Chicago, IL

PROBLEM STATEMENT: Pilot training includes a comprehensive curriculum on judgement, decision-making, and risk management, but underestimating the risk associated with a given operation remains the root cause of many aviation mishaps. Decision-making in the face of uncertainty relies upon specific neuronal pathways that guide our estimation of risk and reward. Understanding the neurocognitive basis of risk-taking behavior is therefore critical to increasing the safety of flight operations. **TOPIC:** People making a risky decision estimate the subjective value of a reward against their individual risk preference, and this process is correlated with activity in specific brain regions. Activation of the brain's reward center in gamblers is more strongly correlated with activation of the structures that estimate risk than in non-gamblers. Functional MRI studies show differential activation patterns within the anterior cingular cortex (which is involved in reward anticipation), the posterior cingular cortex, and the caudate (which is involved with goal-directed activity) during each phase of risky decision-making. These patterns correspond to an individual's risk seeking behavior. The posterior cingular cortex appears to be correlated with decisions related to subjective value. One study correlated the volume of gray matter in the human posterior cingular cortex to preferences in economic decision-making and concludes that a larger amount of gray matter permits a less-compressed model of value, thus increasing a person's willingness to assume risk. **APPLICATIONS:** If our willingness to accept or reject risk is determined in part by individual neuroanatomy, is it possible to reason our way out of potentially dangerous behavior? Decision-making in the face of uncertainty requires that a person estimate the probability and magnitude and of a given reward (e.g., completing a flight) in comparison to the possibility of an adverse consequence. This behavior is partially encoded in specific brain structures. Understanding the neurobiology of risk-seeking behavior can help us to develop specific mitigation strategies that use human factors principles to help pilots to understand and manage risk.

Learning Objectives:

1. Participants will understand our "hard-wired" propensity for risk and how it can affect the safety of flight operations.
2. Participants will be able to explain how specific brain structures modulate risk-seeking behavior and develop training strategies that mitigate this effect.

[187] INDIVIDUAL DIFFERENCES IN RISK PROPENSITY: CAN WE PREDICT RISK TAKING BEHAVIOR AMONG AVIATORS?

T. Olson and M.W. Natali
Operational Psychology, Naval Aerospace Medical Institute, Pensacola, FL

PROBLEM STATEMENT: Despite technological advances, human error remains the primary causal factor in aviation mishaps. The aviation environment is inherently ambiguous, requiring the pilot to make decisions quickly and without complete information. As such, the relationship between decision-making and risk-taking is critical. Pilot decision-making is influenced by psychological factors, including experience, motivation, and personality attributes. Although most would agree individuals exhibit differences in risk-taking behaviors, to what extent are those differences driven by stable, underlying dispositions, and can these underlying dispositions be reliably measured? Understanding individual differences in risk propensity and the motives underlying choices about engaging in risky behavior is therefore critical to developing effective risk management strategies. **TOPIC:** Individuals differ in risk-taking behavior, and some research suggests individual differences in risk propensity may explain some of this variability. Personnel selection is the systematic process of identifying skills, abilities, and other characteristics in applicants that contribute to success on the job and organizational effectiveness. Given the relevance of risk-taking behavior in aviation, the ability to measure risk-taking propensity among applicants could prove valuable. A number of risk propensity measures have demonstrated significant relationships with risk-taking behaviors, such as substance abuse, crime, and risky driving. Minimal research has evaluated the utility of these measures in predicting risk-taking behaviors among pilots, but there is growing recognition of the value of assessing risk propensity within this population. **APPLICATIONS:** A comprehensive approach to risk management in aviation requires emphasis on multiple facets of human performance, to include personnel selection. This presentation will discuss current research examining individual differences in risk propensity, to include personality traits associated with risk-taking and perceptions of risk, the mechanisms through which these individual differences influence risk-taking behaviors, and potential applicability within the aviation environment. If we can reliably assess risk-taking propensity among aviators, we may be able to better identify (and potentially screen out) individuals who are more likely to be involved in aviation mishaps, as well as develop targeted training strategies to improve risk management skills.

Learning Objectives:

1. The participant will be able to understand how individual differences in risk propensity and their relationship to risk-taking behaviors influence the development of risk mitigation strategies in aviation.

[188] A FRAMEWORK FOR SAFETY AUDITS AND THREAT ERROR MANAGEMENT FOR NAVAL AVIATION

J. Patrey, C. Foster and N.B. Corpus
4.6, NAWCAD, NAS Patuxent River, MD

Aircrew coordination training and crew resource management has been well-established as a valuable tool for flight safety over the past several decades. Military and commercial aviation have slowly diverged over the past several decades, with the military maintaining a traditional approach to training aircrew on beneficial crew coordination behaviors and commercial aviation evolving to include what has come to commonly be termed 'line operations safety audits' (LOSA) within a threat error management (TEM) framework. Commercial aviation has established LOSA's value to flight safety, the FAA cites LOSA as a best practice for flight safety, and the USAF has begun introducing a LOSA approach for some of their airframes, so an expansion to Naval platforms is worthy of consideration. The evidence supports updating the practices of Naval aviation to crew resource management and introducing a LOSA/TEM inspired approach, however, the implementation within commercial aviation and the USAF seem a poor fit for Naval aviation's staffing, mission, and platforms. An approach for Naval aviation is proposed herein which captures the benefits of in-flight safety observations and adapts to the unique mission and constraints of Naval aviation.

Learning Objectives:

1. Develop an understanding of the history of crew resource management in aviation.
2. Develop an understanding of current practices in crew resource management.
3. Develop an understanding of how in-flight safety observations can enhance Naval aviation safety.

[189] LINKING THE NEUROBIOLOGY OF RISK PERCEPTION TO BEHAVIOR: LAYING THE FOUNDATION FOR ENHANCING DECISION MAKING PERFORMANCE

J.V. Cohn[1], J. Freeman[2] and W. Stacy[2]
[1]RDA, Defense Health Agency, Washington, DC; [2]Aptima, Washington, DC

PROBLEM STATEMENT: Risk assessment is fundamentally a decision making activity. In order to develop new approaches for enhancing risk assessment, it is therefore necessary to understand the processes underlying decision making and then identify approaches to augment these processes. **TOPIC:** It is now well-recognized that there are two types of decision making, analytical and intuitive, mediated by different processes. Analytical decision making is mediated by processes that reflect a sequential, step-by-step, methodical, and time consuming process. In contrast, intuitive decision making relies upon a more holistic approach to rapidly process basic patterns in information. Importantly, intuitive decision making can support analytic decision in varied ways. Intuition can rapidly characterize the problem at hand for subsequent analytic validation, generate solutions for analytic exploration, and determine whether uncertainty or risk are sufficient to warrant investing time and attention in deliberate analysis. Moreover, recent research suggests that intuitive decision making processes may be amenable to augmentation, through a process known as implicit learning. **APPLICATIONS:** In this talk we will present a conceptual model, based on recent advances in neurobiology and cognitive neuroscience, that highlights the connections between these two decision making processes, and that lays the foundation for developing a training- based approach to augment them. It is proposed that this approach may be one way in which to help manage risk perception.

Learning Objectives:

1. Distinguish between two types of decision making, Analytic and Intuitive.
2. Gain insight into the neurobiology of decision making.
3. Understand the synergy between decision making and different types of training approaches.

Tuesday, May 02 ***2:00 PM***
Plaza F

S-039: SLIDE: LEARNING FROM SPACE

Chair: Cathy DiBiase
Titusville, FL

Co-Chair: Steven Guyton
Pittsburgh, PA

[190] LESSONS FROM MOL: MEDICAL IMPLICATIONS OF RADIATION EXPOSURE DUE TO ITS LOW-ALTITUDE POLAR ORBIT

J. Chancellor[1], S. Auñón[3] and J. Charles[2]
[1]Physics & Astronomy, Texas A&M, League City, TX; [2]Human Research Program, Johnson Space Center, NASA, Webster, TX; [3]Johnson Space Center, NASA, Webster, TX

PROBLEM STATEMENT: The relatively minimal shielding of the MOL program's space vehicle and the high inclination polar orbits left the crew susceptible to exposures of cosmic radiation and Solar Particle Events (SPEs). It is reasonable to presume that future commercial and military spaceflight missions in Low-Earth Orbit (LEO) will have vehicles with similar shielding and orbital profiles. Studying the impact of cosmic radiation to the mission's operational integrity and the health of MOL crewmembers provides an excellent surrogate and case-study for future LEO spaceflight missions. **TOPIC:** An important question to be answered for future commercial and military spaceflight missions is the short- and long-term health effects of space radiation on participants. Exposure to a cosmic radiation and SPEs can have a serious impact to all biomedical aspects of space exploration. This paper will model the nominal and off-nominal radiation environment that a MOL-like spacecraft vehicle would be exposed to during a 30-day mission. Projected doses from historically large SPEs (e.g. the August 1972 solar event) will be analyzed in context of the MOL mission profile, providing an opportunity to study the impact to crew health and subsequent contingencies. From these, hypothetical operational guidelines will be discussed, including in the context of possible future missions. **APPLICATIONS:** Commercial and military spaceflight crews could be exposed to SPEs that might induce prodromal effects and further exacerbate biological outcomes from the concurrent chronic galactic cosmic ray environment. The MOL flights were susceptible to high-energy charged particles existing in the Earth's Heliosphere. Each with the ability to damage critical cellular components when passing through the tissues of the body. In addition, behind shielding neutrons produced by interactions of cosmic rays in the spacecraft structure can also be highly penetrating and can deliver a significant dose to critical organ systems. **RESOURCES:** 1.John Charles and Dan Adamo, "Thirty Days in a MOL, Biomedically-relevant aspects of a reconnaissance mission inferred from orbital parameters," *Quest* vol. 22, No. 2 (2015): 3-14. 2. Chancellor, J., Scott, G. & Sutton, J. Space radiation: The number one risk to astronaut health beyond low earth orbit. *Life* 4, 491–510 (2014)**.**

Learning Objectives:

1. The attendee will understand the significance of the MOL program and its biomedical contributions to the future of human spaceflight in spite of being cancelled before a single flight in its program.

[191] LESSONS FROM MOL: CREW AUTONOMY, PERFORMANCE, AND PSYCHOLOGICAL DEMANDS

T. Williams[2] and J.B. Charles[1]
[1]NASA Human Research Program, Houston, TX; [2]NASA/Behavioral Health and Performance, Seabrook, TX

The training of individual astronauts on the of MOL, a joint U.S. Air Force/National Reconnaissance Office program, anticipated many of today's space medicine and biomedical research requirements to better understand and mitigate potential risk for crewmembers on long-duration missions. In addition, the challenge and multiple demands on crewmembers can help to enhance our understanding of the potential risk factors of spaceflight related to crew performance and teamwork, circadian rhythms, and autonomous decision-making in uncertain, ambiguous and complex missions. This presentations provides a concise overview of the behavioral and psychological demands on the MOL crew envisaged by the MOL program. These include the physiological dysregulations that were likely to impact on the psychological capabilities and readiness to perform demanding, ambiguous mission requirements. The MOL program also generated critical thinking demands for autonomous, operational decision-making, as well as the potential impact of a low-altitude polar orbit on mission activities, duty day schedules, teamwork, and adaptation within a shared volume of 400 ft^3 (i.e., interior volume of a VW minibus).

Learning Objectives:

1. The attendee will understand the significance of the MOL program and the behavioral health and performance challenges that its astronauts would have experienced.

[192] ONE GIANT LEAP TO PROTECT ALL MANKIND: AN OVERVIEW OF THE LUNAR RECEIVING LABORATORY

J. Hayes[1] and J. Dooling[2]
[1]Biomedical Research and Environmental Sciences Division, NASA, Houston, TX, Friendswood, TX; [2]Rice University, Houston, TX

MOTIVATION: In 1961, President John F. Kennedy charged the nation "to land a man on the moon and return him safely to Earth". Eight years later, the Apollo 11 astronauts splashed down in the Pacific Ocean after this first 8-day journey to the moon. As humans had never ventured to another extraterrestrial body, the U.S. government noted the great uncertainty associated with the unknown exposures related to this historic mission. **OVERVIEW:** With this uncertainty in mind, a newly formed Interagency Committee on Back Contamination (ICBC) was established to review the potential for lunar contaminants and establish the prevention of their escape into the biosphere during crew and sample recovery operations from the floating command module to the mobile quarantine facility on the recovery ship and return to the Johnson Space Center. **SIGNIFICANCE:** As a result of the ICBC recommendations, in 1966 NASA planned and built the Lunar Receiving Laboratory (LRL) at the Johnson Space Center in Houston, Texas. The LRL served a great role in service of human space exploration to quarantine Apollo crewmembers, their space vehicles, and the lunar samples collected. Almost an afterthought in the space race to the Moon, the 83,000 ft^2 LRL was designed and completed in 1967 for $7.8 million. The core purpose of the LRL was "to protect the public's health, agriculture, and other living

resources; to provide lunar sample distribution to approved scientific investigators; and to preserve the scientific integrity of the lunar samples at all times". Its layout was comprised of three major zones: a quarantined Crew Area, a separate but also quarantined Sample Operations Area, and a Support and Administration Area outside the controlled biological barrier. This facility required trained personnel to live and perform within it for several weeks postflight, to include astronaut crewmembers, flight surgeons, scientists, and vehicle recovery engineers. The LRL holds memories of these historic events but has since been repurposed for NASA's medical and environmental sciences activities, in what is now known as Building 37. As we approach its 50th anniversary, the LRL story will end in demolition as NASA advances its facilities for the next steps in human exploration of space.

Learning Objectives:

1. To capture the historical relevance of the NASA Lunar Receiving Laboratory.
2. To understand the requirements of receiving crew and samples from the moon for the first time.
3. To describe the facility capabilities in protection of public health.

[193] INTRODUCING AN AEROSPACE MEDICINE SYSTEMATIC REVIEW GROUP

A.J. Winnard[3,5], S. Evetts[2,4], R. Velho[4], M. Nasser[5,6], E. Boudreau[1], N. Caplan[3] and D. Gradwell[7,8]

[1]Department of Medical Informatics and Clinical Epidemiology, 4Oregon Health and Science University, Portland, OR; [2]SeaSpace Research Ltd, Deepcut, United Kingdom; [3]Health and Life Science, Northumbria University, Newcastle upon Tyne, United Kingdom; [4]UK Space Environments Association, Harwell, Oxford, United Kingdom; [5]Plymouth University, Plymouth, United Kingdom; [6]Cochrane Collaboration, London, United Kingdom; [7]King's College London, London, United Kingdom; [8]Aerospace Medical Association, Alexandria, VA

INTRODUCTION: A systematic review finds, appraises and interprets evidence to inform clinical and operational decision making and guidelines. Systematic review methods reduce bias, increase statistical power and perform gap analysis. Conducting systematic reviews requires specific methodological skills, therefore, systematic review groups are established. Due to an increasing amount of research in Aerospace Medicine, there is a need for systematic review in this field. We have, therefore, begun developing an Aerospace Medicine Systematic Review Group and conducted: (A) A pilot systematic review on the effectiveness of countermeasures against spinal changes due to spaceflight. This developed methods for judging the applicability of bedrest simulation studies to spaceflight and statistics to compare countermeasure results to baseline data. (B) Priority setting exercises involving key stakeholders. **METHODS:** (A) Electronic databases were searched from the start of their records to November 2014. Studies were assessed with PEDro, Cochrane Risk of Bias and a bed-rest study quality tool. Magnitude based inferences were used to assess countermeasure effectiveness. (B) The CAA, AsMA, RAF, ESA, International Space University and SeaSpace Research Ltd. were asked for feedback
on group proposals and recommend topical and beneficial reviews to conduct during group establishment. **RESULTS:** (A) Seven studies were included in the systematic review that found heterogeneity of outcome measures, no participant reported outcome measures and no countermeasure able to fully protect against all expected spaceflight induced changes. Research and operational recommendations were made and included in a European Space Agency Topical Team Report on post-mission rehabilitation. (B) Stakeholders felt the proposed group would be useful and contributed ideas for initial review topics. **DISCUSSION:** The initial systematic review and its impact to an ESA Topical Team Report demonstrates the research and operational usefulness of the group concept. Initial positive response of several major organizations in the Aerospace Medicine field provides support to group proposals and a list of quick win review titles will be reviewed to determine the most beneficial. Funding options to undertake initial reviews and develop resources such as a website with methodological guidance and directory of reviews will be sought.

Learning Objectives:

1. Understand the basics of systematic review methods within an aerospace medicine context.
2. Understand the application of basic systematic review methods to a space medicine question, presented as an example of the benefits and knowledge systematic review methods can bring to the aerospace medicine field.
3. Gain awareness of a developing Aerospace Medicine Systematic Review Group that aims to provide benefits of systematic review methods to the aerospace medicine community.

[194] SURGICAL ROBOTICS FOR SPACE APPLICATIONS

J. Raiti and D. Drajeske

Applied Dexterity, Seattle, WA

Applied Dexterity produces, sells, and supports the RAVEN surgical robot as a research platform and rapid prototyping environment for advances in robotically assisted surgery. RAVEN was developed between 2002-2007 at the University of Washington, with funding from the Department of Defense. While robotically assisted surgery was making commercial inroads, the systems were large and dominated an operating room. Existing systems did not fulfill the military's vision of a surgical robot that could be deployed in the field. The DoD's requirements for a compact, rugged, surgical robot are consistent with many of the requirements of a surgical robot for space applications. In the US Army sponsored HAPs/MRT demonstration (High Altitude Platform/Mobile Telesurgery, 2005), RAVEN was set up in a tent in the desert (Simi Valley, CA). A surgeon performed simulated surgery by teleoperation from a distant tent. Control signals were relayed via an autonomous drone circling above the surgical site. To accommodate limited communication bandwidth, the frequency of sending position updates from the controller to the robot was reduced and the video signal was highly compressed, but surgical performance was not hampered. In a separate test, as part of NASA's NEEMO12 mission, sections of RAVEN were transported in dive bags to the Aquarius underwater habitat. Following 2 days of training on system assembly, startup, and disassembly tasks, NASA aquanauts successfully assembled and commissioned RAVEN in the habitat. The system was teleoperated from Seattle, 3000 mi away to perform a variety of surgical skills tasks. These tasks were successfully completed while experiencing communication delays of about one second. We conducted a weeklong demo at NASA-JSC to pursue installation of a modified RAVEN on the ISS to facilitate ongoing rodent research. The system, teleoperated from the ground, will be used to perform rodent dissections that are currently performed by flight crew. In addition to buying back crew time, the installation will provide dramatic demonstration of long distance surgical teleoperation to enable a range of complex procedures. Our research now includes: surgical robot design for space facilities, long distance teleoperation, methods to mitigate limited bandwidth, time delay, and periods of loss of signal (LOS), Human/Robot Interaction, methods to achieve complex tasks through integrated efforts of robotics/automation, flight crew, and remote subject matter experts.

Learning Objectives:

1. The future of robotic surgery has potential benefits to facilitate surgical care in space.

[195] THE HISTORICAL SUMMARY OF PAST SYMPOSIUMS ON 'SURGICAL CARE IN SPACE'

M. Campbell

Paris, TX

PROBLEM STATEMENT: The various aspects of surgical care during remote long duration space flight has been a topic of tremendous interest as it is a subset of the medical care system that will be the most difficult to provide for. Over the last 32 years there have been six formal symposiums dedicated to the discussion and debate of the issues of providing surgical care in space. **TOPIC:** Over the last 35 years there have been a series of NASA sponsored symposiums that dealt with the issues of surgical care during spaceflight. The presenter has been an attendee at five of the last six formal symposiums concerning surgical care in space. Although not present at the symposium held in 1983, it was well documented and discussed with the author by the many attendees present. This review briefly summarizes those

workshops and highlights the changing thought processes of the participants. It is interesting to note that the issues and questions to be resolved are essentially the same from symposium to symposium but both the questions and conclusions become more sophisticated over the years. Recurring topics include what surgical procedures will need to be performed, the level of training of the crew medical officer, the treatment of appendicitis, the use of laparoscopy and robotic surgery, what equipment will be mandatory, and the technical details of performing a surgical procedure in weightlessness. **APPLICATIONS:** Previous symposiums have highlighted controversies in what surgical capabilities will be required on a remote long duration spaceflight. These controversies continue to the present time and highlight that medical system planning will be of utmost importance as our ability to provide surgical care will be limited. **RESOURCES:** Houtchens B. System for the management of trauma and emergency surgery in space: Final report. NASA Johnson Space Center. NASA Grant NASW-3744. Houston, Texas, 1983. Billica R, Lloyd CW, Doarn CR. Proceedings of the Space Station Freedom Clinical Experts Seminar. NASA Conference Publication 10069. Houston, Texas. 1991. Campbell MR. Surgical Care in Space- a Review. J.ACS 2002;194: 802-812. Campbell MR. Surgical Care in Space. Aviat Space Envir Med. 1999; 70:181-184. Campbell MR, Johnston SL, Marshburn T, Kane J, Lugg D. Nonoperative Treatment of Suspected Appendicitis in Remote Medical Care Environments: Implications for Future Spaceflight Medical Care. Journal American College Surgery 2004; 198: 822-830.

Learning Objectives:

1. To understand the controversies and issues of previous symposiums on surgical care in space.
2. To understand the difficulties of providing surgical care in space.
3. To understand the future challenges to providing surgical care in space.

Tuesday, May 02 ***2:00 PM***
Governor's Square 14

S-040: PANEL: UNITED STATES AIR FORCE PROACTIVE SAFETY PROGRAMS – EDUCATION AND VALIDATION

Chair: Tracy Mayfield
Albuquerque, NM

PANEL OVERVIEW: USAF safety programs aim to identify and eliminate hazards or mitigate the hazard's potential consequences. Proactive safety programs and safety investigations provide a means to identify these hazards and make recommendations. This panel will educate the audience and provide validity data on various safety programs. The first panel presentation will provide awareness of proactive safety programs' functionality and successes. The second panel presentation will demonstrate the predictive capability of the Air Force Combined Mishap System online safety culture survey. The third panel presentation will highlight Organizational Safety Assessment's impact on mishap reduction. The fourth panel presentation will explore the human factors coding frequency analysis trends in aviation mishaps to date and reveal potential mitigation areas. The last panel presentation will discuss the effectiveness of aviation mishap recommendations in addressing identified human factors.

[196] ORGANIZATIONAL SAFETY CULTURE AND MISHAP OCCURRENCE

T.E. Mayfield[1] and E. White[2]
[1]Human Factors Division, USAF Safety Center, Albuquerque, NM; [2]Booz Allen Hamilton, Albuquerque, NM

INTRODUCTION: Air Force Combined Mishap Reduction System (AFCMRS) is the Air Force's safety culture assessment tool. The survey has been administered over 600,000 times. AFCMRS is offered in 15 forms that are designed to align with organizational tasks. The survey collects and summarizes Airmen's opinions concerning their units' organizational safety climate (resources, safety processes, morale, organizational culture and leadership). AFCMRS results are used at every level of command to help commanders improve their understanding of a unit's safety culture. **METHODS:** The use of advanced statistical techniques appears to be very important when dealing with large and complex data sets. In 2015, AFCMRS data for 60 Air Force Squadrons were used to predict mishap likelihood for the same Squadrons in the following 12 months. These data have been re-analyzed using advanced survey techniques, revealing complex patterns of interactions among leadership, resource availability and organizational culture. Data were analyzed using factor analysis to identify clusters of variables which correlated with and may be predictive of mishaps. **RESULTS:** The use of advanced statistical techniques revealed a high correlation between specific AFCMRS survey questions and subsequent mishap events. Initial multiple regressions were conducted to predict mishap risk (incidence and severity) from the factors "Resources" and "Leadership." Both factors were significantly indicative of mishap risk (R^2=.28, F = 3.84, p <.005). Use of these techniques are likely to increase commanders' awareness of potential future mishap thus enabling them to mitigate the risks. **DISCUSSION:** Human factors research has contributed to a significant reduction in mishap rates across the aviation community, both commercial and military. As a result of that research and subsequent technological design implementations, very few mishaps occur for technological reasons. Organizational culture and supervision contribute significantly to aviation mishaps. Using tools such as AFCMRS surveys to identify leadership, resource availability and organizational culture improvement areas can lead to a necessary reduction in mishaps. Future research should analyze these same trends in other branches of the Department of Defense and/or the civilian aviation communities.

Learning Objectives:

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

[197] U.S. AIR FORCE AVIATION MISHAPS: MITIGATING HUMAN FACTORS THROUGH RECOMMENDATIONS

K. Lee[2], B.T. Musselman[1], T.E. Mayfield[1], T.S. Strongin[1] and S. Stouder[1]
[1]Human Factors Division, USAF Safety Center, Albuquerque, NM; [2]Resilient Solutions, LLC, USAF Safety Center, Albuquerque, NM

MOTIVATION: United States Air Force conducts aviation safety investigation boards to prevent future mishaps. Prevention is achieved by way of recommendations from the safety investigation board. Recommendations should mitigate causal findings and associated causal human factors. The United States Air Force uses the DoD Human Factors Analysis and Classification System (DoD HFACS) to categorize human factors present in mishaps. This panel will discuss recommendations' effectiveness at mitigating the identified causal human factors. **OVERVIEW:** Primary recommendations are associated with causal findings. Beginning March 2015, U.S. Air Force safety investigators were required to associate causal human factors (DoD HAFCS codes) with causal findings. There is currently no requirement to associate causal human factors with primary recommendations. Therefore, primary recommendations and causal human factors codes are associated with a causal findings, however, there is no direct association between causal human factors codes and primary recommendations. For Class A aviation flight and remotely piloted aircraft mishaps from 1 Mar 2015 to 30 Sep 16, five expert human factors safety investigators analyzed each mishap to assess whether or not the causal human factors codes were mitigated by primary recommendation. We will discuss the outcome of this assessment. **SIGNIFICANCE:** Actions taken to complete a recommendation should eliminate or reduce the consequences of identified causal human factors. This U.S. Air Force safety process review assesses the effectiveness of safety investigation board recommendations at mitigating identified causal human factors. This understanding is pertinent to aeromedical medicine and human performance practitioners involved in mishap prevention and safety investigations.

Learning Objectives:

1. Aerospace medicine and human performance professionals will understand effectiveness of U.S. Air Force safety investigation board recommendations on mitigating identified causal human factors.

[198] U.S. AIR FORCE AVIATION PROACTIVE SAFETY PROGRAMS

B.T. Musselman, T.S. Strongin, T.E. Mayfield and S. Stouder
Human Factors Division, USAF Safety Center, Albuquerque, NM

MOTIVATION: Aerospace medicine and human performance practitioners are quite familiar with aviation mishap investigations. They may not be as familiar with proactive safety programs. The United States Air Force Safety Center manages five proactive safety programs that analyze leading indicators in order to prevent mishaps before they occur. **OVERVIEW:** As part of an overall just culture, Airman Safety Action Program (ASAP), Military Flight Operations Quality Assurance (MFOQA), Line Operations Safety Audit (LOSA), Air Force Combined Mishap Reduction System (AFCMRS), and Organizational Safety Assessments (OSA) collect data from airmen, aircraft, operations and organizations. These data provide insight into indicators that, if modified, can prevent a mishap. Each of the five proactive safety programs has demonstrated success in providing safety personnel, leaders, policy makers and operational personnel key information to drive positive change. This panel will briefly discuss how each program provides leading indicators and the changes they drove. **SIGNIFICANCE:** U.S. Air Force Safety aims to safeguard airmen, protect resources, and preserve combat capability and readiness. Proactive safety programs support these priorities. This panel provides aerospace medicine and human performance professionals greater awareness of proactive safety functionality and successes.

Learning Objectives:

1. Aerospace medicine and human performance professionals will understand U.S. Air Force Safety proactive program's leading indicators and demonstrated successes.

[199] U.S. AIR FORCE AVIATION SAFETY INVESTIGATION FAQS HOT FROM THE FIELD

D. Windhorst, D. Porter and K. Lee
Aviation Safety Division, United States Air Force Safety Center, Kirtland AFB, NM

MOTIVATION: U.S. Air Force Aerospace Medicine and Human Performance personnel (e.g. flight surgeons, aerospace and operational physiologists, aviation psychologists) are frequently tasked as Safety Investigation Board members for manned and remotely-piloted aircraft mishaps. These board members have varying training and experience levels and frequently require expedited answers and clarifications to policy and procedural questions during investigations. **OVERVIEW:** Air Force Instruction 91-204, Safety Investigations and Reports and AFMAN 91-223, Aviation Safety Investigations and Reports, and various training courses including USAFSAM's Aircraft Mishap Investigation and Prevention (AMIP) course provide guidance on performing U.S. Air Force safety investigations. However, aerospace medicine and human performance safety investigators often need guidance clarification during safety investigations. Experienced human factors professionals at the U.S. Air Force Safety Center formulate answers to policy and procedural questions from these board members on a frequent basis. This presentation will list and discuss some of the more common and/or pertinent of these questions to help prepare interested professionals for future safety investigations. **SIGNIFICANCE:** Frequently asked questions is a common proactive practice to provide answers to common questions. This presentation will help future aerospace medicine and human performance safety investigators prepare for and effectively accomplish safety investigations.

Learning Objectives:

1. Aerospace medicine and human performance professionals will be familiar with solutions to some of the most common and pertinent questions that will arise during aviation safety investigations.

[200] U.S. AIR FORCE HUMAN FACTORS TRENDS AND PREDICTIVE MODELS IN AVIATION MISHAPS

S. Stouder[2], E. White[2], T.S. Strongin[1], T.E. Mayfield[1], B.T. Musselman[1], K. Lee[1] and B. Johnson[1]
[1]Human Factors Division, USAF Safety Center, Albuquerque, NM; [2]Booz Allen Hamilton, Albuquerque, NM

INTRODUCTION: United States Air Force Safety Center manages the Air Force Safety Automated System (AFSAS) as a tool to evaluate and analyze aviation mishap investigations. AFSAS includes Department of Defense (DoD) Human Factors Analysis and Classification System (HFACS) coding, as well as a variety of data related to demographics, mishap personnel, and aircraft type. The authors' intent is to inspect the quality of the data, validate its efficacy as a safety tool, and identify trends in the data to preemptively address causal human factors that lead to mishaps. **METHODS:** All U.S. Air Force flight related class A and B mishaps from FY 2006-2016 were factor analyzed to identify clusters of variables that predict mishaps, type and severity. We conducted a multiple regression to determine the impact of these variables on a predictive safety model. **RESULTS:** Statistical analyses identified human factor variables which significantly correlated with frequency, type, and severity of mishap. Multiple regression models demonstrated predictive validity. However, logistic regression suffers from a small-sample bias and is not the ideal analytic tool. The data is currently being reanalyzed following methodology outlined by King and Zeng, 2001. **DISCUSSION:** Patterns of human factors that predictively lead to mishaps represent opportunities for evidence-based proactive safety interventions that may be customized by aircraft type and associated supportive military organization. This study identified specific trends that may be used for interventions at the individual, supervisory, and organizational level to reliably prevent future mishaps. The utility of DoD HFACS is demonstrated, as well as suggesting additional ways to refine HFACS codes and improve investigative approaches.

Learning Objectives:

1. The audience will know the clusters of human factors variables that significantly contributed to U.S. Air Force flight related class A and B mishaps between FY 2006-2016.

Tuesday, May 02 ***2:00 PM***
Governor's Square 15

S-041: PANEL: HYPERBARIC OXYGEN TOXICITY – COMPARING CURRENT GUIDELINES TO 15 YEARS OF NASA NEUTRAL BUOYANCY LAB EXPERIENCE

Chair: Alex Garbino
Galveston, TX

Co-Chair: Robert Sanders
Houston, TX

PANEL OVERVIEW: Hyperbaric oxygen toxicity can have dire consequences during underwater operations. Current limits published by NOAA were based on expert opinion, and were designed to be conservative. No specific data set was used to develop the exposure times, nor the risk change with ppO2 change. This panel will begin by reviewing the history of the NOAA limits, as well as published data sets regarding oxygen toxicity rates and symptomatology in hyperbaric oxygen therapy – a separate but related exposure. The second presentation will detail the experience base developed over the last 15 years at NASA's NBL (Neutral Buoyancy Lab), where over 10% of dives exceed the NOAA limits. It will also discuss the process of extracting detailed ppO2 and time exposures for every suited dive over that time frame, and the resulting metrics derived. The third presentation will discuss the use of this NBL data to develop an evidence-based risk model for oxygen toxicity, considering the effective exposure depth and time as well as symptoms, and compare it to the NOAA published data. It will highlight were the two differ, and postulate were NOAA diving limits may be too conservative. The final presentation will discuss how these limits affect future NBL operations, in particular future suit operations, and discuss a path forward using an appropriate animal model for extrapolation of oxygen toxicity limits.

[201] HYPERBARIC CNS OXYGEN TOXICITY - CURRENT RISKS AND LIMITS

A. Garbino[1], D. Nusbaum[1], S. Walker[2] and R.W. Sanders[3]
[1]Aerospace Medicine, University of Texas Medical Branch, Houston, TX; [2]UCSF, San Francisco, CA; [3]NBL, NASA, Houston, TX

MOTIVATION: Aerospace and hyperbaric medical professionals may be familiar with the risk of CNS oxygen toxicity experienced in both hyperbaric oxygen therapy (HBOT) and during diving operations. These risks also apply during dive operations at NASA's Neutral Buoyancy Lab (NBL), where subjects in a pressurized extra-vehicular mobility unit (EMU) – a space suit – practice space walks on a mockup of the International Space Station (ISS) and, until its retirement, the Space Shuttle Orbiter. Current limits published by NOAA (National Oceanic and Atmospheric Administration) were developed by expert opinion to be conservative, and impose operational limits that would constrain NBL dive profiles. **OVERVIEW:** NOAA dive limits were developed in the 1990s to ensure a safe diving environment for scientific and academic diving operations managed by NOAA, a US governmental agency. Due to a dearth of research in this field, and the effectiveness of these limits to ensure safe diving operations, these limits have become de facto reference standards in the international dive community. No significant research efforts have been undertaken to develop an evidence base to substantiate these limits, and the degree of risk associated with respecting or exceeding these limits is qualitative at best. The recent popularity of rebreather diving has significantly changed dive profiles. By allowing recirculation of exhaled gases, with CO2 removal and replacement of metabolic O2 use, rebreathers can be used to dive for significantly longer times and deeper than traditional open circuit SCUBA diving. However, rebreather diving results in higher ppO2 exposures at shallow depth and prolonged exposures – dives that would traditionally be limited to 20-40 minutes may now last 1-2 hours. There is limited data regarding CNS oxygen toxicity with these dive profiles. Hyperbaric oxygen therapy also carries a risk of CNS O2 toxicity, and several published studies show variable rates in development of symptoms. **SIGNIFICANCE:** The history and development of CNS O2 limits will be reviewed, as well as current literature reviewing risks in HBOT. The risks – and lack of quantitative data – will be presented in light of current and future dive practices in the rebreather and aerospace community.

Learning Objectives:

1. Learn the historical basis for CNS O2 toxicity limits
2. Understand the rates of CNS O2 toxicity observed in Hyperbaric Oxygen Therapy
3. Become aware of the operational limitations imposed by current CNS O2 limits

[202] HYPERBARIC CNS OXYGEN TOXICITY – REVIEW OF 15 YEARS OF NBL OPERATIONS

S. Walker[2], A. Garbino[1], D. Nusbaum[1] and R.W. Sanders[3]
[1]Aerospace Medicine, University of Texas Medical Branch, Houston, TX; [2]UCSF, San Francisco, CA; [3]NBL, NASA, Houston, TX

INTRODUCTION: NASA's Neutral Buoyancy Laboratory (NBL) contains a 6.2 million gallon, 12-meter (40 ft) deep pool where astronauts prepare for space missions involving space walks (extravehicular activity EVA). Training is conducted in a pressurized pace suit (extravehicular mobility unit EMU) for up to 6.5 hours. To reduce the risk of nitrogen DCS a 46% NITROX mix is used. The trade-off with using a higher partial pressure of oxygen is increased potential for oxygen toxicity. Despite that, in over 50,000 hours of suited training dives since the facility opened in 1997, there has never been an occurrence of decompression sickness (DCS) or oxygen toxicity. **METHODS:** Suited run data are recorded in the Environmental Control System (ECS) database. The detailed oxygen exposure dive profiles for all suited training runs from 1998-2016 were reviewed. For each dive profile the average oxygen partial pressure (ppO2) exposure, the accumulated continuous ppO2 exposure, the maximum instantaneous ppO2 exposure, and the total exposure time were calculated. A medical assessment for potential DCS and oxygen toxicity was also completed following each suited run. **RESULTS:** There were 10173 eligible suited dives totaling 53800 submerged man-hours. The runs for which the average ppO2 was between 0.65 atm (9.6 psi) and 1.15 atm (16.9 psi) and total time ranging from 120-400 minutes were eligible. Of those, 3348 exceeded the NOAA CNS Oxygen Toxicity limit (CNSOTL) recommendations, with over 1000 runs that exceed the limits by a significant margin. The most frequently occurring (i.e. the statistical mode) average ppO2 exposure was around 0.86 atm (12.6 psi) and the most frequently occurring dive time was around 370 minutes which falls just over the NOAA limits. **DISCUSSION:** The NOAA recommendations are the result of expert consensus and don't necessarily reflect rigorous experimental evidence. There is reason to suspect that these recommendations might be overly conservative and anecdotal evidence suggests they are routinely exceeded. The data from NBL EVA dive operations, with no adverse CNS or DCS events over many thousands of dives that often exceed the NOAA recommendations would seem to support this notion, at least for the ppO2 and time regime in which NBL operates. The NBL suited training protocols are safe and time tested and offer a unique opportunity to provide evidence that can make a meaningful contribution to the expert discussion on oxygen toxicity recommendations.

Learning Objectives:

1. Gain an understanding of the type and extent of diver operations conducted at the NBL.
2. Understand the relationship between CNS oxygen exposure, depth, suit pressures and dive time.
3. Learn how NBL dive operations differ from current NOAA CNS oxygen toxicity limits.

[203] HYPERBARIC CNS OXYGEN TOXICITY – RISK LIMITS DERIVED FROM 15 YEARS OF NBL DIVE OPERATIONS

A. Garbino[3], S. Walker[2], D. Nusbaum[1] and R.W. Sanders[4]
[1]Aerospace Medicine, University of Texas Medical Branch, Houston, TX; [2]UCSF, San Francisco, CA; [3]University of Texas Medical Branch, Galveston, TX; [4]NBL, NASA, Houston, TX

INTRODUCTION: CNS O2 tox is a concern with any hyperbaric oxygen exposure. It can result in a variety of clinical symptoms, including seizures. Although rare in hyperbaric oxygen therapy (~1/10,000 treatments), the risk is higher in dive operations. Furthermore, a seizure during dive operations can have significant repercussions, including death. At NASA's Neutral Buoyancy Laboratory (NBL), astronauts train for EVAs ('spacewalks') underwater. Although neutral buoyancy is effective to mimic microgravity, diving operations carry a risk of decompression illness (DCI) and oxygen toxicity. The risk of DCI is decreased by using a 46% oxygen mixture (Nitrox), but this results in a theoretical increase in risk of oxygen toxicity. NOAA publishes maximum limits for oxygen exposure during diving; however, these were derived from expert opinion and not data. Operational requirements at the NBL results in dives that exceed them. **METHODS:** We analyzed a data set of 10,173 dives over the course of 15 years of dive operations at the NBL, of which 3348 (33 %) exceeded published NOAA limits. No cases of oxygen toxicity were observed, despite a large number of exposures. We developed a risk model based on an inverse binomial approach to assess the full data set. Since there were no observed toxicity events, we used a zero-observed event probability to determine the upper-bound risk of observing O2 tox. **RESULTS:** Although this data set only uses the specific conditions found in the NBL (46% Nitrox, maximum of 40 feet depth and up to 415 minutes), they provide a framework to derive *empirical limits* and also serve as guidance for future research projects. The probability distribution map also provides flexibility so one can define limits based on a maximum allowable risk of symptoms, rather than the current NOAA tables that only provide a qualitative, binary threshold of risk. **DISCUSSION:** This is the first evidence-based risk model of hyperbaric oxygen toxicity. Although it uses a medically-screened population and is limited to a narrow range of ppO2 and time exposures, it does extend beyond currently published NOAA models. Furthermore, this approach can serve as the basis to develop an international registry where rebreather divers could input exposures and populate a risk-space, as well as serve as a platform to develop animal studies that provide insight into how to extend the risk model to different ppO2 and time exposures, and thus elucidate the ppO2-time equivalence equation.

Learning Objectives:

1. Understand the risk limits published by NOAA.
2. Understand how the NBL experience relates to NOAA limits.
3. Gain a basic understanding of risk modeling and predicting risk.

[204] HYPERBARIC CNS OXYGEN TOXICITY – THE PATH FORWARD

D. Nusbaum[2], A. Garbino[1], S. Walker[3] and R.W. Sanders[4]
[1]Emergency Medicine, Baylor College of Medicine, Houston, TX; [2]Aerospace Medicine, University of Texas Medical Branch, Houston, TX; [3]UCSF, San Francisco, CA; [4]NBL, NASA, Houston, TX

INTRODUCTION: The National Oceanic and Atmospheric Administration (NOAA) has established guidelines for recommended exposure time limits for different partial pressures of oxygen in breathed gas to avoid oxygen toxicity. Actual experience have shown that these limits can be exceeded without negative consequences and that the published limits may be overly conservative. However, it is impossible to quantify risk of oxygen toxicity for given oxygen exposures without subjecting individuals to undue risk. As such, further animal work is needed to better quantify risk of oxygen toxicity with various exposures and to better elucidate appropriate oxygen exposure limits for individuals exposed to these environments. **METHODS:** This presentation will provide an overview of the various potential animal models for acute oxygen toxicity and seizure risk, the benefits and drawbacks of each model with regards to their level of fidelity to human disease, and initial experiments that could be conducted to better quantify oxygen toxicity and seizure risk at different partial pressures of oxygen, different lengths of exposure, and different physiologic states. **RESULTS:** Multiple considerations factor into an appropriate animal model to study oxygen toxicity. The first is the fidelity of the animal model compared to human subjects. The best animal model may vary depending on the organ system being studied. A second consideration is eliciting a phenotype in the animal model, as some animal models do not experience the same symptoms as humans when introduced to the same exposure. A third consideration is the usefulness of a particular animal model to study the question of interest, as different research techniques can be used with different animal models. For example, some animal models are easier to manipulate genetically, and thus study biochemical pathways, than other models. All of these characteristics must be taken into consideration when selecting an appropriate animal model, and will be relevant when attempting to explore knowledge gaps related to oxygen toxicity and exposure. **DISCUSSION:** We provide a framework by which animal models can be used to elucidate risk of oxygen toxicity with various exposures. This work will help understand oxygen toxicity risk that is difficult to quantify utilizing available human data alone. This will improve existing exposure limits, in order to maximize operational capability and flexibility, while still ensuring safety.

Learning Objectives:

1. Understand the current limitations in knowledge of CNS O2 toxicity.
2. Develop a framework for how to choose different animal models depending on the study.
3. Understand the limitations of animal models as they pertain to translating to humans.

Tuesday, May 02 ***2:00 PM***
Governor's Square 12

S-042: SLIDE: GUIDELINES & PROCESSES FOR IN-FLIGHT MEDICAL EMERGENCIES & TRAINING

Chair: Kathryn Hughes
Dayton, OH

Co-Chair: Anthony Mitchell
Dayton, OH

[205] LESSONS LEARNED FROM US ARMY AVIATION – MEDICAL CHECKLIST DEVELOPMENT AND IMPLEMENTATION PROCESS

N. Powell-Dunford[2], B. Pineda[3], M. McPherson[1] and S.J. Gaydos[1]
[1]School of Aviation Medicine, US Army, Fort Rucker, AL; [2]Exchange Officer, USAARL, AE; [3]White House Medical Unit, Washington, DC

MOTIVATION: Checklist utilization, a practice adopted from aviation, has been associated with improved patient outcomes in a number of healthcare settings. However, improved clinical outcomes are not always achieved and compliance rates vary. Aeromedical specialists are increasingly consulted with regards to the adoption of aviation-based practices in healthcare. To attain positive outcomes and high rates of compliance, it is important to understand effective processes for checklist development and implementation. **OVERVIEW:** The joint U.S. military service checklist for air ambulance blood product delivery was developed as a result of local collaboration with established subject matter experts. The checklist was rehearsed under multiple environmental conditions and during all point of care transitions in order to increase confidence with use in the actual clinical setting. The checklist size and co-location with transfusion supplies were developed with consideration of human factors. Demonstration of proficiency in checklist utilization was a requisite for skill certification. Flight medics were subject to 'no notice' evaluations with revocation of skill certification for failure to use the checklist. Rehearsal of checklist use in a variety of controlled environments increased end-user confidence in ability to use the checklist. After-action reviews of an initial series of transfusions included assessment of checklist use. Utilization of the checklist in its first six months of analysis resulted in improved casualty trauma scores, zero instances of transfusion reaction or en-route blood wastage, and 100% checklist utilization compliance. **SIGNIFICANCE:** Checklist development must take into account established best practices, subject matter expertise, and end-user feedback. Checklist usage must be recognized as a non-innate skill – requiring rehearsal in all likely operating environments. Checklist compliance can be optimized by making skill certification contingent on checklist utilization and ensuring that human factors are considered. This checklist development and implementation process can optimize human performance across civilian and military spheres on an international level.

Learning Objectives:

1. Identify the rationale for rehearsal of the aviation and medical checklist.
2. Identify ways in which human factors should be considered in fielding of a medical checklist.
3. List ways to enhance compliance with medical checklist utilization.

[206] MANAGING IN-FLIGHT MEDICAL EVENTS: GUIDANCE FOR HEALTH PROFESSIONALS

C.L. Harris Graessle
USAF School of Aerospace Medicine, Wright-Patterson AFB, OH

MOTIVATION: Despite the growth in international commercial air travel, there is a paucity of standards governing in-flight medical events. To further complicate this issue, a lack of global standardization for the provision of in-flight medical care; medications and supplies included in the on-board medical kits; and medical equipment available during flight; creates a significant vulnerability in providing safe commercial passenger flight. A standardized process should be implemented and enforced internationally to mitigate this potential lack of adequate medical care during passenger flight. **OVERVIEW:** Management of medical events during commercial air travel has not been standardized and mandated in global commercial flight. Many health professionals, when asked to assist with medical events during flight, may be hesitant due to lack of knowledge of resources available or potential for liability. A greater understanding of medical capabilities during flight, along with a review of liability, may increase the chances of healthcare provider assistance during medical crises occurring in commercial flight. A more comprehensive review of the most common presenting medical events during commercial passenger flight, with the corresponding medical capabilities to mitigate such events, will provide healthcare workers a framework upon which to guide the crew in making crucial decisions that impact the safety and life of critically ill patients in flight. Finally, recommendations for standardization of medical capabilities during international flight may increase capabilities and provider willingness to render medical care. **SIGNIFICANCE:** Standardization of management of medical events during domestic and international flight is clinically significant by ensuring greater medical capabilities will be available worldwide. Additionally, healthcare provider knowledge of this standardization, such as medical supplies available, equipment, resources, and crew training, may increase successful medical outcomes after such a medical event. By identifying gaps in the provision of medical care while in commercial passenger flight, recommendations can be postulated for mitigation of these deficiencies.

Learning Objectives:
1. Understand on-board medical capabilities, medical kit contents, equipment, and cabin crew training.
2. Understand the resources and options in the event of an on-board medical event.

[207] IN-FLIGHT CARDIOPULONARY RESUSCITATION: GUIDELINE FROM THE GERMAN SOCIETY OF AEROSPACE MEDICINE

J. Hinkelbein[1] and C. Neuhaus[2]
[1]University Hospital of Cologne, Cologne, Germany; [2]University Hospital Heidelberg, Heidelberg, Germany

BACKGROUND: Approximately 3 billion people worldwide will travel by commercial air transport in 2016. A calculation based on the number of passengers transported shows that between 1 out of 14,000 to 1 out of 50,000 passengers will experience acute medical problems during a flight. Cardiac arrest accounts for 0.3% of all in-flight medical emergencies, yet it is responsible for 86% of in-flight events resulting in death. So far, no guideline for in-flight cardiac arrest (IFCA) exists to provide specific treatment recommendations. **METHODS:** A task force was created to develop a guideline for the treatment of in-flight cardiac arrest based on clinical and investigational expertise in this area. By using a systematic literature search including GRADE, RAND, and DELPHI methods, specific recommendations for the treatment of IFCA have been created. **RESULTS AND CONCLUSIONS:** Several main recommendations have been developed: emergency equipment location as well as content should be mentioned in the pre-flight safety announcement; ECG should be available for patients with cardiac arrest, it is very important to request help by an on-board announcement after identification of a patient with cardiac arrest; two-person CPR is considered optimum and should be performed if possible; the crew should be trained regularly in basic life support – ideally with a focus on CPR in aircraft; a diversion should immediately be performed if the patient has a return of spontaneous circulation.
Learning Objectives:
1. Causes of in-flight cardiac arrest.
2. How to act in case of an IFCA.
3. Galley is better than aisle to perform CPR.

[208] IMPROVING RESPONSES TO IN-FLIGHT MEDICAL EMERGENCIES THROUGH A SIMULATION-BASED CURRICULUM

A. Padaki[2], W. Redha[1], T. Clark[1], T. Nichols[1], L. Jacoby[1], R. Slivka[1,3], C. Ranniger[1] and K.R. Lehnhardt[1]
[1]Department of Emergency Medicine, George Washington University, Washington, DC; [2]Department of Emergency Medicine, Thomas Jefferson University, Philadelphia, PA; [3]Department of Emergency Medicine, INOVA Fairfax Hospital, Falls Church, VA

INTRODUCTION: In-flight medical emergencies require health care providers to operate in confined spaces with limited resources and delayed access to definitive care. These emergencies are relatively common, with an estimated frequency of one per 100 to 1000 flights. Despite this, dedicated training for medical response in these environments is limited, and is not a component of standard medical education. We hypothesize that integrating such education into a pre-existing medical student elective course would improve knowledge and ability to respond appropriately to in-flight medical emergencies. **METHODS:** The available literature surrounding in-flight medical emergencies was reviewed. Syncope, respiratory distress, allergic reaction, and cardiac arrest were identified as common and potentially life-threatening in-flight medical complaints. Simulation cases were designed based upon each of these complaints, and a simulation training room was modified to physically mimic an airplane cabin. These simulation cases, and accompanying relevant didactic lectures, were incorporated into an existing wilderness and extreme environmental medicine course, with pre and post multiple-choice knowledge tests completed by the students at the beginning and end of the two-week course. **RESULTS:** 18 students participated in this study, including 3 third-year medical students and 15 fourth-year medical students. Students averaged 76% on the knowledge pre-test, and improved to 87% on the post-test ($p<0.001$). No student decreased in performance between the tests. Qualitative feedback regarding this type of training was overwhelmingly positive. **DISCUSSION:** Our study suggests that simulation-based training for in-flight medical emergencies can significantly improve medical student knowledge. This training was very well-received by the target audience. Opportunities for training to manage in-flight medical emergencies remain limited in general; incorporating such training into existing wilderness or emergency medicine curricula could provide a means by which to improve provider knowledge. Such a curriculum could also be adapted for use by flight crews and other pertinent populations.
Learning Objectives:
1. At the end of this presentation, audience members will be able to outline how to create simulation scenarios that can be used to improve physician responses to in-flight medical emergencies.

[209] A GAP ANALYSIS OF TRAINING CURRICULA FOR EN ROUTE CARE CLINICIANS: A BASIS TO TRANSFORM FUTURE EDUCATION

M.J. DeJong[1] and F.M. Lewis[2]
[1]Graduate School of Nursing, Uniformed Services University of the Health Sciences, Bethesda, MD; [2]University of Washington, Seattle, WA

MOTIVATION: Advances in en route care (ERC) during United States (US) military operations in Iraq and Afghanistan have contributed to unprecedented survival following combat injury. Nonetheless, US military medical leaders have identified opportunities to improve training of ERC clinicians, especially concerning life-saving skills and overall patient management, and to further abate combat-related morbidity and mortality. Each military Service is responsible to train its ERC clinicians and meet patient movement requirements across the chain of evacuation. To date, there has been no systematic examination of ERC training programs either within or among the Services, no analysis of curricular gaps, and no evidence-based identification of needed curricular improvements. **OVERVIEW:** ERC clinicians require robust training to prepare them to transport combat casualties and ill patients. The purposes of our project were to 1) analyze the curricula for all Army, Navy, Air Force, and Joint ERC courses, 2) identify strengths and any training gaps, and 3) consider the potential to enhance within-Service or Joint ERC training. The ERC training curricula resides within the military Services, which can promote accountability and responsibility, but also result in Service-specific eligibility criteria, content, instructional methods, and exit competencies. In this presentation, we will describe training gaps in 1) instructional pedagogy, 2) didactic content and training scenarios, 3) performance assessment and exit competencies, 4) monitoring ERC clinicians' performance in the field, and 5) sustainment training, and will propose concrete recommendations for addressing each gap. **SIGNIFICANCE:** ERC has evolved substantially during the past 15 years of continuous combat operations. Given that demands for ERC have moderated, this is an ideal time to study and improve training, noting the high likelihood that in the future, ERC will be carried out in diverse anti-access and area denial environments, on new platforms, over long distances following prolonged field care, and in collaboration with international partners. It is essential that training enables ERC clinicians to learn the core clinical and transport competencies that will enable them to safely transport patients, and that patient care requirements, rather than transport mode or phase of transport, determine the clinical and transport competencies that ERC clinicians must acquire and maintain.
Learning Objectives:
1. Identify at least three training gaps that pertain to United States Army, Navy, Air Force, and Joint en route care training.
2. Describe at least three recommendations for resolving training gaps within and among the United States military Services.

Tuesday, May 02 ***2:00 PM***
Governor's Square 11

S-043: PANEL: PENGUINS AND KIWIS - NON-FLYERS WHO OPENED THE DOORS TO AEROSPACE MEDICINE

Sponsored by Aerospace Physiology Society

Chair: James Davis
Shaw AFB, SC

Chair: Troy Faaborg
Alexandria, VA

PANEL OVERVIEW: History is filled with stories of pioneers of aerospace medicine who made contributions to the advancement of our field. The legendary flyers such as the Montgolfiers, the Wright brothers, and Wiley Post are only part of the story, and this panel will explore the contributions of a few non-flyers who truly opened doors in aerospace medicine. These are the stories of flightless aviators - the penguins and kiwis of aerospace medicine!

[210] DR. ARVIND CHATURVEDI: SCHOLAR AND HUMANITARIAN

P. Kemp
Forensic Sciences, Civil Aerospace Medical Institute, FAA, Oklahoma City, OK

Understanding the impact of drugs and other chemicals on a pilot's ability to operate an aircraft is of paramount importance for optimizing aviation safety and is a focus of research at the Civil Aerospace Medical Institute (CAMI) in Oklahoma City, Oklahoma. For more than 25 years, Dr. Arvind Kumar Chaturvedi (1947 – 2016) dedicated his extraordinary analytical and management skills to this mission. His contributions to the scientific community include more than 270 publications and numerous presentations at national and international scientific meetings. He conducted extensive research on such problems as the prevalence of pharmaceuticals in fatal aviation accidents, method development for the analysis of drugs and other chemicals in postmortem specimens, and understanding the effect of fluid load on urine specimens collected for workplace drug testing. He was considered an international expert on the toxicity of combustion gases. This presentation will offer a glimpse into Dr. Chaturvedi's fascinating life and will bring to light the many contributions he made to forensic toxicology and aviation safety.

Learning Objectives:
1. Outline the contributions Dr. Arvind Chaturvedi made to understanding the effects of drugs and chemicals on humans.
2. Describe the impact of Dr. Chaturvedi's research on forensic toxicology and aviation safety.
3. Present the career of a kind and gentle soul who helped those around him and who believed that if you don't share your knowledge with others then it is useless.

[211] A WATERSHED DISCOVERY FOR CLINICIANS AND AVIATORS: DR. ROBERT BARANY, PATHOLOGY AND PHYSIOLOGY OF THE HUMAN VESTIBULAR APPARATUS

A.J. Metelko
USAF, Pensacola, FL

ABSTRACT: Dr. Robert Barany (1876-1936) was a medical doctor who explained the physiology and pathology of the vestibular apparatus. At the time that Barany practiced medicine, it was common to irrigate the external auditory canal of patients presenting with an ear infection. One of Barany's patients reported a sensation of disorientation and exhibited nystagmus when cold water was used to irrigate the patient's external auditory canal. The patient stated that irrigation at home with warm water did not produce disorientation. Barany subsequently irrigated the patient's external auditory canal with hot water, and the patient again experienced disorientation, and nystagmus. Barany surmised that cold and hot water irrigation affected the direction of the endolymph flow in the vestibular apparatus semicircular canals, and that warm water being close to body temperature did not alter endolymph flow. This discovery was the impetus for Barany's research advancing the treatment and diagnosis of conditions of the inner ear and was transformative in explaining spatial disorientation. Barany was awarded the Nobel Prize for Medicine in 1914 for his work. Clinicians and aviators alike have been empowered by Barany's work exemplified by the Nylen-Barany test for vertigo and disorientation mitigation techniques to include acclimation with the Barany Chair.

Learning Objectives:
1. Describe the function of the semicircular canals.
2. Describe the caloric response.
3. Describe the impact of Dr. Robert Barany's research on aviation.

[212] A CURE FOR MOTION SICKNESS IN SIX HOURS: THE LIFE-LONG WORK OF PATRICIA COWINGS

A. Lippert
NAVAIR, US Navy, California, MD

While many people know Dr. Patricia Cowings to be one of the first American women to be trained as an astronaut (and the first African American woman to do so), some of her most prized work within the aeromedical community has been as an aerospace psychophysiologist who confronted the challenges of motion sickness in space. As a Principal Investigator at NASA Ames, she has researched and published numerous studies and authored several books on preventing and treating motion sickness, ultimately helping astronauts all over the world adapt to the space environment. Dr. Cowings has even patented a system used to train astronauts, called the Autogenic-Feedback Training Exercise. Her love for science and her drive to serve in her field has been recognized by several organizations. She has received many prestigious awards and continues to shine as a leader and role model for aerospace professionals.

Learning Objectives:
1. Explain the basic workings of the Autogenic-Feedback Training Exercise.
2. Describe the key attributes of Dr. Cowings research and career during her time as a scientist with NASA.

[213] NATHANIEL KLEITMAN: SLEEP AND LIVE TO 104 YEARS OLD - TIPS FROM THE FATHER OF SLEEP!

D. Bonetti
AMU, RNZAF, Auvkland, New Zealand

Nathaniel Kleitman (1895-1999) was a physiologist who is recognized as the father of modern sleep research. Kleitman commenced work in the 1920s specifically investigating the regulation of sleep and wakefulness. This work included extensive studies of sleep architecture, sleep inertia, circadian rhythms and sleep deprivation. He was the first person to recognize that sleep deprivation influenced cognitive performance and also conducted some of the first scientific studies of drug effects on sleep. His self-experimentation involved keeping himself awake for over 100 hours and spending more than a month 150 feet underground in Mammoth cave to better understand daily fluctuations in wakefulness and temperature. In 1939, he published the first major book on sleep "Sleep and wakefulness" and in 1953, along with one of his students, Eugene Aserinsky, made the discovery of Rapid Eye Movement (REM) sleep. Understanding the influence of circadian rhythms, sleep, and wakefulness on fatigue mitigation is now a critical aspect of aerospace physiology training and a key early contribution to research in human performance and aerospace medicine.

Learning Objectives:
1. List the influences Kleitman made to the understanding of sleep deprivation, circadian rhythms and sleep architecture.
2. Describe the impact of fatigue mitigation to aerospace physiology training.

[214] ROBERT HOOKE: HE TRIED TO FLY BUT COULDN'T, SO HE BUILT AN ALTITUDE CHAMBER INSTEAD!

N. Sevilla
USAF, Alexandria, VA

Robert Hooke (1635-1703) was a leading mechanist of the 17th century and as Robert Boyle's assistant worked on the first air pump. His fascination in aviation started at a young age when he designed the first early concepts of aircraft, but calculating that human muscles were not sufficient for flying machines heavier than air. Hooke catapulted the first

experiments in decompression sickness from small animals to creation of a decompression chamber, "so large that a man might fit in it." His self-experimentations observed the first cases of physiological effects under artificial altitude. Robert Hooke further contributed to aviation medicine with one of the first experiments in artificial respiration. His experiments on animals described the role of gas exchange as a critical maintenance of life versus the actual movement of the lungs. The understanding of respiration within the understanding of Boyle's Law and the creation of the first human altitude chamber are part of the foundations of aerospace physiology training and key early contributions to aerospace medicine.

Learning Objectives:

1. List the influences Robert Hooke made to understanding high-altitude physiology.
2. Describe the impact of the altitude chamber to aerospace physiology training.

Tuesday, May 02 ***2:00 PM***
Governor's Square 10

S-005B: PANEL: BOARD REVIEW SESSION 2

Sponsored by American Society of Aerospace Medicine Professionals

Chair: Kimberly Toone
Alexandria, VA

PANEL OVERVIEW: This panel is sponsored by American Society of Aerospace Medicine Specialists and is designed to be a review of specific board exam topics. There are three such sessions throughout the annual scientific meeting. This specific panel includes a lecture on Epidemiology and Biostatistics and on Common Indications, Concerns and Patient Management in Aeromedical Transport.

[023] BOARD REVIEW SESSION 2: AIR MEDICAL TRANSPORT REVIEW; AMSA CLINICAL REVIEW 2017

D.M. O'Brien
Aeromedical Certification Division, FAA, Oklahoma City, OK

Air Medical Transport will present an overview and update of current topics in fixed and rotary wing patient transportation. The review will provide an overview of inflight patient physiological stressors, advantages and disadvantages of air transport modalities and clinical considerations for typical patient evacuation diagnoses to include cardiace, neurological, trauma and perinatal emergencies. This review will help prepare applicants for the ACPM board exam as well as provide review and new information to physicians, nurses and medical technicians.

Learning Objectives:

1. Describe physiological stressors of flight as they relate to patient movement, to include a description of the effects of hypobaria, hypoxia, low humidity, low temperature, noise and vibration. Students will be able to identify symptoms of these exposures and appropriate prevention and treatment strategies.
2. Describe the advantages and disadvantages of evacuating patients with fixed and rotary wing transportation modalities. Students will be able to identify when each of these modalities are appropriate for patients based on their medical condition, geographical location and location of referal medical facilities.
3. Students will describe typical clinical conditions and aeromedical treatment interventions for air transport patients. Clinical conditions will include emergent cardiac, neurological, trauma and perinatal conditions.

[024] BOARD REVIEW SESSION 2: EPIDEMIOLOGY AND BIOSTATISTICS REVIEW

N. Almond
Aerospace Medicine Residency, NAMI, Cantonment, FL

PROBLEM STATEMENT: MOC credit is required for certification in medical specialties. **TOPIC:** This MOC will include a review of epidemiology and biostatistics. **APPLICATIONS:** This review will provide a review of epidemiology and biostatistics that may be used in evaluating and performing research.

Learning Objectives:

1. Review design and methods of studies to include data sources and coding, study design, biases and controls, and confounding.
2. Review interpretation of tests to include measures of central tendency, tests of significance, hypothesis testing, type I and type II errors, power, sample size, number needed to treat, causation, and association.
3. Review concepts of prevention and control, to include screening tests and outbreak investigation.

Tuesday, May 02 ***4:00 PM***
Plaza A/B

S-044: PANEL: ADVANCED AEROSPACE MEDICINE FOR INTERNATIONAL MEDICAL OFFICERS (AAMIMO) AEROMEDICAL CLINICAL CASE PRESENTATIONS

Chair: Jeffrey Lawson
Wright-Patterson AFB, OH

PANEL OVERVIEW: The Advanced Aerospace Medicine for International Medical Officers (AAMIMO) course is an intensive 6 month long curriculum taught at the USAF School of Aerospace Medicine (USAFSAM), WPAFB, OH. As part of this course, these flight surgeons from around the globe are able to bring aeromedical cases for presentation from either their country's Air Force experience or cases of interest from the USAFSAM Aeromedical Consult Service (ACS). Cases are selected for presentation in accordance with both the 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 US Department of Defense and the Federal Aviation Administration. Following a brief conclusion, limited questions will be allowed for each presenter by the panel chair.

Tuesday, May 02 ***4:00 PM***
Plaza D/E

S-045: SLIDE: AEROSPACE PHYSIOLOGY IN ACTION

Chair: Rebecca Blue
Fayetteville, NY

Co-Chair: Vivienne Lee
Farnborough, Hampshire, United Kingdom

[215] COLD PROTECTION AND MANUAL DEXTERITY ASSESSMENT OF AIRCREW GLOVES

A.S. Weller, J. Boyd and K.P. Puxley
Air and Space, QinetiQ, Farnborough, United Kingdom

INTRODUCTION: Aircrew report cold hands and impaired manual dexterity during cold-weather operations. However, the physiological cold protection and manual dexterity performance of UK aircrew gloves are not known, and were therefore quantified in a laboratory study, to support cold-weather operational advice. **METHODS:** Eight men undertook a 60-min work-rest (each 15 mins x2) protocol in a thermal chamber wearing rotary-wing aircrew clothing (Thermal Test, TT). The TT was undertaken at 5 air temperatures (+20, +10, 0, -10 and -20 °C) with 3 glove types of increasing insulation (G1, Cape leather; G2, Cape + silk inners; G3, Gunner glove). Physiological measures (including finger skin temperature, $T_{SK\text{-}F}$) and subjective ratings (including finger thermal sensation and comfort) were recorded every 15 mins, and Purdue finger and Minnesota hand dexterity performance assessed during the rest periods, with bare-hand performance obtained prior to chamber

exposure at +20 °C. Data were analysed by ANOVA or Friedman's Tests, and post hoc tests where appropriate (Significance accepted at $p<0.05$). **RESULTS:** 22 TTs were stopped early, 20 due to low T_{SK-F} (<10 °C for 30 mins or <5 °C) at -10 °C (n=3) and -20 °C (n=17). At 0 °C, there were between-glove differences in T_{SK-F}: G1, 15.2 (mean) ± 5.1 (1SD) °C; G2, 17.9 ± 4.5 °C; G3, 22.4 ± 6.4 °C) ($p<0.05$), and at -10 °C, T_{SK-F} was higher in G3 (13.6 ± 4.4 °C) vs. G1 (10.6 ± 2.4 °C) ($p<0.05$). Ratings of thermal sensation were consistent with T_{SK-F}, and cold discomfort was reported at -10 °C in G1 and G2, and at -20 °C in G3. At +20 °C, finger dexterity was impaired 44, 54 and 69 % relative to bare-hand performance in G1, G2 and G3, respectively, with values of 4, 15 and 38 % for hand dexterity. There was no environmental impact on finger dexterity, although at 0 °C vs +20 °C, hand dexterity was impaired 13 % in G2 ($p<0.05$). **DISCUSSION:** From a safety and dexterity perspective, Cape gloves may be worn down to 0 °C, although at this air temperature, the addition of silk inners will enhance thermal comfort and protection and likely be more acceptable to aircrew, if the additional dexterity burden (13-27 %) can be accommodated. Although the Gunner glove provided the best cold protection, the physiological benefit was relatively modest at -10 °C and resulted in considerable detriment to dexterity performance (16-26% vs. G2). Gloves providing greater thermal protection than those tested are required for prolonged exposure below -10 °C.

Learning Objectives:

1. To understand the main physiological limitation to operating in a cold environment.
2. To explore the dilemma of providing gloves that meet cold protection and dexterity requirements for aircrew to operate safely, comfortably and effectively in cold environments.
3. To understand the principal factors limiting manual dexterity performance in the cold with and without gloves.

[216] SIMULATION OF SKIN TEMPERATURE FEEDBACK CONTROLS FOR A MICROCLIMATE SYSTEM

X. Xu[1], B. Laprise[2], W. Teal[3] and L. Blanchard[1]
[1]Biophysics and Biomedical Modeling Division, US Army Research Institute of Environmental Medicine, Natick, MA; [2]Natick Soldier System Research and Development Center, Natick, MA; [3]Battelle Natick Operations, Natick, MA

INTRODUCTION: To reduce the power consumption of a microclimate cooling system (MC), feedback control cooling (FCC) can be used to periodically cycle cooling rather than maintaining constant cooling (CC). The FCC scheme maintains the skin temperature between 33-35°C by cycling the cooling system between ON (coolant circulation) and OFF (no coolant circulation) in response to real-time skin temperature feedback. This minimizes cutaneous vasoconstriction while maintaining enough temperature gradient for heat loss. The purpose of this paper is to evaluate the efficacy of FCC using the Six Cylinder Thermoregulatory Model (SCTM). **METHODS:** Equations were derived from the energy balance principle and used to estimate MC heat removal during ON and OFF periods. Algorithms for MC and FCC characteristics were developed and incorporated into the SCTM. The modified SCTM was used to simulate human thermoregulatory responses with FCC and no cooling (NC) under a range of conditions: environmental temperatures of 24-42°C, relative humidity of 3-100% and metabolic rates of 200-500W. **RESULTS AND DISCUSSION*:*** Predicted endurance times (i.e., time for core temperature to reach 39°C) and predicted core temperature responses revealed that FCC enhances MC efficiency and reduces heat strain in comparison with NC. The predicted system operating time with a single 240Wh battery indicated that FCC may extends operating times ~100% from 3 hours up to 6 hours in comparison with CC. FCC extends operating time throughout the range of conditions simulated, but works more effectively at lower metabolic rates or less severe environmental conditions. **CONCLUSIONS*:*** FCC enhances MC efficiency, but the magnitude of the improvement is dependent on the metabolic rates, environmental conditions, and ensembles worn. Simulation is a useful tool to define the operating envelope where the FCC has efficacy and to estimate FCC system operation durations.

Learning Objectives:

1. What is one of effect measures to prevent heat strain?

[217] LAYPERSON TOLERANCE OF CENTRIFUGE-SIMULATED SUBORBITAL SPACEFLIGHT: AGGREGATE FINDINGS, 2007-2016

R.S. Blue, J. Vardiman, C. Mathers, T. Castleberry and J. Vanderploeg
Preventive Medicine and Community Health, University of Texas Medical Branch, Galveston, TX

As the commercial spaceflight industry rapidly progresses towards flight, a thorough and current understanding of aerospace physiology and the effects of acceleration on the untrained layperson population is necessary to help anticipate tolerance, risks, and other human factors during flight. To date, over 300 layperson volunteers have participated in centrifuge training simulating suborbital flight, providing significant data and insight into the physiological and psychological challenges of layperson hypergravity exposure and future commercial spaceflight. **METHODS:** A total of 314 layperson volunteers participated in varied-length centrifuge training programs culminating in simulated suborbital spaceflights, with trials spanning multiple studies from 2007-2016. At most, subjects underwent seven centrifuge runs over 2d, including two $+G_z$ runs (peak $+3.5G_z$, Run 2) and two $+G_x$ runs (peak $+6.0G_x$, Run 4) followed three runs approximating suborbital spaceflight profiles (combined $+G_x$ and $+G_z$, peak $+6.0G_x$ and $+4.0G_z$). **RESULTS:** Hemodynamic, demographic, subjective, objective, and psychological findings from a decade of layperson centrifuge research will be discussed. Sex-specific findings, normal and abnormal hemodynamic responses, and psychological trends and mitigation strategies will be presented. **DISCUSSION:** Aggregate data suggest that most individuals, even those representing the extremes of age or with controlled medical conditions, are able to not only tolerate but also enjoy simulated suborbital spaceflight. The aggregate data from the studies presented form a foundation of knowledge that provides significant insight to issues ranging from medical screening, physiological tolerance, anticipation of risk, potential factors regarding informed consent, and training of future spaceflight participants. Such data could help to provide guidance for the medical, psychological, and training concerns of the suborbital spaceflight industry.

Learning Objectives:

1. Discuss aggregate data trends from multiple studies of layperson tolerance of simulated suborbital spaceflight.

[218] THE EFFECTS OF SEQUENTIAL EXPOSURES TO MODERATE AND MILD HYPOXIA ON PERFORMANCE AND RECOVERY IN A SIMULATED FLIGHT TASK

F.E. Robinson[1], J. Gomez[4], M.B. VerStraten[2] and J.B. Phillips[3]
[1]Acceleration and Sensory Sciences, NAMRU-D, WPAFB, OH; [2]Naval Medical Research Unit - Dayton, Wright-Patterson AFB, OH; [3]Biomedical Sciences, Naval Medical research Unit-Dayton, Wright-Patterson AFB, OH; [4]NAMRU-D, Wright-Patterson AFB, OH

INTRODUCTION: Previous studies of hypoxia have examined altitudes in isolation. However, pilots receive two sequential exposures during in-flight hypoxic emergencies (IFHEs): the initial exposure at altitude, and a mild exposure after descending and removing the breathing mask. Recent studies have challenged the assumptions that performance recovers with blood oxygen saturation and that exposure to mild hypoxia is safe. This study therefore examined the possibility that the effects of moderate hypoxia may linger to overlap with the effects of mild hypoxia to increase performance deficits following an IFHE. We hypothesized that performance during exposure to mild hypoxia would be worse following a moderate hypoxic exposure than when experienced in isolation. **METHODS:** Twenty one participants performed a simulated flight task and a time estimation task while being exposed to normobaric hypoxia. Participants experienced four separate altitude profiles. Each profile lasted 50 minutes and delivered a unique combination of ground level, 25,000 feet-equivalent, and 10,000 feet-equivalent oxygen levels. Participants flew ground-level follow up flights one and two hours after the initial exposure. **RESULTS:** Repeated measures ANOVAs with planned comparisons revealed that performance on the flight task was potentially worse during mild hypoxia after exposure to

moderate hypoxia than during mild hypoxia in isolation (7.40 vs. 6.42 normalized root mean square error, $p = 0.06$; one-tailed). Participants also showed significantly more lapses per minute on the time estimation task (0.24 lapses per minute vs. 0.13, $p = 0.05$; one-tailed), and participants' minimum blood oxygen saturation was slightly lower during mild hypoxia following moderate hypoxia than during mild hypoxia in isolation (84.87 vs. 86.61, $p = 0.04$; one-tailed). **DISCUSSION:** Our measures indicated that an additive effect between moderate and mild hypoxia may have occurred. Based on prior research and the pattern of effects, we believe that the observed effect is most likely due to a failure to recover from the initial moderate exposure rather than a combined effect of the moderate and mild exposures together. Even so, our findings suggest that pilot impairment at 10,000 feet following an IFHE may be worse than previously believed. While our observed effects were relatively small, they were evident using simple tasks. More complex flight tasks with greater workload would likely reveal greater impairment.

Learning Objectives:

1. The participant will be able to understand the performance effects of hypoxia both during and after exposure.

[219] COMPARISON OF SYMPTOMOLOGY, PHYSIOLOGIC RESPONSE, AND REACTION TIME IN THREE HYPOXIC ENVIRONMENTS

M. Clayton Gallo[1], M. Funke[1], J.B. Phillips[1], L. Drummond[1], F. Golich[2], B. Wright[3], D. Bryant[2] and M. Wade[2]
[1]Naval Medical Research Unit Dayton, Wright-Patterson AFB, OH; [2]Aeromedical Research, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH; [3]FAA, Oklahoma City, OK

INTRODUCTION: Historically, the hypobaric chamber has been the accepted modality for physiological training of hypoxia symptom recognition for USAF, USN, and civilian aviation. However, altitude chamber (AC) hypoxia training carries significant risks associated with the hypobaric environment. Normobaric modalities such as the reduced oxygen breathing device (ROBD) and reduced oxygen breathing environment (ROBE) have enabled aircrew to experience hypoxia symptoms in safer normobaric environments by altering the percent of oxygen in their inspired air. A primary objective of this study was to determine if hypoxia symptomology experienced under normobaric conditions is similar to that in the hypobaric environment. **METHODS**: Sixteen subjects were tested in the AC, ROBD, and ROBE in a counterbalanced order. Target altitude equivalency was 17,500 feet for up to 45 minutes. Subjects completed a symptomology scale and reaction time (RT) task repeatedly during exposures. Heart rate (HR), breathing rate (BR), and pulse oximetry (SpO_2) were continuously recorded. **RESULTS**: Statistical significance was determined using an alpha set at .05. The time to the onset of the first reported symptom was significantly earlier in the AC and ROBD (~5 min) as compared to the ROBE (~10.5 min). Whereas time to "In Flight Emergency" (IFE; ~21-23 min), for those that reported an emergency (AC=43%, ROBD=81%, ROBE=68%), did not statistically differ between the three environments. While severity of symptoms were significantly correlated across the modalities, specific symptoms were more severe in the ROBD. The most severe symptoms were "blurred vision" in the AC and ROBE, and "trouble concentrating" in the ROBD. HR increased more rapidly and remained higher in the ROBD, while BR decreased sooner when compared to the AC and ROBE. SpO_2 declined significantly in all modalities, but most precipitously in the ROBD. RTs were slower throughout ROBD exposures. **DISCUSSION**: Within the context of this study, results suggest the ROBE was more comparable to the AC than was the ROBD, however, more data is needed to conclude the ROBE to be a substitute for hypoxia recognition training. Additionally, the statistical findings and subject feedback suggest the need to develop a more comparable mask-on type hypoxia training device. Future studies should also compare lower altitude equivalents where hypoxia is more insidious and often unrecognized, as well as the traditional 25,000 foot training condition.

Learning Objectives:

1. To compare similarities and differences in normobaric and hypobaric induced hypoxia.

[220] "OPENING THE DOORS TO AEROSPACE MEDICINE" - ROMANIAN EXPERIENCE IN TEACHING AEROSPACE AND HYPERBARIC MEDICINE TO FIFTH YEAR MEDICAL STUDENTS

A. Macovei[1,2], M. Macri[2] and D. Popescu[1,2]
[1]National Institute of Aerospace Medicine, Bucharest, Romania; [2]Extreme Environments Medicine, University of Medicine and Pharmacy, Craiova, Romania

MOTIVATION: Teaching complex physiological changes common to taxing environments may be a difficult proposition for students. Add this to a narrow career path for that kind of skills and the fact the most training in this field is usually done after graduation one may say it is a daunting task. However, for the last five years, the authors managed to turn this from an optionally discipline into a main curricula based one. **OVERVIEW:** In the Craiova Medical University in Romania, there is a discipline entitled Extreme Environments Medicine, which presents students issues of altitude, aviation, space and hyperbaric medicine (including HBOT) for the main part, with lesser accents in issues that are also covered in other areas like health and cold pathology, travel medicine, toxicology. While little confusion at first, students began to understand the importance of the facts presented and were surprised to find how much real life pathology can be addressed using the acquired notions. As, such, the discipline knew an enhanced progress, and we hope this tendency will continue into the future. We present the basic curricula, and we close with few insights regarding student ability to comprehend more tricky notions like hyperventilation and decompression sickness. Our experience shows that understanding basic laws of physics and physiology eases ones way into this discipline and, also, with a less than solid background into this area, comprehension maybe limited despite otherwise great clinical skills. Starting with 2016, we also had foreign language courses in English, and the profile of information acquiring is kept for most part, despite the different high school education background. The caveat of the program is the difficult access to real hypo- and hyper-baric facilities, which no doubt impairs the information transmission. **SIGNIFICANCE:** Teaching extreme environments physiology and pathology to medical students may be difficult, but it does feel like opening a door. In an age where spatial tourism may become a reality, where access to diving equipment is increasingly available and where highest peak often becomes crowded, we have the certainty that such knowledge should soon prove fundamental to any medical practitioner background and we will continue our quest to improve this.

Learning Objectives:

1. The challenges of presenting medical students a part of curricula most of them didn't know to exist.

Tuesday, May 02 ***4:00 PM***
Plaza F

S-046: SLIDE: HUMAN SYSTEM INTEGRATION IN EXPLORATION HABITATS

Chair: John Charles
Houston, TX

Co-Chair: Alexandra Whitmire
Houston, TX

[221] INTEGRATING BEHAVIORAL HEALTH INTO RECOMMENDATIONS FOR FUTURE EXPLORATION HABITATS

A. Whitmire[1], M. Whitmore[2], T. Williams[1] and S. Thaxton[1]
[1]Wyle, Houston, TX; [2]NASA, Houston, TX

MOTIVATION: Future spaceflight missions beyond low earth orbit (LEO) will require crews to live in isolation and confinement for an unprecedented duration to distant, remote, planetary surfaces. The physiological and psychological risks will be greater than those of past missions. Hence, ensuring that the habitat – in terms of the habitable volume ("acceptable" interior volume that the crew live in), layout, and design – is acceptable for such a journey, is critical for ensuring crew health, safety, well-being, and mission success. **OVERVIEW:** Efforts are currently underway to define ranges of acceptable habitable volume

scalable to support crews on such missions. The process to derive habitable volume mostly employed throughout prior missions is based on historical volumetric data, including overall vehicle volume. Given the unique behavioral health stressors anticipated with future exploration missions, the focus has shifted to a more human-centered approach based on task performance that addresses psychological/behavioral risks in defining habitability recommendations. In addition to habitable volume, guidelines relative to the layout of the habitat proper, also are under development. Task efficiencies (e.g. locating 'messy' functions away from 'clean') have served as valuable drivers in defining layout; behavioral considerations (e.g. private spaces versus shared spaces) are further being assimilated into these evaluations. Lastly, a well-designed work area is essential to supporting performance, given that the less mental energy one needs to function in an environment, the more mental capacity there is to complete the task at hand. Well-designed work areas will be essential towards optimizing the mitigating benefit of meaningful work and activities, which will serve as an important countermeasure for long-duration space exploration missions, particularly during times of monotony and boredom. **SIGNIFICANCE:** This presentation will focus on the process for integrating psychological/behavioral aspects into the overall approach of defining habitable volume, layout, and design recommendations for future exploration missions. Established human system standards exist to help guide habitat designers; an analysis of where further definition is needed, the behavioral health and performance research (completed and current) that is helping to inform this definition, and future plans for testing, will be discussed.

Learning Objectives:

1. The participant will be able to recognize the behavioral health risks associated with poor habitat design.
2. The participant will understand the process currently being implemented to incorporate behavioral factors into habitability recommendations.
3. The participant will recognize specific ways through which the habitat can provide countermeasures to offset behavioral health risks during a long duration exploration mission.

[222] THE MODERATING ROLE OF HUMOR BETWEEN COHESION AND TEAM ADAPTATION: IMPLICATIONS FOR EXTREME ENVIRONMENTS

E.C. Anania, K.M. Anglin, T.N. Cohen, T.J. Disher and J.P. Kring
Human Factors, Embry-Riddle Aeronautical University, Daytona Beach, FL

MOTIVATION: Anecdotally, humor has been cited as a coping strategy for individuals living and working in extreme environments, such as submariners, astronauts, and Arctic and Antarctic expeditioners. Due to the isolation, confinement and subsequent potential emotional repercussions of these environments, a sense of humor is an important quality to look for when both selecting individuals and training them to perform optimally in extreme environments. **OVERVIEW:** Although evidence shows humor can help individuals adapt and cope more effectively with traumatic situations, there is less information, both in terms of research and theory, on how humor functions at the team level. Specifically, there is limited research investigating how humor may improve team-level adaptation to stressful or unexpected events, creating a subsequent lack of a theoretical-based approach to humor research in the team context. Humor has the potential to affect several factors including team cohesion, communication, coordination, cognition, and ultimately the entire team adaptation processes. Many have noted that cohesion, in particular, plays an important role in both team adaptation and team performance. We contend that the interaction between humor and cohesion may positively affect team adaptation in extreme environments. Specifically, this research aims to introduce humor as a moderator between cohesion and team adaptation, influencing the direction and strength of this relationship. **SIGNIFICANCE:** The conceptualization of humor as a potential moderator between team cohesion and team adaptation has numerous invaluable takeaways for those functioning in or supporting extreme environment mission operations. We will present a theoretical model, grounded in empirical research on teams that informs recommendations for selection, training, and psychiatric practices in extreme environments. Although difficult to study, the function and coordination of extreme environment teams is perhaps their most critical factors for safety and success. Despite the fact that humor seems to have a positive effect on team cohesion, the intricacies of this relationship remain undefined. Because this relationship is new to investigation, the directions for future research are limitless, and can have important implications for teams in any extreme setting, from space to military operations.

Learning Objectives:

1. Recognize the effect of humor on team cohesion and team adaptation.
2. Understand the role of humor in extreme environments, and what implications this has for selection and training.

[223] NASA HUMAN EXPLORATION RESEARCH ANALOG MISSION XI: A CREWMEMBER'S EXPERIENCE

E.F. Urquieta
DMA, Houston, TX

The Human Exploration Research Analog (HERA), previously named "Deep Space Habitat", is a three story habitat at NASA JSC. It provides a high-fidelity research facility for scientists to address potential emergencies and complications associated with human performance during long duration spaceflight. The habitat is managed by the Flights Analog Division of the Human Research Program at NASA JSC. The main objective of the studies conducted at HERA is to evaluate how people will respond to isolation and confinement during typical mission exploration scenarios. During the mission XI a 715 day mission to the asteroid 1620 Geographos was simulated over a 30 day period. To improve mission fidelity, this mission included activities/operational tasks that are similar to what exists in flight. Meaningful work activities are designed to evaluate crew interaction with hardware. Categories of operational tasks are: flight simulations, emergency simulations, team tasks, physiological data capture, maintenance and systems checks, environmental monitoring, and research tasks. Schedule change activities consisted of: extended work days and variable workloads, communication delays (up to 10 min OWLT), role ambiguity, task ambiguity, time pressure, confusing communications, and fatigue stressors (i.e. sleep deprivation). An exercise period of low level, submaximal intensity (1.25 hours, including time for setup, cycle ergometer exercise, stowage, cool down, clean up and hygiene). Software-based measurements of behavioral health indicators were evaluated for use in a suite of behavioral health measurement tools. Tasks include cognition, visual analog scales and questionnaires, audio journaling, and actigraphy watches. Virtual reality capability was used to simulate two crew in extravehicular activity. Food bars were tested in order to reduce the mass that will be required to send for a long duration mission. New iPad applications were tested like the ISS FIT currently deployed onboard ISS to track food and liquid intake. Defining standardized measures for assessing behavioral health will allow for the collection of data across multiple analogs.

Learning Objectives:

1. To show the capabilities of the NASA HERA analog, and the experience and perceptions of a crewmember.
2. To define standard measures for assessing behavioral health.

[224] HUMAN-CENTRIC APPROACH FOR DESIGN OF EXPLORATION MISSTION HABITATS

M. Whitmore[1], S. Thaxton[2] and A. Whitmire[2]
[1]NASA-JSC, Houston, TX; [2]KBRwyle, Houston, TX

MOTIVATION: As NASA plans to send human explorers beyond low Earth orbit (LEO), crews will spend an unprecedented extended period of time in a small, confined vehicle. Due to its impact on primary vehicle structure and thus cost and mass, one of the first key questions asked during conceptual space mission architecture studies is – what is the "habitable volume" required for the astronauts to live and work? Given the unique stressors of a distant planetary mission, it will be essential to ensure that vehicle design adheres to the minimum acceptable volume constraints; at stake is the health, safety, and performance of crews living and working in those vehicles. To address this challenge, the proposed approach includes the use of design/evaluation criteria and HSI standards as well as tools and methodologies to assess and validate these

requirements. **OVERVIEW:** The recommended approach is the use of the NHV Process Flow and Mission Attributes Matrix, which together help designers to identify important steps in the human-centered design process such as defining mission/program requirements that affect habitat design, identifying stakeholders, performing a critical task analysis, defining volume envelopes for each planned task, and assessing habitable volume and interior design (e.g., computer-aided modeling, human-in-the-loop evaluations) and its impact on crew performance. For layout considerations, designers should consult NASA-STD-3001 and the Human Integration Design Handbook (HIDH). The approach and its development will be presented including the results of the workshops held, the current research activities and, the planned validation efforts through the providing ground activities. **SIGNIFICANCE:** As the performance envelopes of the Cis-lunar spacecraft (mass, volume, power, specifications, etc.) are being defined via the "proving ground" activities targeted to unfold during the 2016–2029 time frame, habitable volume and internal layout need to be established early in the conceptual design since these factors impact the habitat outer mold line (i.e., outer surface, shape of the vehicle to accommodate the rocket launch vehicle) and are the first requirements to be frozen in preparation for production. Our human-centric approach will help facilitate this, and similar approaches may be relevant for volume-constrained Earth design scenarios (e.g., submarines, oil and gas rigs).
Learning Objectives:
1. The participant will have an understanding of how to apply human-centric approach during the early phases of a design process to ensure ensure human capabilities and limitations are accommodated effectively.
2. The participant will be able to have an understanding of key human-system integration (HSI) considerations in confined and isolated environments, especially for Space Exploration Mission habitats.

[225] TASK ANALYSIS AND INTERFACE DESIGN USING OBJECT-PROCESS METHODOLOGY

Y.E. Yang[2], A. Liu[1], D. Dori[2], R. Galvan-Garza[1] and C. Oman[1]
[1]Aero/Astro, Massachusetts Institute of Technology, Cambridge, MA; [2]Massachusetts Institute of Technology, Cambridge, MA

INTRODUCTION: System design, interface design, and the design of human factors experiments require a description of the underlying relationships between agents, hardware and information. Task Analysis (TA) is a common approach for such descriptions, but multiple models are frequently needed for sufficient fidelity, and the completeness of the analyses often cannot be quantitatively assessed. Object-Process Methodology (OPM; ISO 19450) is a model-based systems engineering language and approach that shares many features of TA but has standard syntax and semantics to represent system elements as stateful objects, and their interactions as processes that transform the objects. **METHODS:** Both OPM and TA were used to model a space telerobotics task and guide the design of an automated electronic checklist system to support safe operations. We compared the utility of OPM to Hierarchical TA (HTA), Tabular TA (TTA) and Abstraction Hierarchies (AH) for supporting this design effort. **RESULTS:** OPM enabled the creation of a single hierarchical model of the task for which the logical correctness of its structure could be evaluated. Multiple TA approaches were required to be combined to create a task model at a comparable level of detail. The graphical representation in the OPM model clearly showed the structural relationships among objects, while the dynamic aspect of the system was expressed by processes. The resulting model was formal yet intuitively clear, enabling it to be coded into the logic of the physical system. **DISCUSSION:** OPM is an effective methodology and tool for producing a single model of a system or task using the basic building blocks of objects and processes. The main benefits of using OPM over classical TA approaches are (1) the explicit representation of the relationship between objects and processes and (2) its executable graphical representation, which supports testing the system's control logic, and (3) the OPM model directly guides how the objects in the actual system must be connected in the implementation. A minor disadvantage is the one-time need to learn and use the OPM language. We also discuss how OPM models can be directly integrated into future advanced interfaces. Supported by NASA Contract NNX15AW35G.
Learning Objectives:
1. Understand how Object-Process Methodology can be used to model human tasks and design task interfaces.

[226] IMPLEMENTATION OF A MARK III COMPUTATIONAL MODEL TO DECOMPOSE HIP JOINT TORQUES

C.R. Cullinane[1], R. Rhodes[2] and L. Stirling[3]
[1]Health Sciences and Technology, Massachusetts Institute of Technology, Hampton, NH; [2]NASA, Houston, TX; [3]Aeronautics and Astronautics, Massachusetts Institute of Technology, Cambridge, MA

INTRODUCTION: Understanding the overall required joint torques to operate a given suit can enable crew performance predictions. However, it is currently not clear how design changes would affect the total torques. A computational method was used to provide component level contributions to the overall required torque, which can be used to select suit designs that minimize total torque. Here the Mark III Planetary Space Suit (MIII) was examined, which uses a multi-bearing, hip-brief assembly (HBA) that provides mobility through three bearings, each with a single rotational degree of freedom. **METHODS:** A computer model of the MIII was built with geometries obtained from external 3D scans and then updated with material properties and pressurized bearing resistances. To validate the model kinetics, the total torque output was compared to existing experimental pressurized benchtop data. After validation, the model was used to decompose the joint torques into the contributing components (due to inertias and bearing resistances), which is not possible experimentally. The model was also used to compare forcing strategies (i.e., motion generated by a force external or internal to the suit). **RESULTS:** Model total torque outputs aligned with experimental outputs when compared to the matched external forcing condition (how the HBA was actually forced). External forcing generated increased use of the mid bearing when compared to the internal forcing condition, showing the importance of protocol produces. Adapting speed within the kinematic profiles provided different torque estimates consistent with the bearing resistance profiles. **DISCUSSION:** The increased use of the upper bearing and reduced use of the mid bearing for the internal compared to external forcing is driven by the locations of the applied forces. The external force was applied distal to the HBA, activating the mid bearing before the upper bearing. The internal force was applied proximal to the HBA, activating the upper bearing first. In addition to providing insight into suit design parameters, this modeling effort provides the effect of benchtop testing methodology. Experimental procedures may be preferred that more closely align with operational use of the suit to obtain improved estimates of the operator kinetics.
Learning Objectives:
1. [The participant will be able to…] Understand how computational modeling, once validated, can be used to decompose systems into components for use in developing design requirements and experimental testing protocols.

Tuesday, May 02 ***4:00 PM***
Governor's Square 14

S-047: SLIDE: CHALLENGES, MITIGATIONS, AND INVESTIGATIONS

Chair: G. Merrill Rice
Pensacola, FL

Co-Chair: Andrew Timboe
Beavercreek, OH

[227] VERIFICATION OF DIFFERENT PULSE OXIMETERS IN HYPOXIA RECOGNITION TRAINING

O. Bassovitch
R&D, Biomedtech Australia, Melbourne, Australia

INTRODUCTION: Pulse oximeter technology celebrates 40 years of commercial use. Originally intended for clinical observations, they are now widely used to monitor the degree of hypoxia and student wellbeing during practical hypoxia training. As a result of their use as a critical safety net in aviation training, their accuracy and responsiveness is important in this context. Manufacturers use standard ISO80601-2-61 (Pulse oximeter safety and essential performance) to validate SpO2 in vivo as part of their

pre-market validation. This paper compares the convergence and consistency of readings between different makes of pulse oximeters under normobaric hypoxia conditions. **METHODS:** Four healthy volunteers (26-52 years, 2 male and 2 female), all experienced with practical hypoxia awareness training, were exposed to 5 min normoxia (FiO2=0.21) followed by 5 min normobaric hypoxia (FiO2=0.10, appox. 19,000ft.), recovering on 3 min hyperoxia (FiO2=0.38). Three different pulse oximeters (benchmark oximeter: 'A'; and two test oximeters: 'B' and 'C') were attached to adjacent fingers, and SpO2 data (1/s) was acquired from them simultaneously. Subjects' data collection was repeated several times after a >30min normoxia break. The participants repeated this experiment over a 4 weeks period, aiming to minimize the influence of environmental and physiological variables. Over 120 datasets were captured and exported to a spreadsheet. Integrated values of bias between A-B and A-C were calculated. **RESULTS:** Integrated average difference SpO2 readings between A and B and A and C calculated ±1.4% and ±2.9%, with variance ±2.4% and ±5.4% correspondingly ($p<0.05$). **CONCLUSION:** Despite its limitations, the convenience and non-invasiveness of pulse oximeter technology remains a valid and acceptable method to monitor SpO2 trends during practical hypoxia training. Since different manufacturers use their proprietary averaging algorithms and validation lookup tables, SpO2 readings from different oximeters may not be identical at any given time of hypoxemia, although this difference is minimal after 90 s. Regardless of the manufacturer, at the range of SpO2>70%, readings converge within SpO2±3% (absolute value). Data for SpO2<70% were not available for comparison and future research is required.

Learning Objectives:

1. Review state of the art of pulse oximeter technology and its limitations.

[228] SIX NECK PAIN MITIGATING SOLUTIONS TO BE IMPLEMENTED IN RCAF GRIFFON HELICOPTER AIRCREW

P.S. Farrell[1], G. Chafé[2], G. Fusina[1], J. Hollands[1], T. Karakolis[1], V. Wickramasinghe[3], T. Wong[4] and H. Wright Beatty[3]
[1]Human Systems Integration Section, Defence Research and Development Canada, Toronto, ON, Canada; [2]Applied Science Group, Canadian Forces Environmental Medicine Establishment, Toronto, ON, Canada; [3]Flight Research Laboratory, National Research Council Canada, Ottawa, ON, Canada; [4]Integrated Personnel Support Centre, Canadian Forces Base Borden, Borden, ON, Canada

MOTIVATION: Neck pain prevalence rate was 75% in 2014 amongst Royal Canadian Air Force (RCAF) Griffon Helicopter aircrew. Defence Research and Development Canada (DRDC) and Canadian Forces Environmental Medicine Establishment proposed and assessed ten solutions, which led to credible scientific advice for the RCAF. After briefing the assessment results to the Griffon Squadrons Commander, it was decided that the following six solutions would be implemented: Helmet Fit, Education, Exercise, Task Sharing, Low Demand Postures, and Seat Ergonomics. This abstract provides a solution overview and the significance of this implementation decision. **SOLUTIONS OVERVIEW:** Helmet Fit: Royal Netherlands Air Force study indicated a significant reduction in neck pain using a novel Helmet Fit protocol. The RCAF plans to implement a similar protocol. Exercise: Neck-specific exercises have been reported to reduce neck pain. Although the Canadian exercise study is in progress, the RCAF plans to mandate general fitness for all aircrew. Education: Weak evidence has suggested education is effective for various neck disorders. Nevertheless, RCAF neck pain mitigation curricula are being developed. Task Sharing: the flying pilot (FP) and non-flying pilot (NFP) can share centre console tasks within the Griffon cockpit. Simulation results produced a 71% reduction and a 34% increase in NFP and FP muscle fatigue, respectively, yielding a 37% overall team muscle fatigue reduction. Low Demand Postures: several postural sequences have been identified that minimise neck loads while performing aircrew tasks (e.g., Flight Engineer neck torque was reduced by 64% during equipment handling). Seat Ergonomics: National Research Council of Canada studies have shown an overall vibration reduction with novel passive cushions. The RCAF will investigate the feasibility of replacing seat cushions. **SIGNIFICANCE:** The six mitigating solutions hope to lower neck pain prevalence. Methods, based on research surveys and an objective pain metric, need to be developed to monitor solution effectiveness in operations. Transitioning neck pain mitigating solution advice into operations is becoming a success story for the RCAF and DRDC.

Learning Objectives:

1. To understand that there are very high aircrew neck pain prevalence rates.
2. To understand that there is no 'silver bullet' to solve the neck pain problem, but there are several solutions that can mitigate the problem.
3. To understand the challenges related to implementing research results into operations.

[229] MAGNETIC E-RESONANT THERAPY ALLEVIATES COMBAT RELATED POSTTRAUMATIC STRESS DISORDER

J. Gentry[1], G. Bates[3], S. Biedermann[1], Y. Jin[2] and J. Zhang[1]
[1]Aerospace Medicine, Tinker AFB, Oklahoma City, OK; [2]Brain Treatment Center, Mission Viejo, CA; [3]Mental Health, 22 MDOS/SGOW, McConnell AFB, KS

INTRODUCTION: After decades of war, Postraumatic Stress Disorder (PTSD) has become pervasive in veterans. The RAND and National Centers for PTSD, estimates the prevalence of PTSD in 2.6 million U.S. service members who have served in Iraq or Afghanistan wars since 2001 range from 13-20%. Among the psychosocial treatments of PTSD are exposure therapy, cognitive therapy, eye movement desensitization and reprocessing, and group therapy. The combinations of cognitive behavioral therapy and pharmacotherapies for PTSD are often used with limited success and are associated with significant medication side effects. Transcranial magnetic stimulation of the brain is an FDA approved neuromodulation technology to treat patients with depression and may become an emerging adjuvant treatment modality for PTSD as well. Recent clinical trials produced promising results in the treatment of PTSD by this new modality. We have conducted a human subject study at Tinker AFB to investigate the effect of transcranial Magnetic e-Resonance Therapy (MeRT) on veterans suffering with PTSD from combat experience. **METHOD:** Eight subjects (projected 25) were enrolled and completed MeRT treatment after obtaining Air Force Institution Research Board approved consent. The MeRT treatment is guided by baseline EEG and is composed of five 30 min sessions weekly for 4 weeks. Subjects were randomly assigned to receive active (Group I) or Sham (Group II) treatment for the first two weeks with transition to an open label study so that all subjects received a total of 4 weeks of active MeRT. The PTSD Checklist Military Version (PCL-M) score and Cognitive and Physical Functioning Questionnaire (CPFQ) were used to measure clinical response at interval follow ups. **RESULTS:** 1). There were no serious side effects observed related to MeRT treatments. The most common side effect was a self-limiting headache due to the transcranial magnetic stimulation. 2). After four weeks of active treatment, compared to baseline, on average MeRT reduced the PCL-M score from 66 to 37, and from 79 to 50 in both groups respectively. 3). CPFQ scores also showed improvement in areas of motivation, alertness, energy level, focus, recall, ability to find words and mental acuity. **CONCLUSION:** Our preliminary results suggest that transcranial MeRT is a promising adjuvant treatment modality to help veterans suffering from PTSD.

Learning Objectives:

1. To introduce and understand that transcranial MeRT may provide an alternate method to help veterans suffering from PTSD.

[230] JUST CULTURE AND PEER SUPPORT FOR PILOT MENTAL HEALTH: AN EVIDENCE BASED APPROACH

D. De Rooy and S. Mulder
Psychiatry, Leiden University Medical Center, Leiden, Netherlands

MOTIVATION: Several airlines have peer support programs to help pilots suffering from mental health complaints. Ideally, mental health problems are dealt with in a Just Culture environment. Peer support programs differ between airlines, and there is a lack of knowledge on the most optimal design and how they can be implemented in a Just Culture. We combined findings from aviation accidents and incidents with current scientific knowledge to provide data-based recommendations for optimal peer support and a Just Culture approach to mental health issues. **OVERVIEW:** We analyzed commercial aviation accidents and incidents

caused by a mental disorder of a pilot (N=16). Subsequently, we combined these findings to what is known in comparable professional groups. Thereto, PubMed and PsychInfo literature searches were performed on the risk of negative life-events on developing suicidal ideation and behavior, peer support programs and Just Culture human resource management. Several incidents and one lethal accident were due to acute psychotic symptoms. Lethal accidents were mostly related to impaired coping with negative life-events. In comparable professional groups, negative life-events are clearly related to suicidal thoughts, attempts and completed suicide. A protective effect of peer support programs on mental health problems has not been established. However, peer support programs are generally appreciated by those involved. We did not find literature on how mental health risks can be incorporated into Just Culture safety management. **SIGNIFICANCE:** There is still a lack of evidence on how peer support groups should be designed and how mental health risks can be implemented in a Just Culture. However, negative life-events and acute psychotic symptoms are risk factors for both military and civilian aviation safety. The presence of negative life-events is easy to establish, and negative life-events mostly cause less stigma compared to mental health complaints. We therefore propose that: 1. Peer support programs are easily available for pilots encountering negative life-events. 2. All involved in peer support are made aware of the risk of loss of contact with reality, which indicates the presence of a psychosis. 3. Specific rules are made to ensure that pilots can report negative life-events and mental health problems without a risk for job or income loss.

Learning Objectives:

1. Peer support programs should be easily available for pilots encountering negative life-events.
2. All involved in peer support should be aware of the risk of loss of contact with reality, which indicates the presence of a psychosis.
3. Rules needs to be made to ensure that pilots can report negative life-events and mental health problems without a risk for job or income loss.

[231] ON USEFULNESS AND INCONVENIENCE OF HFACS MODEL

Y. Kakimoto
Japan Institute of Human Factors, Tokyo, Japan

INTRODUCTION: Among many human error analysis models, HFACS (Human Factors Analysis and Classification System) has been popular since Shappell and Weigmann proposed the model in 2000. The objective of this study is to discuss the usefulness and inconvenience of the model through using an actual near midair collision (Jan,31, 2001) and the derailment accident by JR West Nippon (April 25,2005)**. RESULTS:** In the case of near midair collision, the unsafe acts are those ATC trainee issued A/C A's call sign different from his intention. He intended to issue A/C B's call sign. His supervisor also did not notice the error. As a result, both aircrafts were approaching each other and finally evaded. Organizational items were not related to the near midair collision. In case of the derailment, unsafe act was to "delay to operate braking just before the right curve (r=304m)". And finally this accident was closely related to the organization failure. Specially safety culture is closely related. **DISCUSSION:** Surely, by using HFACS model, we can easily classify human errors, but some inconvenience remained. That is, in case of multiple persons concerned, or when we want to follow events sequentially, inconveniences might appear to analyze human errors.

Learning Objectives:

1. Understand the characteristics of human error analysis model HFACS and get some hints to develop the next step.

Tuesday, May 02 ***4:00 PM***
Governor's Square 15

S-048: PANEL: EVERYTHING OLD IS NEW AGAIN

Sponsored by the International Association of Military Flight Surgeon Pilots

Chair: Thomas Travis
San Antonio, TX

Co-Chair: Christopher Backus
JBMDL, NJ

PANEL OVERVIEW: Formation of the Air Force Research Laboratory (AFRL) in 1997 restructured budget priorities in areas of traditional aeromedical concern: Work in fatigue, cognition, and toxicology was spared because it provided essential operational support, but severe cuts came to altitude and acceleration research, and the fledgling spatial disorientation program: Their funding, together with that for life support equipment development and cockpit integration was severely curtailed or eliminated. This was in part due to acquisition reform, which shifted responsibility for these areas to airframe manufacturers, who saw them as engineering problems instead of research areas. Critical personnel also began leaving as funding diminished, and losses increased further when the 2005 Base Realignment and Closure Commission (BRAC) moved USAFSAM to Wright-Patterson AFB. This trend was arrested in 2008, with establishment of the 711th Human Performance Wing (HPW) within AFRL, but by then an entire generation of needed aeromedical investigators had drifted away. Thus it came as no surprise when the Wing's new Human Performance Directorate (HP) began to identify operational "capability gaps", that many of them resulted from the funding and personnel shortfalls described above. Notably, remediation of the F-22 breathing system, and elimination of neurological DCS risk in the U-2 have gained national and international attention. This panel, made up of members of the International Association of Military Flight Surgeon Pilots (IAMFSP), who have been directly or indirectly part of these investigations and research efforts, will present the most prominent of these "old" problems that have become "new" again. Areas such as oxygen systems and high altitude have reemerged as major concerns, bringing aerospace medicine to the fore and funding for new research to the service aeromedical research entities. This discussion is not only relevant to legacy systems, but to the newest systems, either in production or proposed.

[232] HYPOCAPNIA IN AVIATORS: UPDATING AN OLD PARADIGM

W. Mueller
USAF, Dayton, OH

PROBLEM STATEMENT: This talk will present findings of a recently completed Independent Review of F-15C physiologic incidents characterized by hypoxia-like symptoms, and explain why hypocapnia was hypothesized to be a likely cause of many of these incidents. **BACKGROUND:** Aerospace medicine professionals know that hypoxia-like symptoms have multiple potential medical causes. However, a recent increase in the rate of F-15C physiologic incidents were attributed to hypoxic hypoxia, even though the aircraft's liquid oxygen supply and CRU-98 regulated oxygen system are highly reliable. This presentation will explain why hypocapnia was thought to be a likely cause of many of these incidents and an under-appreciated cause of hypoxia-like symptoms in a hypobaric environment. **CASE PRESENTATION:** Twenty-Five F-15C physiologic incidents over a 2-year period were reviewed. Factors contributing to these incidents included cockpit depressurization, lack of understanding of the CRU-98 regulator, and lack of awareness of the need to reduce rate and depth of breathing in all physiologic recovery procedures. Due to the reliability of the oxygen system, careful consideration was given to all possible causes of these incidents. Hypocapnia due to increased rate of CO2 loss in a hypobaric environment was hypothesized to be the most likely cause of many of these incidents. **OPERATIONAL RELEVANCE:** All possible causes for hypoxia-like symptoms must be considered as a routine part of any physiologic investigation. The lack of current research on the effects of hypobaric environments on alveolar and blood CO2 levels has resulted in prevailing assumptions that these levels are relatively constant as cockpit pressure decreases. The resulting paradigm is that inappropriate hyperventilation is the only potential cause of hypocapnia in aviators. This presentation will highlight how "old" experimental data about physiologic CO2 levels must be updated to consider a potentially "new" risk for aviators - hypocapnia in a hypobaric environment. If testing validates this hypothesis, other sequelae of hypocapnia may also be found.

Learning Objectives:
1. Attendees will understand the normal and degraded modes of the CRU-98 oxygen regulator, and the meaning of an out-of-spec 180-day regulator test.
2. Attendees will be able to identify at least 5 causes of "hypoxia-like" symptoms found in an aviation environment.
3. Attendees will be able to explain why aviators may have an increased risk for hypocapnia in a hypobaric environment, and why hypocapnia maybe a more likely explanation for hypoxia-like symtpoms when aircrew flight equipment is properly worn.

[233] US AIR FORCE LIFE SUPPORT EQUIPMENT DEVELOPMENT - CURRENT STATE AND A NEED FOR CHANGE

K.G. Hughes
USAF Pilot-Physician, Retired, Dayton, OH

MOTIVATION: Enhancing aircrew safety and performance is a critical mission of aerospace medicine professionals. Key to this is the proper development, improvement and sustainment of life support equipment (LSE). This results in equipment that is reliable, effective, seamlessly integrated, and ensures aircrews' confidence in its operation. This presentation will review the current USAF LSE fielding process and make recommendations for improvement to include in-flight evaluation of equipment. **OVERVIEW:** Existing aircraft systems incorporate LSE which have historically protected the aircrew from environment threats and provided methods to ensure survivability during normal and emergency operations. Recently, equipment has also been developed that enhances and sustains improved performance of the operator and the weapon system, such as OBOGS and helmet-mounted display systems. The USAF LSE Program takes input from the aircrew, LSE personnel, Major Commands, safety, acquisition, aerospace medicine and has oversight from the Aircrew Performance Executive Council. The Life Cycle Management Center is the acquisition and initial procurement authority, and oversees safe-to-fly certifications. Current aircrew performance issues that arise with these new weapon systems include thermal burden, helmet weight/CG, noise protection, in-flight urination, information fusion/SA and physiologic monitoring for adverse events. Significant research is underway in the AF Research Lab's 711th Human Performance Wing to study these issues and incorporate HSI requirements into new weapon system development. Some aircrew performance/flight equipment research has been conducted with the USAF Test Pilot School, yet the AF lacks dedicated in-flight testing platforms, much like the RAF Centre of Aviation Medicine Hawk aircraft. Building this capability, and updating the process by which the USAF develops, modifies, tests and fields life support equipment can greatly improve the performance and safety of operators in current and new weapon systems. **SIGNIFICANCE:** Aircraft systems are increasingly complex, requiring the optimum performance of the aircrew operating within that system. The process in which the USAF develops and modifies in-service life support equipment must change to incorporate better methods that meld research, test/evaluation, industry partnership, and include in-flight trials in order to field systems that are the most cost efficient, operationally effective and reliable.

Learning Objectives:
1. Understand the current process for life support equipment development and modification in the US Air Force.
2. Understand the human performance and safety requirement for well-integrated life support equipment.
3. The audience member will gain an understanding of the increased complexity of life support equipment as it pertains to human performance and weapon system safety, and the need for an improved process for development and testing life support equipment to include in-flight testing.

[234] U.S. DOD CRASHWORTHY TROOP SEATING: A HISTORY OF UNDERACHIEVEMENT

J.D. Glatz
Glatz Aeronautical Corporation, Newtown, PA

PROBLEM STATEMENT: In the 1960s the US DoD determined that rotary-wing crash survivability systems would provide a tremendous benefit. Yet, installed crashworthy cabin / troop seats still do not meet originally established minimum requirements for protecting occupants. **BACKGROUND / LITERATURE REVIEW:** Publicly available documents were researched to establish the history of helicopter seating requirements. **CASE PRESENTATION:** Analyses of the mishap environment in the 1960s led to the development of performance requirements for seating systems: *regardless* of location within the aircraft. For cockpit / crew seats these are contained in MIL-S-58095. All operational crashworthy crew seats have been held to these originally established requirements. In 1977, contractor recommendations, implemented by the DoD in MIL-S-85510, reduced the performance requirements of crashworthy cabin / troop seating. A misinterpretation of the reason for the reduction further impacted troop seat performance capability during US Navy efforts in the mid-1980s to field a seat on the V-22. This seat was inadequate from the outset; and, not even "crashworthy". Subsequent efforts by all services resulted in seats with improved performance. The performance capability of these later seats has been generically termed ***RC*** for Reduced Capability. This is because they do not even meet the performance requirements of MIL-S-85510. A draft study completed in 2006 quantified the differences and determined that the safety degradation was significant. **OPERATIONAL / CLINICAL RELEVANCE:** The performance requirements of MIL-S-85510, are significantly less than those of MIL-S-58095 (and those of ***RC*** more so). An analysis determined that this was due to the H-60 troop seat not being able to meet the original, and accepted, performance requirements. This resulted in the H-60 troop seat's performance limitations being projected on to all future troop seats. Current crashworthy troop seating has a significant "technology deficit" compared to all other crash survival systems; especially, crashworthy crew seats. Efforts to improve the performance of troop seating to match that of crew seating should receive the highest priority for crash survival system funding. Correction of this deficiency will require: the quantification of the performance of each deployed seat system; an updating of development and acquisition methodologies; as well as, innovation in the fundamental development of new crashworthy troop seats.

Learning Objectives:
1. That the US DoD crashworthy troop seat technology deficit was caused by a combination of fundamental and simple mistakes.
2. That efforts to solve the US DoD crashworthy troop seat technology deficit have been hampered by a failure to understand the fundamental cause of the deficiency.
3. That if the seat breaks, the man breaks!

[235] ASSESSMENT OF CARGO SPACE SEATING PERFORMANCE IN ROTORCRAFT DURING MISHAPS

N.L. Wright[1], P. Mapes[2] and G.A. Ruderman[3]
[1]Air Force Research Laboratory, Wright-Patterson AFB, OH; [2]Defense Health Headquarters, Falls Church, VA; [3]Aircraft Live Fire Test and Evaluation, OSD Office of the Directory, Operational Test & Evaluation, Washington, DC

INTRODUCTION: Epidemiological analyses of operational mishap data shows that US military rotorcraft cabin (cargo compartment) passengers are more likely to have major or fatal injuries than pilots. Studies were conducted from 2012-2015, funded by OSD Live Fire Test and the Defense Safety Oversight Council, to quantify occupant protection of operational and prototype rotorcraft troop seats during crash events. **METHODS:** H-60A/L, UH-60M, CV-22, CH-53, and several prototype troop seats were dynamically tested in multiple impact orientations, accelerations, and energy levels using small female through large male manikins. Test configurations were based on H-60A/L seat qualification tests and MIL-S-85510(AS). Acceleration, force, and moment data were collected using instrumented manikins and compared to established injury criteria. **RESULTS:** Performance and structural failures of operational seats were observed which correlate to injury and mortality trends during mishaps. A prototype modification kit was developed for the H-60A/L seat to address structure failures seen in testing; the modified H-60A/L seat demonstrated improved seat strength and occupant protection. Side facing H-60A/L seating suffered consistent failure of webbing and inertial reels during Combined Horizontal tests. **DISCUSSION:** The studies demonstrate a methodology to quickly and inexpensively

compare occupant protection across different designs and platforms. The studies also identified serious structural and functional deficiencies of several operational seats that correlate with rotorcraft mishap injury and mortality data. It is anticipated that modifications to seats, or technology-sharing across rotorcraft platforms, can reduce excess mortality and major injury during helicopter mishaps. Additionally, the use of MIL-S-85510(AS) as a general specification should be re-evaluated due to its technology-specific solution and divergence from the US Army Crash Survival Design Guide Mishap Data Analysis.

Learning Objectives:

1. Dynamic impact testing of rotorcraft seating can be correlated with operational mishap data; use of this data can focus and drive improvements or replacements to operational equipment, and anticipated improvements to injury and mortality rates can be quantified.

[236] HEALTH AND BIOLOGICAL EFFECT OF HIGH POWERED LASERS

I. Manigault
AFSOC SG Office, United States Air Force, Mary Esther, FL

EDUCATION: Defining and understanding the health and biological effects of exposure to direct and indirect high energy laser operating from an air platform. **PROBLEM STATEMENT**: The Air Force is rapidly expanding its understanding of occupational hazards associated with operating in and about the target area of high energy platforms. Operators' safety must be maintained while maximizing system effectiveness. **TOPIC:** Defining, understanding and controlling the impact of high energy laser's weapon on the human weapon system. **WHAT YOU NEED TO KNOW ABOUT HIGH ENERGY LASER PROBLEM STATEMENT**: In order to safely operate a high energy laser a thorough health risk assessment is underway for individuals operating the systems as well as those who may receive secondary exposures from being in the vicinity of an operating system. **TOPIC:** Centuries of military advancements has progressed the deployment of projectiles from a simple sling shot, to bow and arrow, catapults, cannons, atomic bomb and now lasers. In 1915, Albert Einstein's equation (E=MC^2) paved the way for the development of lasers. In just 100 years, the advancement in laser technology has revolutionized communication, manufacturing, medical treatment and warfare. In most instances, high powered lasers are operated in controlled environments which pose little to no threat to the operator and public. As we transition to future technologies, the capability of putting a laser on an aircraft for offensive and defensive actions are becoming a reality. Air Force Special Operations Command is the lead USAF MAJCOM to develop a high powered laser on an airborne platform. With these technological advancements and the rapid advancement of these weapons ability to meet mission objectives, the collateral health effect must be evaluated in order to mitigate any threats to the safety of our warfighters and the exposed general public. **APPLICATIONS:** The laser health risk assessment will provide operators and friendly forces the ability to understand the risk, hazards, and control measures needed to protect themselves during system operation. This technology, cost effectiveness, will drive its expansion to multiple platforms throughout the Department of Defense; solidifying the necessity of acknowledge the hazards associated with its use.

Learning Objectives:

1. Defining and understanding the biological effects of exposure to direct and indirect high energy laser.
2. Understanding the three primary means of eliminating or reducing lase exposure.
3. Defining and understanding what Nominal Hazard Zone is and how it effects explore to lasers.

Tuesday, May 02 ***4:00 PM***
Governor's Square 12

S-049: SLIDE: HEALTH & WELFARE OF AIRCREW PART I

Chair: Karen Klingenberger
Williamsburg, VA

Chair: Mary Brueggemeyer
Bethesda, MD

[237] BARRIERS AND VALUES OF MORAL DISTRESS AMONG CRITICAL CARE NURSES

M.A. Wilson
School of Aerospace Medicine, United States Air Force, Fairborn, OH

INTRODUCTION: Moral and ethical encounters in healthcare systems are negatively impacting patients and providers. These situations are such that an increasing frequency or an intense single encounter could result in painful, psychological disequilibrium identified as moral distress. The existence of this phenomenon in civilian critical care nurses is well established, but minimal research has been conducted in military providers. Moral distress results in poorer patient clinical outcomes, burnout, turnover of nurses, and increased healthcare expenses. This research effort investigated the phenomenon of moral distress in critical care nurses within the civilian and military en route care environments. **METHODS:** Two nonexperimental descriptive studies were completed with civilian and military critical care nurses who self-reported having experienced moral distress. The first effort utilized primary i nterviews with seven critical care nurses from the civilian sector. Specific barriers and values were identified and analyzed throughout the self-reported experiences of moral distress. The second study involved primary interviews with critical care nurses from the United States Air Force Critical Care Air Transport Teams (CCATTs). Consistent with qualitative methodology, preliminary data analysis took place after the initial interviews and continued after each subsequent interview. Data analysis included first and second coding strategies within the qualitative software program NVIVO. Demographics data from participants were obtained. **RESULTS:** A list of five barriers and associated values from the civilian critical care nurses was generated from their stories of moral distress in the first study. Interviews with the selected CCATT nurse population are currently being completed. Future measures will examine similarities and differences in barriers and values of moral distress within civilian and military experiences. **DISCUSSION:** These studies attempt to establish the phenomenon of moral distress among CCATT nurses and then compare the experiences to experiences of moral distress in civilian critical care nurses. Studying barriers and values present in civilian and military critical care nurses who have experienced moral distress provides direction for targeting interventions to lessen the impact of this detrimental phenomenon in healthcare to improve patient outcomes and provider well-being.

Learning Objectives:

1. Define moral distress.
2. Identify the barriers present in critical care nurses that lead to moral distress.
3. Compare the experience of moral distress in civilian and military critical care nurses.

[238] PROFESSIONAL STRESS, COPING, PSYCHOLOGICAL WELL-BEING AND DENTAL ATTRITION AMONG AIRCREW OF INDIAN AIR FORCE

M.P. Marwaha
Aviation Medicine, Air Force Central Medical Establishment, Delhi, India

INTRODUCTION: The literature suggests a relationship between psychological status and dental attrition. So this study was designed with objectives to study the professional life stress among aircrew, the coping strategies being used by aircrew, the psychological well-being of the IAF aircrew and to find the relationship between stress, coping, well-being with dental attrition. **MATERIAL AND METHODS:** Study sample constituted (n=112) aircrew from two strategic forward airbases of IAF. The subjects were administered professional life stress scale (David Fontana, 1989); stress coping inventory (Carver et al.'s COPE, 1989), and psychological general well-being schedule (Harold J. Dupuy's 1984). Bruxism grading was done according to Smith and Knight Tooth Wear Index (1984). Periodontal Disease Index was measured according to Periodontal Disease Index scale given by Ramjford (1959). Gingival Index were

measured the criteria given by Loe & Silness (1967). Data were analyzed through the Statistical Package for Social Science (SPSS-ver.11). **INTERPRETATION**: Professional life stress scores range was 10.40 ± 4.88 (scale 0- 59) suggestive of mild to moderate stress. The main coping strategy being used was problem-focused coping 58.46 ± 8.26 (scale 20-80). The study sample used other coping strategies as 'emotional focused coping' 49.09 ± 8.47(scale 20-80) and 'avoidance focused coping'23.51 ± 4.74 (scale 13-52). The data shows that psychological well-being of aircrew was towards higher side 87.35±11.20 (scale 0-110). The data suggests that aircrew has dental attrition problems, as mild degree of gingivitis 0.87 ± 0.87 (scale 0-3) is present. Periodontal disease index 1.06 ± 0.81 (scale 0-6) was mild to moderate, showing inflammatory gingival changes that are not extending around the tooth. Bruxism 2.15 ± 1.48 (scale 0-4) shows loss of enamel exposing dentine for less than one third of surface. **CONCLUSION:** Present study indicates that aircrew have mild professional life stress and the coping strategies mainly used are 'Problem focused coping strategies'. However, they sparingly use 'Emotional & Avoidance focused coping strategies'. Aircrew has moderately high psychological well-being & mild problem was found in dental attrition but with significant bruxism. The study shows a positive correlation amongst the variables of dental attrition, but there is no significant correlation between the stress coping strategies being used & the dental attrition.

Learning Objectives:

1. Evaluation of Professional Stress, Coping strategies being used, Psychological Well-Being of Aircrew and Dental Attrition among Aircrew of a forward airbase of Indian Air Force, also the relation between Stress and dental attrition.

[239] AN EPIDEMIOLOGICAL ANALYSIS OF U.S. ARMY AVIATOR HEALTH OUTCOMES

I.P. Curry[2,1] and A. Kelley[3]
[1]MOD, Fort Rucker, AL; [2]USAARL, Fort Rucker, AL; [3]USAARL, Fort Rucker, AL

INTRODUCTION: Aeromedical policy and subsequent decision making should be an evidence-based process. Large amounts of data are potentially available, but there have been very few attempts to perform epidemiological studies in this area. One largely unexplored source of aeromedical data is the Aeromedical Electronic Resource Office system (AERO). This aeromedical database is used by the US Army, Navy and Coast Guard to process aviation aircrew Flight Duty Medical Examinations (FDME). The FDME is a periodic physical examination performed for occupational and preventive medicine purposes to promote and preserve the fitness, deployability, and safety of aviation personnel and resources. FDMEs are performed yearly, at a minimum, as well as after a period of absence from flying to include involvement in an aviation mishap. **METHODS:** The FDMEs for 24,568 aviators consisting of 180,756 records were extracted for examination from the AERO database. The system contains demographic data, clinical decisions on flight status with associated ICD-9 coding and a significant breadth of biomedical data ranging from simple height and weight through to full blood test panels. **RESULTS:** This presentation will outline the initial epidemiological outputs from our analysis in the areas of demographics, prevalence of disorders and associations between outcomes and biomedical indices. The data includes AERO records between 2005 and 2015 of those records where a waiver was granted, the top five most frequently cited ICD codes were: 1) hypertension (10%), 2) hearing loss (8.4%), 3) sleep apnea (4.6%), 4) hyperlipidemia (3.8%), and 5) fibromyalgia (2.9%). **DISCUSSION:** The AERO database captures the aviation member's health status throughout the entirety of their career. AERO holds demographic information and personal health histories, physical examination and laboratory results as well as waiver status. There has never been a published comprehensive statistical study of the AERO database to determine prevalence of disease and injury in the Army aviator and our aim in performing such a study was to provide significant insight into categories of risk and their magnitude.

Learning Objectives:

1. The participant will be appraised of the most prevalent clinical conditions leading to waiver and disqualification from flying status in the U.S. Army and the relation of those conditions to policy.

[240] AN EPIDEMIOLOGICAL STUDY OF WOMEN'S HEALTH ISSUES IN MILITARY AVIATORS

A. Kelley[2] and I.P. Curry[2,1]
[1]MOD, Fort Rucker, AL; [2]USAARL, Fort Rucker, AL

INTRODUCTION: Approximately 5.2 percent of the U.S. Army rated aviators are female (U.S. Army Human Resources Command, 2016). However, there is a paucity of research available on health outcomes specific to female aviators. The main objective of this study was to determine and document evidence of the current state of aeromedicine with respect to women's health. **METHODS:** Reports for a total of 1,282 female aviators were retrieved from the Aeromedical Electronic Resource Office system (AERO). This system contains information from all aviation aircrew Flight Duty Medical Examinations including demographics (e.g., age), physical examination results (e.g., body mass index [BMI], blood pressure), laboratory results (e.g. lipid panel), waiver status, and International Classification of Diseases (ICD-9) codes. **RESULTS:** The most frequently cited ICD-9 codes for granted waivers ($N = 466$) in female aviators were: 1) hypothyroidism (4.5 percent), 2) migraine unspecified (3.9 percent), 3) lumbar disc displacement (3.9 percent), 4) cervical disc displacement (3.2 percent), and 5) unspecified adjustment reaction (2.8 percent). **DISCUSSION:** Differences in health status and medical outcomes between males and females are important to identify in order to develop appropriate injury prevention mitigation strategies with respect to anthropometrics and other factors.

Learning Objectives:

1. The participant will gain insight into the clinical issues presented by female U.S. Army aviators and be able to contrast those with males from the same cohort.

[241] UPDATE TRAVEL PROPHYLAXIS FOR FLIGHT CREWS

J. Siedenburg
Lufthansa Medical Department, Uetersen, Germany

PROBLEM STATEMENT: Travel prophylaxis is critical to prevent infectious diseases in flight crew operating in tropical and subtropical areas. **TOPIC:** Infections may not only jeopardise the health of flight crews but aviation safety as well. Therefore, pre-travel advice is an important element of care for flight crews operating on international flights. **APPLICATIONS:** As the epidemiology of infectious diseases changes over time, recommendations for flight crew have to be updated regularly. The presentation gives an overview about current hazards and mitigation measures. **INTRODUCTION:** Flight crews operate in tropical and subtropical areas frequently. Albeit layovers rarely exceed 48 hours, in 5-star hotels in urban areas they are exposed to a range of infectious diseases. Preventive measures encompass exposure prophylaxis, vaccinations, chemoprophylaxis and early detection and treatment of infections. Major clinical signs of infections acquired during layovers encompass fever, diarrhea, skin affections. **DISCUSSION:** Most of malaria infections imported to Western Europe and the US are imported from Sub-Saharan Africa. Flight crews operating there are at considerable risk and need meticulous exposure prophylaxis and chemoprophylaxis. In case of fever or other suspicious symptoms a malaria should be ruled out immediately in order to prevent complications or even a fatal outcome. Other mosquito borne viral fevers include Dengue, Chicungunya, West Nile and Zika virus. For the time being prevention of mosquito bites is the only effective prophylactic regime. A range of infectious diseases can be prevented by vaccinations. Yellow fever vaccination is required by many countries on arrival. The vaccination renders a life-long protection. All flight crew should be vaccinated against tetanus and diphtheria, those not only operating on domestic flights against poliomyelitis as well. A vaccination against hepatitis A should be generally recommended. Other travel vaccinations, which may be recommended on a case-by-case basis, are those against hepatitis B, typhoid fever, meningococcal meningitis and tick borne encephalitis. Vaccinations against rabies, Japanese encephalitis and cholera are only rarely indicated in flight crew. Traveler's diarrhea is a common symptom, usually lasting for a couple of days only. Prevention consists of careful hand, food and drinking hygiene. Therapy consists of substitution of fluid and electrolytes, antibiotics are indicated only rarely.

Learning Objectives:

1. Malignant malaria is a potential occupational hazard of flight crews operating in risk areas. Malaria awareness has to be encouraged.

2. Flight crew should be educated about infectius hazards and how to protect themselves.
3. A proper prophylaxis to prevent infectious diseases consists of exposure prophylaxis, vaccinations, chemoprophylaxis and early diagnosis and treatment.

Tuesday, May 02 ***4:00 PM***
Governor's Square 11

S-050: PANEL: AEROSPACE DENTISTRY PANEL

Chair: Michael Hodapp
Houston, TX

PANEL OVERVIEW: Expeditions below the earth, under the sea, during flight, and into the far reaches of space can have a detrimental on the human body. Aerospace medicine focuses on the effects of barometric changes to the human body. The specialty of aerospace medicine is unique in that it encompasses a broad range of sciences and specialists to accommodate the vast range of events, and safety issues that occur when exposing humans to harsh environments. Aerospace dentistry addresses issues that occur within the maxillofacial complex during changes in atmospheric pressure, takes preventative measures to reduce complications, and assists in dental preparedness for exploration to remote locations. Dentistry's unique position allows for the assistance in identifying and ability to provide treatment for oral sleep apnea, as well as assist in forensic identification. Dental specialists have the ability to rehabilitate the compromised orofacial complex to provide good function, and speech as well as improving facial aesthetics. Recent developments in surgical techniques allow the clinician new options when treating complex rehabilitation cases. This panel will present two methods of oral rehabilitation that can reduce trauma and decrease healing time for crewmembers. Recommended time for healing from these procedures will also be addressed. This panel will also address dental related spaceflight considerations for exploration class missions.

[242] THE USE OF TITANIUM MESH IN ORAL IMPLANTOLOGY; CLINICAL APPLICATIONS IN AEROSPACE DENTISTRY

J.L. Dominguez-Mompell[1,4], J.L. Chao[1,4], D. Robles[4], V. Lopez Pizarro[2] and R. Dominguez Mompell Mico[3]
[1]Oral Surgery, DL Cirugia Oral, Madrid, Spain; [2]Hospital Principe de Asturias, Aranjuez. Madrid, Spain; [3]Orthodontics, University of California Los Angeles, Madrid, Spain; [4]Universidad Rey Juan Carlos, Madrid, Spain

Tooth loss is one of the most common complaints in the dental office. The loss of dentition is usually the result of dental decay, periodontal disease, or traumatic facial injuries. In many cases long term or traumatic tooth loss can lead to atrophy of either the maxilla or mandible. There are three basic methods to replace missing teeth, fixed dental bridge work, partial or complete dentures, and dental implants. Each alternative method has its own benefits and drawbacks. It is important to consider a patient's medical, financial, as well as emotional status when considering the appropriate treatment. With the advent of dental implants, patients are likely to request fixed rehabilitation of the missing teeth, even if it requires extensive surgery and bone grafting procedures. The recent development of titanium mesh allows the restoration of many patients in a fraction of the time, and with a shorter recovery period. Titanium mesh can have an impact in sinus augmentation procedures within the aeronautical environment. Since the mesh is fixated with osseous screws, it adds long term stability, and reduces the chance of extrusion of graft material when barometric changes occur. As with all surgical procedures, flight personnel should be restricted from flying until sufficient healing has occurred. This presentation will cover the benefits of titanium mesh in oral rehabilitation, and discuss the recommended healing period to prevent complications that can occur during barometric changes.

Learning Objectives:
1. To understand the use of the new titanium meshes in oral surgery.

[243] ORAL BIOFILTER

V. Lloro[1] and V. Lozano de Luaces[2]
[1]Oral and Forensic Dentistry, Centro Dental Sant Andreu, Barcelona, Spain; [2]Ergonomics dentistry, Universidad de Barcelona, Hospitalet de Llobregat - Barcelona, Spain

The prospect of long term human habitation of the space environment is in the not too distant future. Aerospace dentistry will have to make the leap from emergency-only treatments to comprehensive dental care, to prevent the development of dental disease during long-term spaceflight. Use of standard dental equipment such as dental turbines, contra-angles or cavitrons can generate contaminated suspended aerosols that could potentially infect other crewmembers. Studies have shown that microgravity can enhance bacteria replication, which only increases the infection risk. With support of the European Space Agency, we have designed an oral biofilter to mitigate dental care generated sprays from leaving the patients oral cavity. This presentation will discuss how the use of an oral biofilter in a space environment, can help prevent contamination of the crew environment.

Learning Objectives:
1. To present how an oralbiofilter may help in the prevention of air contamination in long time space missions.

[244] "SPACE DENTISTRY" CHALLENGES CONSIDERATIONS AND PRACTICE

M.H. Hodapp
Private practice, Houston, TX

With the advent of flight, and the development of self-contained underwater breathing apparatus (SCUBA), physicians and dentists alike have been perplexed with a whole new set of challenges. Barometrically related events occurring during flights and diving expeditions, affected crewmember performance, thus compromising mission success and safety. "Barodontalgia" barometrically related dental pain, can cause pain so intense that it incapacitates the afflicted crewmember with vertigo, lack of concentration, and premature cessation of flights. Spaceflight presents its own distinct set of challenges. The environment of space is harsh and unforgiving. With barometric pressure approaching zero, lack of a breathable atmosphere, and outside temperatures ranging from -157° C (-250° F) to 121° C (250° F) every 90 minutes during low earth orbit, the ability to live in space is highly complex. In addition, working in a micro-gravity environment is challenging, requires research, creative thinking, and a level of skill, for a crewmember to be task proficient during the free-floating effects of spaceflight. Barometrically related issues that could occur during spaceflight require special preventive measures to keep the crew safe and able to perform their mission. Dentistry, is a specialized medical field that encompasses the teeth, the temporomandibular joints, the maxillary sinuses, and the rest of the oral-facial complex. If overlooked, dental pain can completely incapacitate a crewmember, causing safety issues as well as risking mission success. Even with the most meticulous dental care and oral hygiene practices, dental emergencies can and do occur without warning. This presentation will cover some of the dental challenges faced by the space program, and give an insight to how these issues were overcome, and things to consider for future exploration class missions.

Learning Objectives:
1. Identify potential oral complications that can occur during exploration class missions.

[245] ADVANTAGES OF MAXILLARY EXPANSION: HORIZONTAL BONE AUGMENTATION TECHNIQUE

D. Robles[2], J.L. Chao[3,2] and J.L. Dominguez-Mompell[1]
[1]Oral Surgery, DL Cirugia Oral, Madrid, Spain; [2]Universidad Rey Juan Carlos, Madrid, Spain; [3]DL CIrugia ORAL, Madrid, Spain

Oral implantology procedures have improved significantly over the last few years. Patients that were compromised by significant bone loss, now have the ability to be treated with bone grafting procedures. Protocols usually consist of harvesting bone from a donor site, either in

block form or shaved particulate bone and can be placed with or without other biomaterials in a recipient site. Grafting procedures are usually associated with inflammation, edema, trismus and hematoma from both the donor as well as the recipient site. Ridge expansion or cortical split is a horizontal bone regeneration technique that allows dentists to place dental implants in the same surgical site by spreading the remnant bone without the need of a donor site. This technique reduces the healing period and morbidity

Learning Objectives:

1. To understand the possibilities of this technique and its advantages in compare to other bone augmentation techniques.

Tuesday, May 02 ***4:00 PM***
Governor's Square 10

S-005C: PANEL: BOARD REVIEW SESSION 3

Sponsored by the American Society of Aerospace Medicine Specialists

Chair: Kimberly Toone
Alexandria, VA

PANEL OVERVIEW: This panel is sponsored by American Society of Aerospace Medicine Specialists and is designed to be a review of specific board exam topics. There are three such sessions throughout the annual scientific meeting. This specific panel includes a lecture on the Pressure Effects and Physical Factors in regards to the Biosphere, on Issues regarding Air and Water Quality, and on Travel Medicine.

[025] BOARD REVIEW SESSION 3: BIOSHERE: PRESSURE EFFECTS, PHYSICAL FACTORS

N. Mahmoud
Dayton VA Medical Center, Kettering, OH

The biosphere is the global ecosystem, which includes the entire portion of Earth inhabited by life. It encompasses a wide scope including the atmosphere (air), lithosphere (earth), hydrosphere (water) and ecosphere. There is no clear cut demarcation between the geosphere and biosphere and overlap exists. The Biosphere is the least harsh environment as well as the most habitable. However in the past two decades we have become more threatened by hazards such as pollution, global warming, and radiation exposure in particular from medical diagnostic studies. The main focus of this presentation is to discuss the biosphere and the ecosystem of the Earth and its surrounding layers. It includes discussion of pressure effects and physical factors. From the aerospace perspective, it is important to clarify the differences between ecology, science and the environment in order to facilitate applications to aviation safety, as well as occupational and recreational scuba diving.

Learning Objectives:

1. Education: What you need to know about the biosphere and ecological systems theory.
2. Problem Statement: In order to provide a systematic review of the biosphere and how it impacts human physiology, aerospace medicine and human performance.
3. Applications: Development of a reference guide for aerospace medicine examinees taking either the initial or recertification exams.

[026] BOARD REVIEW SESSION 3: TRAVEL MEDICINE

A.J. Parmet[1,2]
[1]Aviation Safety & Security, University of Southern California, Kansas City, MO; [2]Community Health, University of Kansas, Kansas City, Kansas, KS

This tutorial reviews the procedure for assessing risks to international travelers, providing education, counseling, prophylactic medications and vaccinations based upon risk analysis. Use of the available tools including the Centers for Disease Control and Prevention website, Yellow Book and World Health Organization travel information. There are about 80 million international travelers from developed to undeveloped countries annually, most by air.

Learning Objectives:

1. Understand the international requirements and recommendations for infectious diseases.
2. Know the recommendations for travelers with personal health conditions such as cardiac disease, asthma and diabetes mellitus.
3 . Develop educational points for prevention of injuries and illnesses while traveling internationally.

[027] BOARD REVIEW SESSION 3: PRESSURE AND PHYSICAL EFFECTS OF THE BIOSPHERE THAT YOU NEED TO KNOW FOR AEROSPACE MEDICINE BOARD REVIEW

M. Orzech
Physician Team Strategies, Albuquerque, NM

PROBLEM STATEMENT: In order to pass the Aerospace Medicine Board Exams you need to be familiar with the pressure and physical effects of the biosphere. This presentation is in support of the Aerospace Medicine Board Review section. **TOPIC:** This presentation will be on the Biosphere and describe the pressure and physical effects. The presentation will cover the characteristics of the atmosphere, such as humidity, temperature, and density; the structure of the atmosphere: troposphere, stratosphere, mesosphere, and thermosphere. The gas laws will be presented: Boyle's Law, Charles' Law, General Gas Law, Dalton's Law and Henry's Law. Examples of the application and implication of the gas laws to aerospace medicine will be presented. The biospheric properties of the atmosphere will be described such as composition of oxygen in the atmosphere, pressure changes in the atmosphere, and space-equivalent regions. The pressure environment will be described based on physiologic zones: physiologic zone, physiologically deficient zone, the space-equivalent zone, and space. Advantages and disadvantages of pressurization will be presented.

Learning Objectives:

1. The participant will be able to understand the Gas Laws that are applicable to aerospace medicine.
2. The participant will be able to understand the biospheric properties of the atmosphere.

[028] BOARD REVIEW SESSION 3: ENVIRONMENTAL RISKS TO HEALTH: AIR AND WATER QUALITY

M. Brueggemeyer
USUHS, Bethesda, MD

PROBLEM STATEMENT: A review of Environmental Health is necessary to maintain a core competency of preventive medicine and required for continued certification. **TOPIC:** Air and water pollution are two of the top environmental risks to health and a key contributor to the global burden of disease attributable to modifiable environmental risks. This presentation will describe the global burden of disease attributable to modifiable environmental risks to health with a focus on air and water pollution. Components of ambient air pollution and the role of PM 2.5 as a known cardiovascular toxicant and independent risk factor for cardiovascular disease will be presented. Sources of indoor air pollution and its contribution to disease will be identified with a brief discussion on sick building syndrome. Sources of water pollution, standards for water quality and challenges to achieving and maintaining water quality will be presented. Finally, components of an environmental health assessment will be reviewed. **APPLICATIONS:** Understanding air and water pollution as environmental risks to health and ways to mitigate these risks are key components of preventive medicine practice. **RESOURCES:** World Health Organization. Preventing Disease Through Healthy Environments: A global assessment of the burden of disease from environmental risks. 2016. http://apps.who.int/iris/bitstream/10665/204585/1/9789241565196_eng.pdf?ua=1.

Learning Objectives:

1. Participants will be able to describe the global burden of disease attributable to modifiable environmental risks to health with a focus on air and water pollution and understand the components of an environmental health assessment.

2. Participants will be able to identify components of ambient air pollution and describe the role of PM 2.5 as a known cardiovascular toxicant and independent risk factor for cardiovascular disease.
3. Participants will be able to recognize sources of water pollution and challenges to achieving and maintaining water quality.

WEDNESDAY, May 3, 2017

Wednesday, May 03 ***8:30 AM***
Plaza A/B

S-051: PANEL: RESIDENT GRAND ROUNDS I

Sponsored by the American Society of Aerospace Medicine Specialists

Chair: Mark Coakwell
Dayton, OH

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

Wednesday, May 03 ***8:30 AM***
Plaza D/E

S-052: PANEL: ROCKY MOUNTAIN HIGH: CIVIL MEDICAL OPERATIONS IN A MOUNTAIN ENVIRONMENT

Sponsored by the American Society of Aerospace Medicine Specialists

Chair: Aaron Parmet
Keystone, CO

Chair: Allen Parmet
Kansas City, MO

PANEL OVERVIEW: Summit County Colorado is the highest county in the United States, with altitude ranging from 8,000-14,270 feet (2,440-4,450 m). Originally inhabited by Native Americans, first trappers and then miners explored and settled in the 19th centrury. The 20 century saw the change from silver and gold to snow as a source of major revenue. Today there are 30,000 permanent residents and over 3 million visiting skiers annually. There are numerous medical challenges in this unusual environment.

[246] SUMMIT COUNTY COLORADO - A UNIQUE ENVIRONMENT FOR WORK AND RECREATION

A.J. Parmet
Aviation Safety & Security, University of Southern California, Kansas City, MO

Summit County Colorado is the highest county in the United States, with altitude ranging from 8,000-14,270 feet (2,440-4,450 m). Originally inhabited by Native Americans, first trappers and then miners explored and settled in the 19th centrury. The 20th century saw the change from silver and gold to snow as a source of major revenue. Today there are 30,000 residents and over 3 million visiting skiers annually. There are numerous medical challenges in this unusual environment. This presentation will summarize the history, geography and physiologic challenges of this area.

Learning Objectives:
1. Understand the physiologic challenges of living in a high altitude/mountain environment.
2. Understand the geography and the opportunities as well as challenges of living in a high altitude/mountain environment.
3. Understand the history and environmental challenges of living in a high altitude/mountain environment.

[247] HELICOPTER OPERATIONS AND SPECIAL PROGRAMS IN A HIGH ALTITUDE ENVIRONMENT.

P.K. Werlin
Flight For Life Colorado, Georgetown, CO

Colorado was the birthplace of civilian, hospital based helicopter operations for medical purposes. Over the last 45 years, flight programs have been created and now cover nearly every area of the United States. Many programs have evolved over that period into highly specialized operations that take care of patients ranging from the smallest of premature newborns to the very complex medical patient up to and including patients on Extracorporeal Membrane Oxygenation. Mixed in with the day to day patient care challenges are the special operations missions. This presentation covers Flight For Life Colorado's package of programs designed to meet the special challenges faced in the Colorado Rockies.

Learning Objectives:
1. Summarize the challenges of helicopter operations at high altitudes.
2. Review the aspects of high risk, low frequency missions.
3. Illustrate 4 types of mission profiles practiced by Flight For Life Colorado.

[248] MOUNTAIN RESCUE IN HIGH ALTITUDE ENVIRONMENTS

B. Taylor[1,2]
[1]*Wilderness EMS, Colorado Mountain College, Breckenridge, CO;*
[2]*Summit County Search & Rescue, Frisco, CO*

PROBLEM STATEMENT: The evacuation of a subject from a high altitude environment presents rescuers with a unique set of obstacles to overcome. It is critical that medical providers and rescuers understand some of the common challenges mountain rescuers face during long, austere evacuations at high altitude. Pre-planning how to deal with these common obstacles will provide a smoother, safer evacuation. **TOPIC:** A highly trained mountain rescue team will have the combination of high situational awareness, technical training, and the right resources to provide an overall safe, timely evacuation of the injured subject. In this presentation, we will explore some solutions to common evacuation problems that are frequently encountered during high altitude evacuations. **APPLICATIONS:** All missions/expeditions should establish pre-plans, contingency plans, and evacuation plans before the start of the expedition. Training hard for the worst case scenario will help ensure a safe evacuation by having already rehearsed potential scenarios. Team members who can serve as rescue leaders should be identified prior to a missions start. These rescue leaders should brief all team members on the search and rescue plans prior to field work. **RESOURCES:** Mountain Rescue Association, National Association of Search and Rescue

Learning Objectives:
1. Participants will learn mountain rescue evacuation strategies utilized in high altitude environments.

[249] HIGH ALTITUDE MINES, HEALTH, AND CLEAN WATER: OLD PROBLEMS AND NEW CONSIDERATIONS

A.L. Parmet
Mine Emergency Response Team, Henderson Mine and MIll, Keystone, CO

PROBLEM STATEMENT: In order to understand the health hazard from high altitude mines, it is necessary to understand the