WWI, international aviation enthusiasm shifted away from military applications of the aircraft to other endeavors, including commercial, passenger, and recreational applications. Although U.S. military vision standards remained somewhat stagnant after the Armistice, the period between the war was not completely devoid of significant aeromedical developments, especially related to color vision testing. This presentation will review the standards and pertinent developments between the wars, many of which carried over from WWI into the opening phase of the next armed confrontation. Because of the tempest of war, practical aeromedical problems related to significantly increased aircraft performance and related threats necessitated renewal of vigorous aeromedical research programs which were pursued against the backdrop of mass medical population screenings in preparation for the impending larger military conflict.
Learning Objectives:
1. The participants will learn the historical context and scientific foundations of modern USAF aircrew vision standards from this period.

THURSDAY, May 4, 2017

Thursday, May 04 ***8:15 AM***
Grand Ballroom

52nd ANNUAL HARRY G. ARMSTRONG LECTURE

Kevin Fong, B.Sc., M.Sc., M.B.B.S.
"Extremes: The Fastest Century"

Thursday, May 04 ***10:00 AM***
Plaza A/B

S-079: SLIDE: VISION

Chair: Harriet Lester
New York, NY

Co-Chair: James Gaska
Wright-Patterson AFB, OH

[413] COLOUR ASSESSMENT OUTCOMES – A NEW APPROACH TO GRADING THE SEVERITY OF COLOR VISION LOSS

M. Rodriguez-Carmona and J.L. Barbur
Applied Vision Research Centre, City, University of London, London, United Kingdom

INTRODUCTION: Recent studies have shown that a significant percentage of subjects with anomalous, congenital trichromacy can perform the suprathreshold, colour-related tasks encountered in many occupations with the same accuracy as normal trichromats. In the absence of detailed, occupation-specific studies, an alternative approach is to make use of new findings and the statistical outcomes of past practices that have been considered safe to produce graded, justifiable categories of colour vision that can be enforced. **METHODS:** We analyzed traditional color assessment outcomes and measured severity of colour vision loss using the CAD test in 1363 subjects (336 normals, 705 deutan, 319 protan and 3 tritan). The severity of colour vision loss was measured in each subject and statistical, pass / fail outcomes established for each of the most commonly used, conventional colour assessment tests and protocols. **RESULTS:** The correlation between the number of Ishihara (IH) test plates subjects fail and the severity of RG colour vision loss was very poor. The 38 plate IH test has high sensitivity when no errors are allowed (i.e., only 0.71% deutans and 0.63% protans pass). Protocols based on zero errors are uncommon since 18.15% of normal trichromats fail. The most common protocols employ either the 24 or the 14 plate editions with two or less errors. These protocols pass almost all normal trichromats, but the deutans and some protans that also pass (when two or less errors are allowed) can be severely deficient. This is simply because the most challenging plates have not been included in the 24 and 14 plate editions. As a result, normals no longer fail, but the deutans and protans that pass have more severe loss of colour vision since they fail less challenging plates. The severity of colour vision loss was measured in each subject and statistical, pass/fail outcomes established for each of the most commonly used, conventional colour assessment tests and protocols. **DISCUSSION:** Historical evidence and new findings that relate severity of loss to the effective use of colour signals in a number of tasks provide the basis for a new colour grading system based on six categories. A single colour assessment test is needed to establish the applicant's Colour Vision category which can range from 'supernormal' (CV0), for the most stringent, colour-demanding tasks, to 'severe colour deficiency', when red / green colour vision is either absent or extremely weak (CV5).
Learning Objectives:
1. To learn about the statistical outcomes of the various editions of the Ishihara test
2. To understand how severity of colour vision loss can be quantified using a single test
3. To become aware of a new system (that can be enforced) based on six categories for grading severity of colour vision loss.

[414] EFFECT OF OPERATIONAL MILITARY AIRCREW VISORS ON VISUAL CONTRAST SENSITIVITY FUNCTION IN COMPARISON WITH VISUAL ACUITY

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Indian Air Force, Institute Of Aerospace Medicine, Secunderabad, India

INTRODUCTION: Maintenance of all aspects of optimum vision during all phases of flight is paramount.The available research finds contrast sensitivity (CS) correlating better to air-to-ground or ground-to-air visual tasks compared to conventional visual acuity tests. Aircrew tinted visors are supposed to maintain optimum vision in bright light and against glare while not affecting the visual perfomance adversely. Literature on the effect of visors on visual performance, especially contrast sensitivity, is scarce and conflicting. This study was conducted with an aim to evaluate the effects on visual parameters, viz. Visual Acuity and Contrast Sensitivity (CS), while viewing through different currently operational visors within IAF. The adherence of present aircrew visors to laid down recommendations and validity of these recommendations was also explored. **METHODS:** In a controlled ambient illumination, visual acuity and contrast sensitivity scores (at four spatial frequencies 3, 6, 12 & 18 cpd) were obtained for 47 visually healthy males, using 05 neutral grey tinted and 01 yellow tinted currently operational visors. Data was analysed using repeated measures ANOVA and Bonferroni's post hoc test for pair wise significance. Pearson correlation coefficient was calculated to find out the strength of linear dependence of contrast sensitivity upon luminous transmittance of the visors. Ethical clearance was granted by the institute level committee. **RESULTS:** All the neutral density grey visors significantly degraded the CS at all the frequencies tested. No significant effect on visual acuity was noted with any of the visors. Yellow visors performed significantly better than the neutral grey tinted visors in all the conditions and at all spatial frequencies. The Pearson correlation also showed strong positive dependence ($r = 0.95$) of contrast sensitivity upon luminous transmittance of the visor. The visor with least transmittance (7.02%) was found to give worst contrast sensitivity scores. **DISCUSSION:** The currently operational neutral grey visors failed to maintain optimal vision and significantly degraded contrast sensitivity function of the wearer, which is directly correlated to their tint density and in turn their luminous transmittance. Yellow tinted visors neither degraded nor enhanced the visual performance significantly. CS testing was also found to be a better metric to assess visual deterioration which might go undetected with visual acuity testing alone.
Learning Objectives:
1. Contrast sensitivity is directly dependent upon luminous transmittance of the transparencies as in aircrew visors.
2. Contrast sensitivity is a better metric to identify any vision decrement as compared to visual acuity when using visors.

[415] VALIDATION OF A TABLET-BASED WAGGONER COMPUTERIZED COLOR VISION TEST

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Ophthalmology, NAMI, Pensacola, FL

INTRODUCTION: Tablet-based Computerized color vision tests (CCVT) are very portable and practical in the military environment at sea or in clinical practice. This study was undertaken to validate the

Waggoner CCVT (WCCVT) on a Microsoft Surface Pro tablet. **METHODS:** 300 subjects at the Naval Aerospace Medical Institute had their color vision tested with the Nagel Anomaloscope, Farnsworth Lantern, pseudoisochromatic plates, WCCVT on a PC monitor, and WCCVT on a Microsoft Surface Pro 3 tablet. The PC was calibrated with a Spyder3 colorimeter, and the Surface Pro 3 utilized the factory calibrated sRGB color profile (50% brightness). Color normals were enrolled randomly, while all subjects failing the PIP during routine physical exams were asked to volunteer. Subjects were 277 male and 33 female, with ages from 18 to 59 and a mean of 23 years, and acuity meeting standard. The passing score for both WCCVT versions was a score of Normal or Mild; failing was Moderate or Severe color vision deficiency (CVD). Scores were compared between all tests. Research was approved by Naval Hospital Portsmouth IRB. **RESULTS:** 255 subjects were identified as color normal by Nagel, and 45 with red/green CVD. The tablet WCCVT classified 46 as red/green CVD, while the PC WCCVT classified 44 as red/green CVD. Plotting the results of PC vs Tablet screening section scores for CVD showed a high correlation, with slope of 0.98x, and R^2=0.93. The slope for Tablet vs PC protan scores had a slope of 1.01x, R^2 = 0.74. The slope for PC vs. Tablet deutan scores was 0.96x, R^2 = 0.89. For naval screening scores, 21 failed the PC WCCVT and 26 failed the tablet WCCVT, whereas 44 failed the PIP. The Farnsworth Lantern failed only 16 CVD subjects, allowing at least five moderate CVD subjects to pass that test. **DISCUSSION:** CVD screening and protan/deutan scores showed a high correlation between both the PC and tablet versions. The tablet graded a slightly increased severity of CVD than the PC version, and is the cause of the tablet version grading five borderline mild subjects as moderate CVD versus the PC WCCVT. The tablet version is accurate in detecting CVD by comparison to the Nagel Anomaloscope. Both WCCVT versions are better at screening mild CVD than the currently accepted Farnsworth Lantern. The tablet-based WCCVT is an acceptable alternative for computerized color vision testing and screening using the Microsoft Surface Pro 3 described in this study.

Learning Objectives:

1. The participant will be able to recall the passing grade for computerized color vision testing in Naval Aviation as either "normal" color vision or "mild" color vision deficiency. Both "moderate" and "severe" color vision deficiency are failing scores in computerized color vision testing.
2. The participant will know that there is a high correlation between the two hardware versions of the Waggoner Computerized Color Vision Test (PC and Surface Pro 3 tablet), and the Nagel anomaloscope.
3. The participant will be able to explain why the Farnsworth Lantern is a poor screening tool for aviation, due to passing moderately severe color vision persons, and why computerized color vision testing is superior in grading and screening aviation subjects.

[417] THE EMAIL TEST – MEASUREMENT OF INTEGRATED SACCADE LATENCY AND VISUAL PROCESSING TIMES WITHOUT EYE-TRACKING

J.L. Barbur[4], E. Llapashtica[1], D.M. Connolly[3], J. Sadler[2], T. Sun[5] and K. Grattan[5]

[1]Division of Optometry and Visual Science, University of London, London, United Kingdom; [2]QinetiQ, Farnborough, United Kingdom; [3]Aircrew Systems, QinetiQ plc, Farnborough, United Kingdom; [4]Applied Vision Research Centre, City, University of London, London, United Kingdom; [5]School of Mathematics, Computer Science & Engineering, University of London, London, United Kingdom

INTRODUCTION: The acquisition and processing of visual information often involve eye-movements and motor responses. Visual processing times and oculomotor parameters are of interest since fatigue as well as temporary changes in alertness caused by common drugs can also affect task completion times and overall accuracy in visual search. Eye-trackers are useful in such studies, but expensive equipment is needed and accurate measurements require careful calibration. We propose a new method to measure integrated oculomotor response parameters that is simple to carry out and does not require eye-tracking equipment. The EMAIL (Eye Movement and Intrinsic Latency) test captures parameters that describe both the time course of eye-movement generation as well as the time needed to detect and process specific object attributes at the end of each saccade. **METHODS:** The test relies on measuring the time needed to detect peripheral targets, carry out an appropriate eye-movement and process some feature of the stimulus (such as colour, coherent motion, rapid flicker, spatial orientation or acuity). In this round of experiments, the stimulus was a Landolt ring flanked by distractors and presented at a randomly selected location on either side of fixation, 8° in the periphery. The measurement variable is the target presentation time, δT, needed to achieve ~73% correct response. The subject's task is to saccade to the peripheral target, to register the gap in the central ring and to press one of four response buttons to indicate its correct orientation. Eye -tracking was added to this initial research study to separate the cortical processing time needed to detect the orientation of the gap in the Landolt ring from the integrated task completion time. **RESULTS:** The results obtained so far show a significant effect of age and fatigue. Under normal conditions, measured times are in the range 160 to 270 ms. In general, δT values are longer when vertical eye-movements are involved. The greatest changes are observed in saccade latency and the cortical processing times. **DISCUSSION:** The new EMAIL test provides a simple method to investigate how fatigue and other factors affect visual processing times. When combined with eye-tracking, the test makes it possible to measure changes in cortical processing times for specific stimulus attributes and may also turn out to be a useful tool to assess the severity of loss in traumatic brain injury studies.

Learning Objectives:

1. To learn about saccadic eye-movement latencies and visual processing times.
2. To investigate whether changes in oculomotor parameters can be used to assess fatigue.
3. To discover the extent to which saccadic latencies and visual processing times are affected by normal aging and / or fatigue.

[416] INTEGRATED SACCADE LATENCY AS A MEASURE OF FATIGUE

E. Llapashtica[1], J. Sadler[2,1], J.L. Barbur[1], D.M. Connolly[2], T. Sun[3] and K. Grattan[3]

[1]Applied Vision Research Centre, School of Heath Sciences, City, University of London, London, United Kingdom; [2]Aircrew Systems, QinetiQ plc, Farnborough, United Kingdom; [3]School of Engineering and Mathematical Sciences, City, University of London, London, United Kingdom

INTRODUCTION: High workload, long working hours, and inadequate sleep patterns can have deleterious effects on an individual's performance. Fatigue is often linked with compromised cognitive and motor function. Our information processing system becomes overloaded and unable to monitor and suppress irrelevant information. Subsequent changes in oculomotor parameters and cortical processing times may therefore provide useful biomarkers to assess one's state of fatigue. We propose a new non-invasive method to quantify fatigue by measuring Eye Movement And Intrinsic Latencies (EMAIL) without the use of any eye-tracking equipment. **METHODS:** The test is easy to perform and employs a Landolt C flanked by ring distractors. The test is presented at an eccentricity of 8°, randomly on either side of fixation point within 5° elevation. The measurement variable is the time of presentation, δT. The subject's task is to saccade to the peripheral target, register the orientation of the gap and respond by pressing one of four buttons. The EMAIL test measures the presentation time, δT, the subject needs to detect the peripheral target, generate an appropriate eye-movement, and register the orientation of the gap. **RESULTS:** The EMAIL test was used to measure the stimulus presentation times needed to achieve 73% correct responses (using a one up, two down staircase). These times were subject-specific and ranged from 165 to 200ms in the absence of fatigue. We investigated how δT is affected by exposure to other visually demanding tasks and levels of controlled fatigue. Measured integrated oculomotor responses such as latencies and visual processing times were found to increase significantly following demanding visual tasks by as much as 20ms, but only when fatigued. Preliminary findings using the EMAIL test also show that this technique can be used to investigate the effect of stimulants such as caffeine and depressants, such as alcohol. **CONCLUSIONS:** The EMAIL test provides a simple method to measure oculomotor parameters and to investigate how these are affected by fatigue. This method can be incorporated in the overall safety management system that is often needed in a number of work areas that involve visually-demanding and

safety-critical tasks. The measured parameters provide information about an individual's level of alertness and may also be of relevance in other industries in order to evaluate drugs developed to control fatigue.
Learning Objectives:
1. Understand how integrated latencies may be used to characterise a subject's level of alertness and effects of stimulants and depressants on their performance.

[418] DEVELOPMENT OF A HUMAN VISION TEST SYSTEM

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Human Systems, Naval Air Warfare Center Aircraft Division, Patuxent River, MD

PROBLEM STATEMENT: Human subject testing and component lab testing can be performed to better understand the specific optical characteristics, but a holistic method that objectively quantifies what a human can actually see through a given optical system is currently unattainable. What is covered here is a method that allows an institution to quantitatively characterize an optical system with little reliance on subjective human testing. **TOPIC:** The new methodology consists of an eye/camera system mounted inside of a head form. The Eye camera system was developed by University of California - San Diego in collaboration with DARPA and produced by Distant Focus Corp. Head mounted equipment can be mounted on the head form in the same manner in which they will be used during missions. Additionally, displays and transparencies can be placed in front of the head form on the orientation that they will be in during flight. Images can then be taken with the eye/camera system and extensive analysis can be performed. By taking an image before and after mounting any optical devices, a thorough comparison can be made of the quality of the scene viewed. Various image analysis software programs can generate quantitative data that describe the optical performance of the device(s) on a pixel by pixel basis. This analysis leads to understanding device performance and user acceptability that usually could not be obtained prior to actual use in an operational environment. The head form also enables collection of other standard optical metrics. Additionally, as the system simulates the human visual system, testing that would otherwise be dangerous for a human test subject can be conducted, such as testing laser glare. The system allows for the characterization of Transmittance, Distortion, Resolution Deterioration, Visual Acuity, Color Perception, Modular Transfer Function, Contrast, Laser Glare, and Laser Leakage of residual laser energy around Laser Eye Protection. **APPLICATIONS:** This system allows for early and fast identification of potential user issues that can be adjusted early on in a program lifecycle and reduce costly "fly/fix/fly" methods of qualification. This method can be used for any visual system, including aircraft display systems, transparencies, or head mounted equipment.
Learning Objectives:
1. The participant will learn details of a new method of characterization of visual systems that simulates human perception.

Thursday, May 04 ***10:00 AM***
Plaza D/E

S-080: SLIDE: EMERGING RESEARCH ON ACCELERATION

Chair: Patricia MacSparran
Edwards, CA

Co-Chair: Rob Monberg
North Pole, AK

[419] THE EFFECT OF +GZ DURATION ON ACCELERATION ATELECTASIS SYMPTOMS AND RELEVANT INDICES

R.D. Pollock, S.D. Gates, J. Storey and A.T. Stevenson
QinetiQ, Farnborough, United Kingdom

INTRODUCTION: Acceleration atelectasis occurs when breathing high oxygen (O_2) concentrations under +Gz combined with anti-G trouser inflation. The effects of acceleration duration on its development, using current anti-G systems, are unknown. **METHODS:** Fourteen subjects, wearing full coverage anti-G trousers and breathing 94% O_2 (6% SF_6), completed four centrifuge runs at +5Gz of various durations (15, 30, 60 or 90s). A further 90s run breathing 21% O_2 ('air') was included to confirm that inflation of anti-G trousers does not cause atelectasis. After each run a series of forced inspiratory vital capacity (FIVC) manoeuvres were performed. Functional residual capacity (FRC; multiple-breath inert gas washout), regional (basal) FIVC (electrical impedance tomography) and respiratory system compliance (Xrs; forced oscillation technique) were also measured. Pulmonary shunt was estimated from the relationship between end-tidal partial pressure of oxygen ($PetO_2$) and peripheral oxygen saturation (SpO_2) during a switch from the hyperoxic to a hypoxic (14% O_2) gas mixture. The minimum SpO_2 during this period was also recorded. **RESULTS:** Compared to baseline, FIVC was lower after the 60 and 90s runs breathing 94% O_2 ($P<0.05$) but remained unchanged after the air, 15 and 30s runs. Similar results were found for regional FIVC although this was also reduced ($P<0.05$) after the 30s run. FRC and Xrs were unchanged compared to baseline after all durations of Gz ($P>0.05$). Evidence of any pulmonary shunt was negligible after 15 and 30s runs but increased to 8.1 and 12.5% after the 60 and 90s runs breathing 94% O_2. Despite a similar $PetO_2$ the reduction in SpO_2 during hypoxia (14% O_2) was greater ($P<0.05$) following 60 and 90s runs. The performance of three FIVC manoeuvres, following the G exposure, restored overall and regional lung volume to baseline levels. **DISCUSSION:** In the majority of subjects +Gz exposures greater than 60s elicit atelectasis when breathing the highest O_2 concentration produced by on-board oxygen generation systems. The level of pulmonary shunt associated with atelectasis could negatively affect G tolerance and the severity of a hypoxic insult. Electrical impedance tomography and estimation of pulmonary shunt show promise as alternate methods to quantify atelectasis formation and its physiological consequences.
Learning Objectives:
1. Undersatnd the conditions which cause acceleration atelectasis.
2. learn about a number of techniques which can be used to assess acceleration atelectasis.

[420] LABELING DYNAMIC ACCELERATION IN AGILE FLIGHT

B. Geier[2], D. Horning[4], E. Ennis[1] and R.S. Mayes[3]
[1]711th HPW, InfoSciTex, Wright-Patterson AFB, OH; [2]711th HPW, UES, Inc, Wright-Patterson AFB, OH; [3]Department of Aeromedical Research, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; [4]NAMRU-D, Wright-Patterson AFB, OH

INTRODUCTION: In the fighter aircraft community, the physiological effects of acceleration (G) are investigated by controlled centrifuge experiments. In a centrifuge context, G exposure labels are easily defined by duration, peak G, and temporal functionality. However, a labeling is usually not possible with in-flight G exposures due to the somewhat random trajectories observed within a sortie. This exploratory data study was performed to test if in-flight G exposures can be represented by a finite set of functions or labels. Additionally, in-flight heart rate measurements were used as a pilot stress proxy to attest population discovery relevance. **METHODS:** Paired tri-axial accelerometer (taken from in-flight INTEGRITY) and heart rate measurements (taken from a NONIN helmet mounted pulse-ox) were available in 441 operational sorties, provided by the 711th Human Performance Wing Raptor Data Library. Inclusion was only limited to appropriate data sampling/quality and no restrictions were put on particular pilot, mission type or other factors. An unsupervised clustering framework was applied to acceleration trajectories to interrogate presence of finite population trends. **RESULTS:** We found that in-flight acceleration exposures can be grouped according to functional similarity. Interestingly, we found that our dynamic acceleration labeling was associated with differences in maximum heart rate. **DISCUSSION:** Physiological changes during acceleration exposure are expected. However, the interaction between accelerative forces and their functional variation are likely more predictive of pilot stress when compared to common simplification techniques such as max G. This large-scale data study is a first attempt to broadly survey in-flight agile acceleration, especially with relevance to next-generation fighters.
Learning Objectives:
1. This exploratory data study is an attempt to show, in an unsupervised fashion, the general make-up of next generation acceleration exposures, and how a generic labeling process may aid sortie interpretation or investigatory questions regarding dynamic flight profiles.

[421] FLIGHT ASSESSMENT OF FULL COVERAGE AND SKELETAL ANTI-G TROUSERS

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INTRODUCTION: Due to obsolescence of the mid-layer fabric, UK full coverage anti-G trouser (FCAGT) and 5-bladder skeletal anti-G trouser (SAGT) design has been changed to include a replacement Nomex material. Following satisfactory performance in a centrifuge assessment at 1G.s^{-1} onset rate, a flight trial was carried out comparing G protection in the new and legacy garments to determine whether the change in material properties had influenced the circulatory support afforded. **METHODS:** High G experienced aircrew (n=10) completed flights in a Hawk T Mk1 fast jet aircraft wearing new or legacy FCAGT (N-FCAGT or L-FCAGT) allocated in a balanced order. In a different series of flights, aircrew (n=10) wore new and legacy SAGT (N-SAGT and L-SAGT). Flights comprised a G warm-up, two series of high G onset (10G.s^{-1}) turns, each with incrementing plateau G up to +9Gz for FCAGT and +8Gz for SAGT, and structured air combat maneuvering. In flights using FCAGT aircrew also used pressure breathing for G protection (+4Gz cut-in providing 60mmHg at +9Gz). Rating of perceived anti-G straining exertion (RPE) after each maneuver and perceived fatigue level for the whole flight were recorded using a modified Borg Scale; +Gz acceleration, cockpit video and audio, anti-G valve outlet pressure and mask tube pressure were also recorded. A safety pilot wearing legacy equipment was aircraft captain for all flights. **RESULTS:** Plateau anti-G trouser pressure and time to 90% garment inflation were similar for N-FCAGT and L-FCAGT, and for N-SAGT and L-SAGT respectively. There was no difference in RPE between N-FCAGT (median rating (MR)=1.3, lower quartile (LQ)=0.6, upper quartile (UQ)=1.9) and L-FCAGT (MR=1.3, LQ=0.7, UQ=1.9). RPE was also no different between N-SAGT (MR=4.3, LQ=2.4, UQ=4.6) and L-SAGT (MR=3.5, LQ=2.3, UQ=4.4). RPE during air combat maneuvering and fatigue rating were also unchanged between new and legacy garments. There was a significant association between anti-G trouser type (FCAGT vs SAGT) and RPE score of moderate or above ($p<0.001$); the odds ratio suggests that pilots were 12 times more likely to rate effort at moderate or above when using SAGT compared to FCAGT. **DISCUSSION:** The change of restraining material in the G trousers did not affect the G protection provided. When comparing anti-G system properties at up to +8Gz, there was significantly less effort associated with use of FCAGT and PBG, which may have influence on mission regeneration and pilot performance.

Learning Objectives:

1. Understand the importance of flight assessment of pilot flight equipment.
2. Understand the potential advantages of using full coverage anti-G trousers and pressure breathing in the high G environment.

[422] ACUTE RESPIRATORY RESPONSES TO +GZ ACCELERATION DURING CENTRIFUGE TRAINING

S. Ilbasmis[1], E. Demir[2], N. Küçük[1] and S.H. Gunduz[2]
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INTRODUCTION: High acceleration (+Gz) affects respiratory functions and may cause some changes in lung volumes and capacities. The objective of this study was to evaluate acute respiratory responses to +Gz acceleration with pulmonary function test (PFT) right after centrifuge training. **METHODS:** 10 male healthy subjects, age range 27-32, participated in this study. Before the training, a survey including smoking habits was applied to the subjects. The centrifuge protocol they underwent consisted of gradual onset rate (GOR) profile up to 4 +Gz, 4.5 +Gz 30 sec, rapid onset rate (ROR)-warm up profile and 7 +Gz 15 sec ROR-desired profile, respectively. They completed the training uneventfully and had no complaints. Before and right after training, each subject underwent PFT. Forced vital capacity (FVC), forced expiratory volume in 1 s (FEV1), FEV1/ FVC, peak expiratory flow (PEF), forced expiratory flow between 25-75% (FEF 25-75%) and maximal voluntary ventilation (MVV) parameters were measured. Before and after training values were statistically compared. **RESULTS:** Mean age and BMI of subjects were 30.3 ±1.3 / 27.2± 2.1 respectively. 6 subjects were active smokers. Mean Pre- and post-training PFT values respectively were FVC: 5.19±0.46/5.23±0.4; FEV1: 4.12±0.46/4.23±0.51; FEV1/FVC: %79±0.6/%80±0.6; PEF: 9.44±1.09/9.91±1.43; FEF 25-75%: 4.18±1.41/4.42±1.53; MVV: 167.3±1.71/174.8±2.02. Among these, significant increase in FEF 25-75% (p= 0,004) and MVV (p= 0,013) was observed. Mean pre- and post-training FEV1 (p=0,062) and PEF (p=0.07) values were found nearly significant. Besides, significant increases in MVV (p= 0,042), FEV1/FVC (p= 0,003), PEF (p= 0,046), and FEF 25-75% (p=0,000) were observed only among active smokers. **DISCUSSION:** According to the results of this study, respiratory responses to +Gz acceleration exposure after centrifuge training was considered to maintain an improvement in respiratory functions, especially regarding small and middle airways. Surprisingly, this improvement was more significant among active smokers. In the light of these findings demonstrated in this preliminary study, we anticipate to find remarkable results by increasing the number of subjects.

Learning Objectives:

1. Evaluate the pulmonary effects of high +Gz exposure.
2. Define the relations between effects of acceleration and pulmonary function changes.

[423] CHANGES OF STROKE VOLUME, HEART RATE, AND CARDIAC OUTPUT IN OPERATING ANTI-G STRAINING MANEUVER

C. Lai, W. Chang, H. Chu and C. Cheng
Aviation Physiology Research Laboratory, Gangshan Branch of Kaohsiung Armed Force General Hospital, Kaohsiung, Taiwan

INTRODUCTION: The purpose of performing anti-G straining maneuver (AGSM) under G force is to reduce blood pooling in lower body, increase venous return to the heart, increase stroke volume and ultimately cerebral blood flow. Proper execution of AGSM can assist fighter pilots overcome high G force in flight and avoid G-force induced loss of consciousness (G-LOC) mishap. The effectiveness of AGSM is usually evaluated subjectively during high G endurance training. **AIMS:** To evaluate the cardiac performances of young adults noninvasively during AGSM in high G endurance training. **METHODS:** This was a longitudinal study design. Young male student pilots from Air Force Academy were recruited. Cardiac performance parameters of the participants, including cardiac output (CO), stroke volume (SV) and heart rate (HR), were evaluated using non-invasive instrumentation (PhysioFlow®Enduro™Manatec Biomedical, Paris, France) before and during AGSM when undergoing high G endurance training (onset rate: 0.1G/second) in human centrifuge (Latécoère, France). Data were analyzed using SPSS 20.0 software. **RESULTS AND CONCLUSIONS:** 14 young males (age, 23.9 ± 0.9 years) participated in the study. Their mean relaxed and straining G tolerances were 5.0 G and 8.2 G, respectively. The effectiveness of AGSM (G increment or gain) was 3.3 G. The ratios of SV during initial (1 to 10 seconds), midway (11-20 seconds) and final stage (21-30 seconds) of AGSM relative to resting status were 1.15, 1.00, and 1.07, respectively. The ratios of CO during initial, midway, and final stage of AGSM were 1.22, 1.11 and 1.20, respectively. The ratios of HR during initial, midway, and final stage of AGSM were 1.06, 1.11, and 1.12, respectively. When compared with G-LOC group (n=7), the ratios of SV and CO in non-G-LOC group were greater although not statistically significant. Based on our preliminary results, cardiac performance parameters can be measured in pilot trainees during human centrifuge training. These parameters increase during AGSM. We will continue our study in human centrifuge rapid-onset-rate training profiles, hopefully to provide a non-invasive measurement of AGSM effectiveness in pilot trainees.

Learning Objectives:

1. To assess the changes of cardiac performance parameters in performing AGSM in high G endurance training.
2. To examine the difference of cardiac performance parameters between GLOC and non-GLOC group.

[424] BATMAN SYNDROME: EVIDENCE OF -GZ ADAPTATION DURING INFLIGHT PHYSIOLOGIC MONITORING OF THE BLUE ANGELS

G. Rice[3,2], D.H. Snider[5], J.L. Moore[7], J. LaVan[6], R.V. Folga[4] and T.B. Van Brunt[1]
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INTRODUCTION: Few studies have evaluated physiologic responses to high acceleration forces during actual flight and to our knowledge, no normative data has been acquired by technologies such as wearable biosensors during high performance jet aircraft operations. **METHODS:** In-flight physiologic data from an FDA cleared portable tri-axial accelerometer and biosensor was observed from five active duty F-18 pilots of the Naval Flight Demonstration Squadron (Blue Angels). Of the five pilots, three were formation pilots who flew lower G profiles and two were solo pilots who flew higher G profiles. Physiologic parameters monitored were: heart rate, respiratory rate, temperature, caloric expenditure and duration of exposure to levels of acceleration. **RESULTS:** Twenty five practice demonstration flights were evaluated; nine flights were excluded secondary to incomplete or inaccurate physiological data. We observed no significant bradycardia during a total of 189 maneuvers which met inclusion criteria for Push-Pull Effect or Isolated –Gz exposures. Upon analyzing HR changes overall, we found a statistically significant increase in HR from the beginning of the Pull to the end of the Push, 106(95% CI, 100:112) to 129(95% CI, 123:135). Similarly, we found significant HR increases for isolated –Gz exposures < -1Gz, 94(86:103) to 121(107:137). Further analysis of 73 Push Pull Events revealed seven out of 24 events had decreases in heart rate for formation pilots, who had less exposure to severe Gz, whereas only one exposure resulted in heart rate decrease for solo pilots, who had more severe Gz exposure, RR 14.3(CI: 1.9-110). **DISCUSSION:** A majority of the flights monitored provided reliable physiologic data. Initial data suggests, contrary to currently held aeromedical doctrine, maneuvers such as the "Push-Pull" did not evoke vaso-vagal based bradycardic responses in seasoned aerobatic pilots. Possible explanations for these findings are sympathetic nervous system activation through adaptation, also known as Batman Syndrome. Alternative explanations for these observations may be sustained isometric resistance from Blue Angel F/A-18 modified control inputs that may overcome carotid baroreceptor stimulation during-Gz maneuvers or possibly that the Push Pull Effect does not occur during dynamic flight. Both alternative explanations are areas of further research by the Naval Aerospace Medicine Institute.

Learning Objectives:

1. Understand the physiology behind the Push Pull Effect.
2. Understand the definition of Batman Syndrome.
3. Describe possible alternative explanations to -Gz adaptation as to why no observable bradycardia has been observed with dynamic inflight physiologic monitoring amongst seasoned aerobatic pilots.

Thursday, May 04 ***10:00 AM***
Plaza F

S-081: PANEL: MARS HABITAT ANALOGS - UPDATES AND OVERVIEW

Co-Chair: Richard Cole
League City, TX

Co-Chair: Robert Zubrin
Lakewood, CO

PANEL OVERVIEW: This panel will present recent updates to and a comprehensive overview of several Martian habitat analogs and include how these confined settings can cultivate the planning and design of future Mars missions. Analogs provide a much safer and cost effective way to understand Mars operations than actual spaceflight. Analog habitats can help planners, astronauts, researchers, engineers, psychologists, and flight surgeons prepare for the unique challenges of Mars planetary missions. Many of these analogs are located in remote harsh environments in order to simulate the austere conditions of Mars. Presentations will include habitat analogs located in the desert, both poles, undersea, and NASA's Johnson Space Center. Individual habitat's equipment, technology, logistics, physical and psychological challenges are some of the topics that will be discussed.

[425] THE UTILITY OF NAVAL NUCLEAR SUBMARINES AS A LONG-DURATION SPACE MISSION ANALOGUE

J.M. Riccitello[1,2]
[1]Clinical, Aviation Medicine Advisory Service, Centennial, CO; [2]Preventive Medicine and Community Health, UTMB, Galveston, TX

MOTIVATION: Long duration spaceflight and interplanetary missions present multiple logistical, medical, physiological and psychological challenges. Given the very high expense of man-hours in space, useful knowledge regarding these issues gleaned from terrestrial experience in similar environments reduces costs. Nuclear powered submarines are one such analogue. **OVERVIEW:** Naval nuclear submarines provide a setting similar in many ways to spaceflight and future Mars expeditions. Missions last weeks to months, and the vessel must provide complete life support to the occupants. The almost complete lack of outside communication and absence of any view to the outside world produces a unique form of isolation and other psychological stressors. Of course the undersea environment does not involve zero gravity, and even variables such as radiation exposure and motion sickness are surprisingly not germane. However other factors such as isolation, crew dynamics and circadian disruption are very relevant. This presentation, given by an Aerospace Medicine physician and former submarine officer, will first provide an overview of the submarine environment via a virtual tour. Next the various factors that the submarine might simulate are presented and discussed in detail. **SIGNIFICANCE:** An understanding of the stressors submariners are exposed to and how those experiences can be applied to similar issues related to spaceflight and extraterrestrial expeditions can inform planning and countermeasures for long duration missions.

Learning Objectives:

1. The participant will be able to recall the various factors relevant to spaceflight that the submarine environment can simulate and their relative applicability.

[426] ANTARCTICA AS AN ANALOGUE FOR LONG DURATION SPACE FLIGHT

J.J. McKeith
Center for Polar Medical Operations, Uinversity of Texas Medical Branch, Galveston, TX

MOTIVATION: The Antarctic stations may serve as a reasonable analogue of LDSF when considering logistics, health screening and maintenance, and stressors. **OVERVIEW:** Antarctica is the coldest, windiest and driest environment on earth. It is difficult to access year round but the isolation is increased during the winter season. The South Pole station is effectively isolated for nine months during the Antarctica winter and may help emulate the health challenges of long duration space flight. Medical screening is designed to evaluate baseline health and to exclude knowable medical conditions that might complicate a season (Gallstone ultrasound, Exercise stress test, etc.). Logistically there is no resupply during the 9 month winter season. All pharmaceuticals, supplies and equipment necessary to treat medical conditions must be anticipated and provided prior to station closure. The pharmacy selection must cover all anticipated disease processes that medical screening cannot exclude and that would be treatable without medical backup available. Experience from longer space missions and other austere environments identify the possibility of psychological symptoms and

conditions that could impede performance, increase conflict and potentially interfere with mission success. Stressors include isolation, confinement, workload, separation from loved ones and disturbances in sleep. These conditions are difficult to study in current austere environment models. **SIGNIFICANCE:** The Antarctic winter mimics many of the conditions found in long duration space flight and as such presents an ideal testing model on earth to help us better understand the stressors and potentially provide routes of mitigation for the future.

Learning Objectives:

1. Participants will understand and evaluate the potential for the South Pole Antarctic Winter season to serve as an analogue for long duration space flight including medical screening, preparation for austere environment medical care and moderation of the stressors from isolation and the environment.

[427] WILDERNESS MEDICAL SOCIETY AT THE MARS DESERT RESEARCH STATION IN PARTNERSHIP WITH THE MARS SOCIETY

R. Cole[1,3], B. Easter[2], D. Levin[1] and J. Lemery[2]
[1]Preventive Medicine, University of Texas Medical Branch, Galveston, TX; [2]Emergency Medicine, University of Colorado School of Medicine, Aurora, CO; [3]Emergency Medicine, University of Texas at Houston Medical School, Houston, TX

MOTIVATION: Mars represents the most remote and austere environment that humans have ever contemplated exploring. To simulate the demands of living and working on Mars, The Mars Society has established an analogue Martian base, called the Mars Desert Research Station (MDRS), in the Utah desert. In partnership with the Mars Society, the Wilderness Medical Society (WMS) uses MDRS as a base of operations for exploring Mars. **OVERVIEW:** Crewmembers enter a dedicated Mars mission by living in the Mars Hab, collaborating with Mission Control, utilizing spacesuits and rovers to explore the Martian surface, learning to navigate using the stars through a dedicated observatory, and studying medical issues unique to astronauts, space flight, and life on other planets. Crewmembers function as a semi-autonomous Mars crew, and to the extent possible, simulate conditions on Mars. This means limited outside communication with Earth (no cell phone service and internet is extremely limited), eating foods that are shelf stable, wearing spacesuits when outside the MDRS Hab, and rationing consumable resources such as power, fuel, and water. While in simulation, the exact day-to-day schedule is determined autonomously by the crew. All days include didactic lessons, at least one extra-vehicular activity (EVA) to study scientific objectives, and a simulated medical scenario. **SIGNIFICANCE:** The purpose of our simulations is to study space and wilderness medicine in the context of a simulated Mars mission at the MDRS site in Utah. The artificial Martian environment exposes unique challenges and demands that need to be overcome for successful Mars missions. Selected experiences and lessons learned will be presented from the WMS's involvement at MDRS.

Learning Objectives:

1. Participants will learn why the Utah desert is a good setting for a Mars Habitat Analog.

[428] NASA'S HUMAN EXPLORATION RESEARCH ANALOG (HERA) FOR STUDYING BEHAVIORAL EFFECTS OF EXPLORATION MISSIONS

R.L. Cromwell[1] and S.H. Platts[2]
[1]Center for Space Medicine, Baylor College of Medicine, Houston, TX; [2]NASA Johnson Space Center, Houston, TX

MOTIVIATION: NASA has plans for deep space exploration that includes landing humans on Mars. Deep space travel will impose conditions of extreme isolation and confinement on the astronaut crew. Crews will need to be more autonomous in their operations, and deal with communication delays back to Earth. The ability to resupply the vehicle, or evacuate a crew member will not be possible on these missions. It is imperative that NASA study the effects of these conditions on the human being, and determine ways to mitigate any untoward consequences. The International Space Station (ISS) is an excellent platform to study for example, the effects of weightlessness on the human body. It is not however, an ideal platform to study the behavioral effects of deep space travel. On the ISS, astronauts can communicate in real time to Mission Control and to their families. Resupply and evacuation are possible. Therefore, ground-based isolation analogs are needed that simulate the conditions of deep space travel. **OVERVIEW:** In 2013, the NASA Human Research Program acquired the Human Exploration Research Analog (HERA). The HERA is used to simulate many of the conditions of deep space travel in an effort to study the behavioral effects and develop relevant countermeasures. This isolation habitat is a two-story, four-port unit with a cylindrical vertical axis that connects to a simulated airlock and hygiene module. The total space of 148 m^3 includes a sleeping loft on the second level that accommodates 4 crew members. The adjacent Mission Control Center supports crew operations 24 hours/day. Missions are designed to simulate the stressors associated with transit to Mars such as isolation, communication delays and sleep deprivation. **SIGNIFICANCE:** The HERA facility enables NASA to simulate and study the behavioral effects of deep space exploration, and develop countermeasures to mitigate untoward effects. Studies began in 2014 with 14-day mission durations and have expanded to 45-days with 3 missions per year. Study complements include participation of international partner investigations. These studies have examined topics such as crew autonomy, phased communication delays, and team cognitive processes. The ability to conduct these studies under controlled conditions using multiple missions per year will allow NASA to be prepared for the challenges that face astronauts on flights to Mars.

Learning Objectives:

1. The learner will understand the reasons for needing ground-based isolation analogs to study the behavioral effects of deep space travel.
2. The learner will understand how the NASA Human Research Program, Human Exploration Research Analog (HERA) provides the necessary infrastructure for NASA isolation studies.
3. The learner will be aware of the research topics that are studied in the NASA HERA facility.

[429] AUSTERE MEDICINE ABOVE THE ARCTIC CIRCLE: LESSONS FOR MARS

B. Easter, C. Davis, A. Bond and J. Lemery
Emergency Medicine, University of Colorado Denver, Aurora, CO

MOTIVATION: Providing medical support to Mars missions will constitute significant operational, logistical, psychological, and engineering challenges given the extreme distances and the lack of back-up systems. Terrestrial polar medicine represents one analogue for such isolated, confined, and extreme (ICE) environments. The University of Colorado Denver (UCD) Department of Emergency Medicine, in partnership with Polar Field Services, provides medical support and direction to American research teams throughout the Arctic Circle. Lessons learned can help advance the care of crewmembers during long-duration spaceflight and extraterrestrial missions. **OVERVIEW:** Medical support in the Arctic Circle defines care in austere environments. UCD's Remote Medicine Service cares for crewmembers at Summit Station, located over 10,000 feet in altitude on the Greenland ice sheet, as well as teams throughout the Arctic Circle. This responsibility includes round-the-clock telemedicine support; supply, management, and staffing of the medical clinic at Summit Station; medical supply chain operations (including medical kit selection and preparation) and logistics for all medical teams; and providing training in polar/wilderness first aid for team members. The operation supports approximately 500 crewmembers in 40 different research teams covering 25 mobile camps, including a traverse of the Greenland ice sheet, and one large fixed base. Global support is coordinated from Denver, CO. **SIGNIFICANCE:** Planning, logistical support, medical screening, remote medical support techniques, behavioral health and performance, and the remote polar environment provide insight into the medical care required for future Mars crewmembers, but also for more general aerospace, military, and civilian operations in extreme environments. The team will present experiences and lessons learned that could inform future polar and interplanetary missions.

Learning Objectives:

1. The participant will be able to describe the challenges of providing medical support in isolated, confined, and extreme (ICE) environments.
2. The participant will be able to apply lessons learned from polar medicine to the aerospace environment.

Thursday, May 04 ***10:00 AM***
Governor's Square 14

S-082: PANEL: NATO AND EACTS AVIATION CARDIOLOGY WORKING GROUPS PANEL: CARDIOVASCULAR CHALLENGES FOR THE FLIGHT SURGEON

Co-Chair: Eddie Davenport
Wright-Patterson AFB, OH

Co-Chair: Ed Nicol
Hitchin, Bedfordshire, United Kingdom

PANEL OVERVIEW: This panel will bring together leading experts from both the NATO Aviation Cardiology Working Group (HFM-251) and the European Association of Cardiothoracic Surgeons (EACTS) Aviation Medicine and Cardiothoracic Surgery Committee to discuss contemporary cardiology challenges that are faced by flight surgeons in clinical occupational practice. This session will discuss National approaches (and consensus) on common electrophysiological challenges (heart block, ventricular ectopy and Atrial Fibrillation (AF) post ablation), cardiothoracic surgery (return to flight post valve and coronary intervention) and screening for coronary artery disease in aircrew. Interactive questions are welcome as is feedback on the consensus CAD screening document that will be presented as part of the panel.

[430] THE CHALLENGE OF ASYMPTOMATIC CORONARY DISEASE IN AIRCREW; DETECTING VULNERABLE PLAQUE BEFORE THE ACCIDENT

G. Gray[8], E.D. Davenport[7], J. d'Arcy[6], N.J. Guettler[1], O. Manen[2], R. Rienks[3], T. Syburra[5] and E. Nicol[4]
[1]Internal Medicine, Bundeswehr Central Hospital, Koblenz, Germany; [2]Aeromedical Expertise, French Military Health Service Academy, Clamart, France; [3]Cardiology, Central Military and University Hospital, Putten, Netherlands; [4]Clinical Aviation Medicine Service, Centre of Aviation Medicine, Hitchin, United Kingdom; [5]Cardiac Surgery, Luzerner Kantonsspital, Luzern, Switzerland; [6]Clinical Aviation Medicine Service, Royal Air Force, Abingdon, United Kingdom; [7]USAF School of Aerospace Medicine, United States Air Force (USAF), Wright-Patterson AFB, OH; [8]Canadian Forces Environmental Medical Establishment, Canadian Armed Forces, Toronto, ON, Canada

PROBLEM STATEMENT: Coronary disease remains a leading cause of loss of trained military aircrew and loss of civilian aeromedical certification. Coronary events in both military and civilian aircrew often occur without prior symptoms, and in many, the initial presentation is sudden death. The aeromedical problem is to identify aircrew at increased risk prior to an acute coronary event, and to initiate appropriate risk factor modification to mitigate risk. **BACKGROUND:** Based on a thorough review of the pathogenesis of acute coronary events, the HFM 251 Panel has developed consensus recommendations for screening aircrew for underlying coronary disease. The recommendations are based on the observation that most acute coronary events occur as a result of the rupture of non-obstructive coronary plaque. Hence, functional screening for obstructive, flow-limiting disease (eg stress testing), which has been traditionally used, has limited utility. Anatomic imaging for plaque with CT provides better identification of individuals with significant plaque burden who are at increased risk for a coronary event. **RECOMMENDATIONS:** The consensus HFM-251 screening protocol recommends an initial screen with a population-appropriate risk equation. Individuals so identified at increased risk should undergo enhanced screening which may include carotid/femoral artery ultrasound imaging for plaque, exercise testing, and anatomic CT imaging for coronary calcium (CACS), alone or in combination with CT coronary angiography (CTCA). Based on enhanced screening, individuals identified at high risk require further assessment with functional testing for ischemia, and coronary artery luminal imaging with invasive coronary angiography or CTCA to appropriately quantify risk.

Learning Objectives:
1. Understand the mechanism of acute coronary syndrome due to plaque rupture.
2. Learn the limitations of functional testing for coronary disease screening and the advantages of anatomic screening for coronary plaque.
3. Learn an evidence-based progressive protocol for screening for coronary disease in aircrew.

[431] PREMATURE VENTRICULAR CONTRACTIONS IN AIRCREW: HOW MANY IS TOO MANY?

R. Rienks[2], N.J. Guettler[5], J. d'Arcy[7], E.D. Davenport[8], O. Manen[4], G. Gray[1], T. Syburra[6] and E. Nicol[3]
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PROBLEM STATEMENT: When screening asymptomatic aircrew the flight surgeon regularly has to face the question as to what is the significance of premature ventricular contractions (PVCs) on the rest electrocardiogram (ECG), 24 hour ambulatory (Holter) ECG or exercise stress test (EST). Single, multiple or polymorphic PVC's may carry a different prognosis depending on the presence or absence of underlying cardiac disease. Very frequent PVCs (> 20,000/24 h) may lead to deterioration of the left ventricular ejection fraction (LVEF). The aeromedical problem is to identify aircrew that are at risk of acute incapacitation due to clinically important arrhythmias. Moreover, it has to be determined if the PVCs represent a risk for cardiac events or underlying cardiac disease. **BACKGROUND:** In asymptomatic individuals, most PVCs originate from the right ventricular outflow tract (RVOT) and are due to enhanced automaticity. They have a typical appearance (left bundle branch block (LBBB), inferior axis). On 12-lead ECG, PVCs have been reported in about 0.8% of aircrew and 2.0%-7.0% of other cohorts. The definition of frequent PVCs varies widely, from >1,000 to >10,000 PVCs/24 hrs. On Holter recordings in aircrew, occasional PVCs occur in about 50% whereas frequent PVCs (defined as >10 %) occur in about 3.5%. l Literature in aircrew suggests frequent or complex PVCs do not predict sustained ventricular tachycardia or associated hemodynamic events. Frequent or complex PVCs on Holter should lead to further investigation for underlying cardiac disease. Special consideration should be given to PVCs occurring or increasing at exercise. Occurrence of ≥10% PVCs (including non-sustained VTs) during EST carries a higher cardiovascular risk, especially in the presence of signs of ischemia. **RECOMMENDATIONS:** It is recommended that in asymptomatic aircrew with an otherwise normal resting ECG, the occurrence of ≥2 PVCs on a resting ECG is followed by a 24 h Holter. Frequent PVCs (> 10%, or > 10,000/24hr) or >10 pairs of PVCs, non-sustained or sustained ventricular tachycardia, or the occurrence of 10 % or more PVCs (including nonsustained VTs) on any ECG during EST requires additional testing (at least echocardiogram, exercise test, possibly cardiac MRI or coronary CT) to exclude underlying cardiac disease. Prognosis of frequent PVCs on Holter or at EST carries a good prognosis if relevant underlying cardiac disease has been excluded. Yearly follow up is recommended.

Learning Objectives:
1. Understand the mechanism of the occurrence of PVC's.
2. Understand the aeromedical relevance of PVC's.
3. Understand the evidence-based protocol for risk assessment of PVC's in aircrew.

[432] NATO AND EACTS CARDIOLOGY WORKING GROUP PANEL: FIRST DEGREE HEART BLOCK - HOW LONG IS TOO LONG?

J. d'Arcy[7], E.D. Davenport[8], G. Gray[1], N.J. Guettler[5], O. Manen[4], E. Nicol[3], R. Rienks[2] and T. Syburra[6]
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PROBLEM STATEMENT: First degree heart block with mild prolongation of the PR interval is a common finding on electrocardiograms of fit individuals, and is widely accepted as a benign finding in isolation. However, the finding of a very prolonged PR interval, or a gradually increasing PR interval with first degree heart block, is seen less commonly and may give rise to a greater degree of uncertainty as to its significance. This paper presents the case of a pilot with pronounced first degree heart block, with a progressively increasing PR interval, and discusses how the case was approached. **BACKGROUND/LITERATURE REVIEW:** Routine screening ECGs are performed widely in the aeromedical community, and may result in findings which are considered acceptable when present in mild forms. However, the threshold for "acceptable" to become definitely abnormal is not always a clear cut off, but includes an equivocal area which gives rise to uncertainties for investigation and aeromedical disposal. Pronounced first degree heart block is one such area. **CASE PRESENTATION:** A 40-year-old single seat fast jet pilot was found to have a PR interval >300ms on routine screening. Review of his previous ECGs also demonstrated first degree heart block, with a gradually increasing PR interval. The pilot was asymptomatic, and undertook moderate levels of cardiovascular exercise, with a normal exercise tolerance and no reported symptoms suggestive of bradyarrhythmia. The finding of a progressively increasing PR interval raised concerns over possible sudden compromise, especially under the influence of negative G. In order to ensure that the pilot could be returned to unrestricted flying without unacceptable risk, full assessment was undertaken.This included exposure to positive and negative G, in both the centrifuge and the Hawk aircraft, with ECG monitoring in situ. **OPERATIONAL/CLINICAL RELEVANCE:** Although the finding of mild forms of first degree heart block is common in the aviation population, more prolonged PR intervals stray into an area of greater uncertainty. The use of appropriate imaging, monitoring and in-flight testing may be required to fully assess the individual for a return to full flying duties.

Learning Objectives:

1. Understand why first degree heart block on a routine ECG is a common finding in aviation medicine.
2. Understand the potential for significant bradycardia to affect flight safety.
3. Understand the need for a multi-parametric approach to the assessment of individuals with more marked forms of ECG abnormalities, which may be considered acceptable in their milder manifestations.

[433] COMPETITIVE FLOW IN CORONARY REVASCULARISATION AND FLIGHT CREW LICENSING REGULATIONS: WHERE IS THE PROBLEM?

T. Syburra[6,1], G. Gray[2], N.J. Guettler[5], D. Bron[1], O. Manen[4] and E. Nicol[3]
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PROBLEM STATEMENT: Flight crew licensing (FCL) regulations are binding to the aviation medicine examiner (AME). Conversely, a body of guidelines of non-binding character leads cardiac surgeons and cardiologists. FCL limit the AME in ischaemic heart disease to ground pilots at low stenotic thresholds (≥30%). Surgical guidelines recommend revascularisation for stenotic lesions >70% lumen narrowing. This applies for percutaneous coronary intervention (PCI) as well. **BACKGROUND/LITERATURE REVIEW:** European Aviation Safety Agency (EASA) regulations on coronary artery disease (CAD) are in the "Acceptable Means of Compliance and Guidance Material to Part-MED" (AMC and GM to Part-MED) issued 2011. A Class 1 Pilot is grounded if the angiogram shows ≥50% stenosis in 1 major untreated vessel including graft, ≥30% stenosis in Left Main Stem (LMS) or proximal Left Anterior descending artery, ≥30% stenosis in >1 major vessel including graft. Those figures are consistent with induction of competitive flow, which is an issue for long-term results in myocardial revascularisation. On 14 September 2016, we performed a PubMed search in all fields with the following keywords: coronary, bypass, failure, competitive, flow. The search resulted in 31 publications. We established 2008 as cut-off to provide consistency in recent data, resulting in 10 remaining publications. The threshold definitions of stenosis grades were: moderate (51-70%), severe (71-90%) and critical (91-100%) No surgical evidence supports revascularisation of stenoses <70% (<50% for the LMS) in any vessel including graft. Neither does it apply to PCI. Considering that competitive flow negatively affects graft patency, the current aviation medicine regulations seem to define unrealistic targets for myocardial revascularisation in flight crew. **RECOMMENDATIONS:** The discrepancy between aviation medicine regulations and surgical or cardiological guidelines for significant CAD needs to be addressed together by cardiac surgeons, cardiologists and AMEs. To avoid being grounded, flight crew would have to undergo procedures jeopardizing the mid- and long-term results of myocardial revascularisation, thus being exposed to redo-revascularisation at higher risk. This is not acceptable in the light of the guidelines from the European Association for Cardio-thoracic Surgery (EACTS) and from the European Society of Cardiology (ESC). There is no evidence supporting the revascularisation of low-grade stenoses.

Learning Objectives:

1. Learn the levels of significant coronary artery stenosis for revascularisation.
2. Learn the effects of competitive flow on the outcome of coronary artery bypass grafting.
3. Understand the differences between the aviation medicine regulations and the civil guidelines for ischaemic heart disease.

[434] ABLATION THERAPY IN AIRCREW

N.J. Guettler[7], R. Rienks[5], G. Gray[1], E.D. Davenport[6], O. Manen[3], J. d'Arcy[4] and E. Nicol[2]
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PROBLEM STATEMENT: Tachyarrhythmias are usually disqualifying for aircrew because of exercise intolerance, possible hemodynamic instability, or simply distraction by symptoms like tachycardia and palpitations. Further aeromedical concerns are side effects caused by antiarrhythmic drugs or thromboembolic events. Various forms of supraventricular tachycardia, atrial flutter, atrial fibrillation, and certain ventricular tachycardias can occur without aeromedically relevant underlying cardiac disease. In many of these cases, catheter ablation offers a curative treatment with the possibility to return to flying status. **TOPIC:** Catheter ablation is a method to inactivate foci of arrhythmias, accessory pathways, or to achieve conduction blocks in order to treat arrhythmias. The most frequently used energy source is radiofrequency current. But for some indications cryo or laser energy can also be used.

APPLICATIONS: Catheter ablation is the appropriate treatment of many tachyarrhythmias. Depending on the treated arrhythmia there are great differences in the complexity of the procedure, success rate, recurrence rate, and complication rate. While an AV node reentrant tachycardia or an accessory pathway can be ablated with success rates of more than 95% and very low complication and recurrence rates, an atrial fibrillation (AF) ablation, which primarily aims at the isolation of all pulmonary veins, is much more complex with lower long term success rates and the risk of recurrence even after years. Besides, there are differences in post-ablation management with a longer observation period following AF ablation and acceptable AF episodes in the so called "blanking period". The need for anticoagulation has to be evaluated. The flight surgeon should have basic knowledge about the strength of recommendation of this therapeutic option in different arrhythmias. Post ablation management and the possibility to return to flying status depend on the kind of arrhythmia, the used ablation technique, underlying cardiac diseases, the ablation success, possible difficulties or complications during ablation, and post-ablation care, which might be necessary.

Learning Objectives:

1. Learn principles of ablation techniques to treat the most important arrhythmias.
2. Understand differences in success rate, recurrence rate, and complication rate between different ablation strategies.
3. Learn principles of post-ablation management and get some decision guidance for a possible return of aircrew to flying status.

Thursday, May 04 ***10:00 AM***
Governor's Square 15

S-083: PANEL: CUTTING EDGE TECHNIQUES IN OPTIMIZING HUMAN PERFORMANCE

Co-Chair: Richard Chapleau
Wright-Patterson AFB, OH

Co-Chair: Clarise Starr
Wright-Patterson AFB, OH

PANEL OVERVIEW: The vision of the Air Force Medical Service is to ensure "our supported population is the healthiest and highest performing segment of the U.S. by 2025." In laying a path toward achieving this vision, multiple Air Force Surgeon General strategic initiatives have been undertaken encompassing better health, better care, best value, and readiness. Inherent in each of these efforts is a desire to better optimize the human performance of our Airmen as a means to promoting operator and mission success. There are many ways to achieve this multifaceted vision, including research focusing on cognition, personalized training, as well as in-depth studies to look at performance biological markers, genetics, and genomics. The purpose of this panel is to provide an educational overview of research methodologies utilized to study human performance. This panel will define current and cutting-edge research techniques, as well as provide examples of studies undertaken by the 711th Human Performance Wing that advance our understanding about our Airmen. Several research tools will be addressed including 1) external monitoring, peripheral biomarkers, wearable sensors, and behavior monitoring; 2) genome-wide association studies, epigenetic profiling, gene knockout models, and endophenotyping; 3) miRNAs as a biomarker for exposure; 4) high-content screening analysis and predictive toxicology using genetics; and 5) next-generation sequencing analyzing exomes, full-genomes, and transcriptomics. Following the overview, five 711th Human Performance Wing research studies covering each of the topics above will be presented. The panel will conclude with a question-and-answer session with a diverse group of human performance researchers.

[435] AIRMAN SENSING AND ASSESSING FOR PERSONALIZED PERFORMANCE

J. Christensen, C. Grigsby and E. Johnson
Airman Systems Directorate, Air Force Research Laboratory, Wright-Patterson AFB, OH

INTRODUCTION: This is a presentation in the panel: "Optimizing Human Performance: Cutting Edge Techniques and Studies to Improve the Individual Warfighter." **DISCUSSION:** The Airman Sensing and Assessing for Personalized Performance (ASAP) portfolio was created as a strategic response to several factors. AF personnel numbers are declining while the demands are increasing for highly skilled Airmen to perform technically challenging missions. Those demands have been translated into S&T needs from the operational Air Force, including increased resilience and enhanced performance. We have also closely followed the growth trend in personalized medicine, health, and performance, as captured in our high-level S&T vision; this development presents an outstanding opportunity to meet the needs of our Airmen. Work in this portfolio also directly supports the DoD Third Offset strategy – enhancing human performance via improved human assessment technology supports better decision making and effective human-machine teaming. Within the ASAP portfolio, there are two primary focus areas. One directly addresses the mobile individual assessment needs of our special duty airmen, who experience heavy physical demands in addition to cognitive. This drives our interest in assessing metrics related to physical performance capability, such as hydration, muscle fatigue, heat stress, and oxygenation. The environment also places limits on the types of sensors we can use; devices should be gear-integrated, highly reliable, tolerant of environmental extremes, and capable of extended operation on internal power. The other primary focus area for ASAP is what we can broadly term workstation operations – this includes intelligence, surveillance, reconnaissance, cyber, and remote piloting applications that all involve cognitively demanding, fatiguing work with increasingly automated systems. In this environment, sensors and assessment must integrate into workstations and provide improved awareness of operator state as part of the overall human-machine team. This presentation will provide an overview of research techniques involving external monitoring, peripheral biomarkers, wearable sensors, and behavior monitoring and challenges that must be addressed to meet DoD and USAF need with these approaches.

Learning Objectives:

1. Understand the state of the art in wearable monitoring, opportunities, and limitations from a USAF perspective.

[436] MICRORNA BIOMARKER DISCOVERY USING IN VIVO INHALATION EXPOSURES TO SAND AND/OR BURN PIT EMISSIONS

C.A. Mauzy[1], J. Frey[1], K. Henderson[1] and B. Wong[2]
[1]711 HPW/RHDJ, Air Force Research Laboratory, Wright-Patterson AFB, OH; [42]Naval Research Unit-Dayton, Wright-Patterson AFB, OH

INTRODUCTION: In 2011, the Department of Veterans Affairs commissioned the Institute of Medicine (IOM) to study the human health risks from particulate matter exposure in Iraq and Afghanistan, with a focus on exposures from burn pits. The IOM report concluded that there was evidence suggestive of an association between exposure to combustion products and reduced pulmonary function, and suggested that personal biomonitoring via biomarkers may aid in evaluating exposures. We hypothesize that upon exposures to burn pit emissions, sand, or a combination of the two, specific microRNA (miRNA) expression signatures occur in lung tissue, and that a subset of these specific expression patterns are reflected in blood. These specific blood miRNAs could be used as biomarkers of effect from airborne hazard exposures. **METHODS:** Male Sprague Dawley rats were exposed to clean air (control), Afghan sand dust (PM 2.5), burn pit emissions (BME), or a combination of PM 2.5/BME administered in whole body inhalation chambers. Total RNA was isolated post-exposure (4 days and 90 days) from lung and blood. MicroRNA changes were identified using Affymetrix GeneChip 3.0 miRNA arrays, and resultant data analyzed using Expression Console and Transcriptome Analysis software (Affymetrix). Specific miRNA species were examined using RT-qPCR and quantitated using the comparative ΔΔCT method. **RESULTS:** In both BME and Sand + BME exposures, expression of two exposure-specific miRNAs was significantly decreased in lung tissue also altered in 4 day post-exposure blood samples. However, these expression changes were not found at 90 day post-exposure blood samples. In sand exposures, no differentially expressed miRNAs were detected in either 4 day post -exposure lung or blood samples. However, one significantly decreased miRNA was identified in lung that was also reflected in blood at

90 days post-exposure. To further explore the biological significance of these molecular changes, pathway analyses were conducted using the Ingenuity Pathway Analysis software (Qiagen) and multiple pathways were determined to be affected. **DISCUSSION:** These data have identified potential biomarkers to airborne inhalation hazards, as well as specific species indicative of emissions exposure type. In addition, the results of this study provide novel insight into the molecular mechanisms of burn pit/sand inhalation toxicology using a realistic mixtures exposure. (In compliance with DODI 3216.01).

Learning Objectives:

1. Understand what are microRNAs are and their utility as biomarkers for exposure to toxins and airborne hazards.

[437] MEASURING PHENOTYPIC VARIATION IN PHYSIOLOGICAL RESPONSE TO CHEMICAL SUBSTANCES THROUGH COMPARATIVE GENETICS

P. McLendon[2], S. Kawamoto[2], H. Pangburn[1], H. Fullenkamp[2], R. Migliozzi[2], S.D. Huff[1], D.K. Ott[1] and T.J. Lamkin[1]
[1]AFRL, Wright-Patterson AFB, OH; [2]UES, Inc., Dayton, OH

PROBLEM STATEMENT: Protecting the health of military operators involves developing countermeasures to illness, injury, or exposure to foreign substances encountered in harsh, varied environments. Complicating these efforts is the unknown effects of an individual's genetic profile on his/her response to a chemical agent. Understanding how genetics influences physiological responses to chemical exposure is critical for advancing personalized medicine and the Air Force's Total Exposure Health. **TOPIC:** To understand how genetic factors affect exposure risk and treatment, new avenues are needed to measure cellular profiles in response to hazards. Genome-wide association (GWA) studies can illuminate how genetics can influence this risk by comparing cellular responses. High-content analysis (HCA) is a powerful method for answering complex biological questions using high-resolution cellular imaging. Using HCA to measure GWA data can provide rich information on exactly how genetics influences the biological response to a stimulus, thus providing unparalleled power for data mining to assess cellular changes at the morphological level. **APPLICATIONS:** Advancing personalized medicine initiatives requires defining how specific genetic factors influence a biological response. To advance this area, we will use genetically characterized human cell lines (B-lymphoblasts; LCLs) treated with different chemical compounds over a wide concentration range to assess cell viability in living cells. For data analysis, we developed an automated pipeline, Clarity Bioanalytics, for high-content image analysis. Clarity Bioanalytics will quantitatively measure and score 11,000 distinct morphological features per cell to define cellular phenotypic signatures for each chemical toxicant. Using GWA and pathway analyses, we can correlate aberrant response profiles for each compound with available genetic data. Studies to cluster the chemically induced HCA signatures of each LCL are currently underway to identify LCLs that are hypersensitive (or resistant) to each compound. These data will allow robust assessment of predictive toxicology: measuring drug effects based on known genetic profiles. This analytical platform has broad applicability toward precision risk assessment to a wide range of potential exposure hazards. These tools will be invaluable in assessing personalized biological effects of chemical exposure, a critical step toward applying Total Exposure Health to personalized medicine.

Learning Objectives:

1. Our learning objective is to have participants understand the capabilities that USAFSAM has in the area of precision medicine/total exposure health.

[438] GENETIC CONTRIBUTIONS TO WARFIGHTER PERFORMANCE

R.R. Chapleau
Aeromedical Research Department, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH

PROBLEM STATEMENT: Optimizing warfighter performance through education, nutrition, and training is a question not only of proper understanding of human anatomy and biomechanics, but also one of personalization and customization. Every individual has a unique combination of genetics, cultural background, nutritional history, and physical training. As a Total Force, new accessions are generally considered to be physically fit, and one of the primary functions of basic military education and initial technical skills training is to increase that fitness to provide mission-ready warfighters. Unfortunately, some of the best candidates for high-risk, specialized career fields fail training late in the pipeline. One approach to reducing the attrition rate is through personalized nutrition, training, and education. **TOPIC:** The 711th Human Performance Wing (711 HPW) uses various methods to identify genetic contributions of nature and nurture indicating success in specialized career fields. We use whole exome sequencing to obtain the information each warfighter was born with and identify unique markers indicative of successful trainees. In our epigenetic studies, we evaluate the impact of environment and upbringing on a warfighter's genome. Through comparative transcriptomics we can determine how these nature and nurture conditions influence a warfighter's ability to perform through comparative transcriptomics. **APPLICATIONS:** We gain the best use of next-generation sequencing technology for optimizing warfighter performance through teaming with personalized training and nutrition. The 711 HPW currently has teams developing functionalized training methods for several career fields and also investigating the effects of nutritional supplements on physical training markers. These topics are also discussed in the Techniques and Future Research Directions for Human Performance Studies panel.

Learning Objectives:

1. Understand the various uses of next-generation sequencing.
2. Identify applications and uses of next-generation sequencing in human performance optimization.
3. Understand the interrelationships between sequencing and individualized physical training.

[439] SYNERGISTIC INTERACTIONS OF NEUROPROTECTIVE AND NEUROTROPHIC FACTORS AGAINST ADVERSE EFFECTS OF SLEEP DEPRIVATION

A. Soto
RHDJ, 711HPW, Wright-Patterson AFB, OH

Sleep deprivation is one of the most common stressors that Airman faces during military operations. Exposure to this stressor results in diminished performance and increased risk of making mistakes, especially under critical and demanding conditions. Investigations have suggested that the damaging effect that sleep deprivation has in the brain is likely caused by decreased antioxidant defense, consequently resulting in an accumulation of reactive oxidant species, dysregulation of the endoplasmic reticulum (ER) molecular chaperones and increased neuronal cell death. During the first phase of this investigation (i.e. the baseline), we exposed animals to sleep deprivation and subsequently performed biochemical measurements using serum and tissues isolated from various regions of the brain to assess the damaging effects of acute sleep deprivation. In addition, immunohistochemistry techniques were also used to measure neuronal cell death, apoptosis and formation of new immature neurons. We also performed gene expression analysis in six brain regions including frontal lobe, cerebellum, hippocampus, parietal cortex, thalamus and brain stem to evaluate ER chaperone functions after sleep deprivation conditions. Overall, analysis of the data of the baseline experiment demonstrated a significant ($p \leq 0.01$) increased in serum corticosterone level when compared to wide platform control and cage control groups. In addition, an increase in oxidative stress markers, reduced activity in antioxidant defense and changes in the gene expression of ER chaperones was also observed. In the second phase of the study, the protective effect of an 8-aimo-acid peptide derived from activity dependent neuroprotective protein (ADNP-8) and that of a 11-aimo-acid peptide derived from ciliary neurotrophic factor (CNTF-11) against the damaging effects sleep deprivation were tested. Our results demonstrated that peptide treatments reversed the sleep-deprivation-induced increase in serum corticosterone. In addition, treatment with ADNP-8 or CNTF-11 restored glutathione peroxidase activity in frontal lobe. Furthermore, immunohistochemistry analysis performed in hippocampal slices demonstrated that peptide treatment decreased neuronal cell death and increase hippocampal neurogenesis. Finally, peptide treatments restored gene expression of the ER chaperones in the brain regions studied.

Learning Objectives:

1. Identify sleep stressors that affect our Airman.
2. Identify markers to help identify oxidative stress.
3. Learn about mitigation procedures for oxidative stress.

Thursday, May 04 ***10:00 AM***
Governor's Square 12

S-084: PANEL: ETHICAL DILEMMAS IN AEROSPACE MEDICINE

Co-Chair: Jeffrey Jones
Houston, TX

Co-Chair: Allen Parmet
Frisco, CO

[440] PANEL OVERVIEW: ETHICAL DILEMMAS IN AEROSPACE MEDICINE - A PANEL DISCUSSION

J.A. Jones[2,8], B.K. Bohnker[3], G.W. McCarthy[1], P. Illig[9], N. Johnson[5], E.M. Ricaurte[4], K. Ruskin[7] and A.J. Parmet[6]
[1]AvMedSafe, Portland, OR; [2]Center for Space Medicine, Baylor College of Medicine, Houston, TX; [3]COMBI, Clearwater, FL; [4]VENESCO, LLC in support of Aerospace Medical Research Division, FAA Civil Aerospace Medical Inst/CND, Oklahoma City, OK; [5]USAFR, Retired, Austin, TX; [6]Aviation Safety & Security, University of Southern California, Kansas City, MO; [7]Anesthesia and Crit Care, University of Chicago, Chicago, IL; [8]U.S. Navy Reserves, Department of Defense, Fort Worth, TX; [9]Aviation Medical Service of AK, Anchorage, AK

The flight surgeon, aviation medical examiner and affiliated aerospace medicine providers face many challenging and often daunting ethical dilemmas over the course of their clinical practice careers. It is important for practitioners of aerospace medicine to recognize when these situations arise, and to be prepared to handle them in a compassionate and diplomatically appropriate manner, while maintaining the highest ethical standards of the Aerospace Medical Association and other governing bodies, such as the American Medical Association and the aeromedical organizations within the DOD, FAA, NASA, NTSB, ICAO, etc. This panel will review several case studies which pose potential ethical conundrums, and discuss the various potential actions and responses of both, the aerospace medicine practitioner, and the airman/ pilot. The panelists will be asked to argue for or against potential actions, and weight the merits, the pitfalls and the possibleconsequences of each. After participation, the attendee of the session should be better able to understand the ramifications of actions associated with many ethical challenges, and to have enhanced preparation via methods to address several types of cases they may encounter.

Learning Objectives:

1. To recognize when an airman's actions place the aeromedicine practitioner in an ethical dilemma.
2. Understand possible responses to ethical challenges and what impact they could have on the practitioner's relationship with the airman and with governing organizations.
3. Provide resources to assist the aeromedical practitioner in tackling ethical challenges.

Thursday, May 04 ***10:00 AM***
Governor's Square 11

S-085: SLIDE: FROM THE NECK UP

Chair: Charles Reese
Pensacola, FL

Chair: Tracy Bozung
Oakwood, OH

[441] HOW OLD IS TOO OLD FOR A MILITARY PILOT?

A.C. Timperley[2] and T. Greenish[1]
[1]RAF Medical Board, RAF, Henlow, United Kingdom; [2]Centre of Aviation Medicine, Royal Air Force, Bedfordshire, United Kingdom

PROBLEM STATEMENT: No internationally agreed upper age limit exists for military pilots, unlike in commercial aviation. Direct read across of civilian standards may not be appropriate as the risks are different. **TOPIC:** Historically, as health, life-expectancy and flight safety have improved the maximum permissible age for commercial pilots has increased. In 1919 the International Commission of Air Navigation set the upper age limit to just 45 years of age. In 1972 the International Civil Aviation Organisation introduced an increased age limit of 60 years, which was subsequently increased to 65 years in 2006. Under UK Military Aviation Authority regulations there is no upper age limit for flying; pilots are permitted to fly solo until age 65 years after which they can only continue to fly with a second pilot, who must be under 65 years of age. This would appear to be less stringent than for civilian commercial pilots regulated by the UK Civil Aviation Authority. Military pilots may be exposed to additional stressors not present in their civilian colleagues, including sustained acceleration, thermal stress, and factors related to the military operational environment. A variety of approaches can be taken to mitigate against age-related cardiovascular mortality in this group. Enhanced cardiac screening including regular resting and exercise electrocardiography may provide additional assurance, but caution should be applied when using all-cause mortality data. The Royal Air Force's (RAF) approach to age related-risk will be discussed. **APPLICATIONS:** Individual risk assessment is the RAF's current method for determining the fitness to fly of pilots over the age of 65 years; however, in the absence of a risk calculator specifically for military aircrew, setting an upper age limit may be an alternative pragmatic approach.

Learning Objectives:

1. The objectives of this session are to consider the scientific basis for an age limit to military flying and the usefulness of available morbidity and mortality data in deciding whether a military pilot is fit to fly or not.

[442] VARIABILITY IN GUIDELINES REGARDING AIRCREW FITNESS TO FLY AFTER TRAUMATIC BRAIN INJURY

J. Risdall (posthumously)[3] and E. Boudreau[1,2]
[1]Department of Neurology, Oregon Health & Science University, Portland, OR; [2]Mental Health & Neurosciences, VA Portland Health Care System, Portland, OR; [3]Royal Centre for Defence Medicine, Cambridge, UK, Birmingham, United Kingdom

INTRODUCTION: Traumatic brain injury (TBI) is a common cause of neurological disability and can adversely impact functioning in individuals working in the aerospace environment. Common symptoms include problems with attention, memory and alertness and there is an increased risk of sudden incapacitation from seizures. Consequently, aircrew are deemed unfit to fly for a period after TBI. There is little/no evidence in the aeromedical literature guiding fitness to resume flying after TBI, so most advice is based on the general medical literature. We compared the U.S. and UK civilian and military guidelines for the classification and evaluation of TBI. Our hypothesis was that there was a lack of standardization with regard to TBI definitions, requirements for evaluation, and time elapsed before aircrew were found fit to resume flying. **METHODS:** The latest TBI guidelines from the UK military, UK CAA, U.S. FAA, U.S. Army, U.S. Navy, U.S. Air Force were reviewed and tabulated for comparison. **RESULTS:** All the guidelines used duration of loss of consciousness (LOC) to help classify TBI severity and all produced a minimum of three severities (mild, moderate, and severe). Mild TBI: LOC: 5 min - >1 hour; disposition: grounded 1-6 months. Moderate TBI: LOC: <15 minutes - <24 hours (very variable); disposition: grounded 3-12 months. Severe TBI: LOC: >2 hours - >24 hours; disposition: grounded 2 years - permanent disqualification. All guidelines required cranial CT or MRI for moderate and severe TBI, with some including imaging in mild TBI, if available. **DISCUSSION:** The classification of TBI severity, guidelines for evaluation, and time to return to flight fitness were variable. Although most guidelines had imaging as the mainstay of evaluation, there was variability in the application of imaging criteria. When significant neurocognitive deficits were present, there was a requirement for neuropsychological testing. There was no consistency in the use of other test modalities, including electroencephalography. Only the UK guidelines recommended a measure of performance (simulator evaluation) as part of the evaluation for fitness to return to duty.

Learning Objectives:
1. Understand the variability in return to flight fitness after TBI, and the range of different requirements across civilian and military services in the UK and US.

[443] COCHLEAR IMPLANTS IN PILOTS

D.G. Schall
Great Lakes Regional Office, FAA, Des Plaines, IL

Many deaf children and older adults are currently being remediated with cochlear implant technology. Applicants as well as pilots are now entering the workforce with these devices. Most individuals with cochlear implants have been able to achieve normal communication skills. The technology, while effective, is complex. Understanding cochlear implant devices, their application and limitations is critical to making aeromedical dispositions for these airmen. Cochlear implant devices will be reviewed as well as the FAA experience in evaluating applicants and pilots who have cochlear implants. This information will be useful to Aviation Medical Examiners and other professionals who evaluate applicants for aviation careers and who are using or considering using cochlear implant technology.
Learning Objectives:
1. Understand how Cochlear Implants work.
2. Understand who can be helped with Cochlear Implant Technology.
3. Understand how Cochlear Implants interface in the Cockpit Environment.

[444] PROCESS FOR DIGITAL CAPTURE OF EAR CANAL GEOMETRY AND RATIONAL FOR USE OF CUSTOM EARPLUGS

K. Semrud
Naval Air Warfare Center Aircraft Division, Patuxent River, MD

MOTIVATION: In the 150dB flight deck environment, personnel are at risk of noise overexposure even if hearing protection is worn perfectly. A 2006 study showed personnel typically do not insert foam earplugs correctly, resulting in low attenuation and high hearing damage risk (Bjorn, 2006). It is thought that custom earplugs provide better real-world attenuation than universal fit earplugs because they conform to the ear and are easier to insert correctly (Tufts et al., 2012). The legacy method to produce custom earplugs has a large logistics footprint and requires an invasive silicone impression procedure that carries a risk of ear injury, such as impression material bonding with the eardrum and ear canal scratches. A digital ear scanning method used in civilian audiology clinics has generated interest within the fleet and military medical community, but has not been validated for hearing protection. As a replacement for the legacy method, the scanner reduces the logistics of fielding custom earplugs. **OVERVIEW:** To compare real world attenuation provided by foam and custom earplugs, the fit-to-fit variability of each earplug type was evaluated by measuring the Personal Attenuation Rating for each fit. Twenty subjects completed five fits of each type of earplug. Standard deviations of the foam fits were compared to custom fits for the same subject. The data presented the expected result of foam earplugs having more fit-to-fit variability than custom earplugs and less consistent attenuation. The digital scanning method validation involved comparing custom earplugs made from both digital scans and legacy silicon ear impressions. Both sets of earplugs underwent attenuation testing using 20 subjects in accordance with ANSI S12.6. The mean attenuation values for each earplug type are comparable indicating no significant difference in attenuation between the two techniques. **SIGNIFICANCE:** Custom earplugs are used throughout the DoD for hearing protection and in-ear communications systems. The reduced logistical footprint of the digital scanning capability along with the proven increase in real-world attenuation using custom earplugs can provide justification for fielding custom earplugs. In addition, the digital scanning method will reduce the risk of discomfort or injury associated with silicone impressions. The scans can also be analyzed over a wide population to support earplug capability improvement efforts through the addition of technologies (i.e., biosensors).
Learning Objectives:
1. Understand the benefits of using a new digital ear canal capturing technique over the traditional silicone impression technique for producing custom molded earplugs.

[445] COLOUR DEFICIENCY TESTING IN AN ASIAN AND MULTI-RACIAL POPULATION - THE REPUBLIC OF SINGAPORE AIR FORCE EXPERIENCE

G. Kang, Z. Tan, J. Low and B. Tan
Republic of Singapore Air Force Aeromedical Centre, Singapore, Singapore

INTRODUCTION: The use of colour and multi-functional displays in aircraft cockpits to display information has placed an increased emphasis on the accurate detection of colour vision deficiencies among aircrew in both the military and commercial aviation environment. While there is existing literature describing the performance of new generation colour vision tests, such as the Cone Contrast Test (CCT) in the Caucasian population, there is currently a lack of data for the Asian population. Singapore, with a multi-racial and multi-cultural population, also presents the unique opportunity to study if there are racial differences in their response to the new generation colour vision tests. **METHODS:** Since Aug 16, the Republic of Singapore Air Force transited from the use of Ishihara pseudo-isochromatic plates and Edridge Lantern Test to the CCT for the colour vision testing and screening of its aircrew and flying-related vocationalists. The CCT results for aircrew applicants and trained aircrew were obtained retrospectively for Aug and Sep 16. Additional results obtained since Oct 16 are still undergoing collation and analysis. **RESULTS:** As of 30 Sep 16, a total of 326 aircrew applicants and 215 trained aircrew and flying-related vocationalists have been evaluated with the CCT, with 7 aircrew applicants and 3 trained personnel diagnosed with colour vision deficiencies by the CCT. This represents a preliminary colour deficiency incidence rate of 1.4% for trained personnel and 2.17% for aircrew applicants. The study population included personnel of Chinese, Indian, Malay and Eurasian ethnicities, and spanned the ages of between 17–55 years old. **DISCUSSION:** The CCT is a relatively new modality of computer-based colour vision testing and this study aims to present initial data obtained regarding its use in a predominantly Asian and multi-racial population. Further analysis will be performed to see if there are any differences in CCT scores between ethnicities. In addition, with Singapore having one of the highest rates of myopia in the world, further analysis was performed to evaluate if myopia, in particular high myopia, had any effect on CCT scores. Management of trained aircrew who are diagnosed with colour vision deficiencies using CCT will also be discussed.
Learning Objectives:
1. To present initial data regarding the performance of next generation computer-based colour vision testing in a predominantly Asian population and whether there are any differences between ethnicities.
2. To observe the correlation between next generation colour vision testing and high myopia.
3. To discuss the management of trained aircrew diagnosed with colour deficiency on CCT.

[446] A COMPARISON OF COMPUTER-BASED COLOR VISION TESTS

J.K. Hovis[2], A. Almustanyir[2] and M.G. Glaholt[1]
[1]Human Systems Integration, Defence Research and Development Canada, Toronto, ON, Canada; [2]School of Optometry and Vision Science, University of Waterloo, Waterloo, ON, Canada

INTRODUCTION: Computer-based color vision tests are increasingly common in aviation medicine. These tests can screen for color vision defects or estimate the severity of the defect by measuring saturation thresholds. Although several of these tests have been compared with traditional clinical tests, few studies have directly compared their accuracy and efficiency. **METHODS:** We compared the Landolt C from the Automated Vision Test Collection, Cambridge TriVector (CTV), Cone Contrast (CCT), ColorDx and Color Assessment and Diagnosis (CAD). Sixty individuals with normal color vision and 40 subjects with red-green color vision deficiencies participated. The Rayleigh color match was used to classify the subjects' color vision. The screening and threshold components were performed by each subject on the CAD, Landolt C and ColorDx. The CTV and CCT only estimate saturation thresholds. With the exception of the CAD threshold component, the tests were performed monocularly. The protocol was

approved by a University of Waterloo Research Ethics Committee. **RESULTS:** Averaged across eye and color discrimination axes, the specificities for the CAD and Landolt C screening were 0.65 and 0.90, respectively. The specificities of the other tests were greater than 0.95. For diagnosis based on thresholds, the specificity of both the CAD and Landolt C improved to 0.93. Sensitivities for the tests ranged from 0.93 to 1.0, with the CCT having the lowest value and the CAD the highest. Up to 25% of the subjects with red-green defects failed both the red-green and tritan screening portions of the CAD and Landolt C. This number decreased to 3% based on thresholds for both tests and this small number of tritan failures in the color-defective group was similar to results obtained on the other tests. **CONCLUSIONS:** The CAD offers several criteria to use for screening, and we used the most stringent one. Our results show that this screening criterion may not be efficient if seeking to minimize threshold testing. The Landolt C screening criterion could also be adjusted to minimize threshold testing. If one considers only the threshold results from these two tests, then all the computer-based tests had similar specificities and sensitivities to each other.

Learning Objectives:

1. Compare the sensitivity and specificity of computer based color vision tests.
2. Understand how each computer based color vision test works.

Thursday, May 04 ***10:00 AM***
Exhibit Hall

S-086: POSTER: SPACE MEDICINE AND OTHER AEROMEDICAL INTERESTS

Co-Chair: Mary Brueggemeyer
Bethesda, MD

Co-Chair: Ted Duchesne
Houston, TX

[447] AIR MEDICAL TRANSPORTATION OF THE TRAUMA PATIENT IN CARDIAC ARREST

E.F. Urquieta[1] and J. Varon[1,2]
[1]DMA, Houston, TX; [2]UTMB, GALVESTON, TX

Air transportation of trauma patients in cardiac arrest is still a controversial topic. We report the first series of a Latin American trauma population. A 13-year retrospective records review was performed and demographic data was collected. The objective of this study was to determine survival rates of trauma patients that suffered a cardiac arrest while being transported by helicopter. During the study period, the Mexico City Police Department Helicopter Emergency Medical Services (HEMS) transported 305 trauma patients that required cardiopulmonary resuscitation (CPR). The average time from the initiation of CPR to the arrival at the trauma center was 37.5 minutes. The initial electrocardiogram (EKG) rhythm at the time of arrival of the aeromedical transport team showed pulseless electrical activity in 121 patients (39.6%), asystole in 126 (41.3%), ventricular fibrillation or pulseless ventricular tachycardia in 55 (18%), and bradycardia in 3 (1.1%). Patients that were discharged were compared to those who expired. There was no statistically significant difference when age was compared (p=0.324). X^2 analysis did not show any significant difference between mechanism of injury and survival (p=0.786). When comparing the time between the initiation of CPR, to the arrival at the trauma center with survival no significant difference was observed (p=0.591). The number of patients who required CPR, and the survival rate of 2.7% is comparable with similar studies in the United States. Survival rates of trauma patients in cardiac arrest seems to be negligible, and for a service area similar to the one presented in this study, the use of a helicopter does not seem to be justified. Helicopter transport resources are very limited and the patient with the highest survival chances must be the beneficiary.

Learning Objectives:

1. The participant will be able to understand the factors involved in survival rates for trauma patients requiring CPR transported by helicopter.

[448] THE RESEARCH AIRCRAFT OF THE GERMAN ACADEMY FOR AVIATION AND TRAVEL MEDICINE: FIRST INFLIGHT MEASUREMENTS

A. Gens[1], C. Gammel[1], U. Stüben[2] and C. Ledderhos[2]
[1]German Air Force Center of Aerospace Medicine, Fuerstenfeldbruck, Germany; [2]German Academy For Aviation And Travel Medicine, Friedrichsdorf, Germany

INTRODUCTION: In 2013 the German Academy for Aviation and Travel Medicine purchased a research aircraft (ASH 30 Mi) produced by SCHLEICHER. The intention was to ameliorate the training process of aeromedical examiners and to promote aeromedical research. The medical monitoring system purposely designed for the special conditions of the ASH 30 by the Karlsruhe Institute of Technology enables simultaneous recording of both flight and physiological data. After completion of the necessary adjustments, first inflight measurements started in October 2014. **METHODS:** Firstly, it was to verify whether the methods used are also suited to produce feasible inflight results regarding vital data such as heart rate (HR), heart rate variability and respiratory rate. Secondly, recorded data were attributed to various flight phases (takeoff, normal flight, landing), but also to flight duration and altitude. **RESULTS:** Altogether 29 flights across Germany (10), France (8) and Namibia (11) with a total of 110 flight hours could be analyzed. 12 out of 29 flights were longer than 5 hours, 7 flights were shorter than 1 hour. The average altitude exceeded 3000 m in 12 flights; it was below 1000 m in two flights. Mean HR for all flights was 90.19 $\pm$ 12.98 bpm (max. 153 bpm, min. 56 bpm); the highest values were reached during takeoff (99.3 $\pm$ 16.31 bpm). During normal flight, HR decreased significantly (89.0 $\pm$ 12.81 bpm) and increased again during the landing phase (90.67 $\pm$ 14.20 bpm). The respiratory rate behaved similarly. Inflight LF/HF ratios were higher than the standard values derived from literature indicating an increased sympathetic tone in pilots. In contrast, the root mean square of successive differences (RMSSD) tended to rise with increasing flight duration, arguing for an incremental parasympathetic influence. In flights above 3000 m (n = 12) HR was significantly lower than in flights below 1500 m (n = 6). This was likely due to the decelerating (bradycardic) action resulting from oxygen supplementation in high-altitude flights. **DISCUSSION:** In conclusion, the measuring technique proved to be user-friendly and easy to operate. Even during long flights there were only a few artIfacts.

Learning Objectives:

1. Special features of inflight measurements.

[449] PERFORMANCE CRITERIA CONSIDERATIONS FOR TRANSPORT AIRCRAFT PASSENGER OXYGEN TECHNOLOGIES

R.P. Garner[1,2]
[1]CAHM, Oklahoma State University, Wichita, KS; [2]Odyssey II Solutions, Wichita, KS

INTRODUCTION: Passenger oxygen will remain an integral component of transport aviation for the foreseeable future. The implementation of recent technical approaches to improve passenger oxygen delivery efficiency during and after a decompression are often not directly interpretable within the context of regulations. Specifically, the historic approach of developing flow profiles to achieve tracheal oxygen pressures do not necessarily correlate with other approaches that clearly provide sufficient oxygenation at altitude. The applicability of new approaches needs to be better understood by many in terms of the physiological demands and how they are met in terms of the anticipated environment and associated constraints. **METHODS:** Testing of a number of high efficiency passenger oxygen systems for both new and existing transport airframes have been conducted in recent years. Available results and associated model and simulation data are presented in context of extensive discussions on how the results should be assessed. This has been a topic of active debate in both the standards development community and among regulatory agencies. A comparison of the generic aspects of basic continuous flow, reduced flow, and dose dependent delivery schemes is presented within the context of physiological demands anticipated during decompression and subsequent descent. The ramifications of associated assumptions of each are discussed in terms of meeting physiological requirements and regulatory mandates. **DISCUSSION:** The history of aviation is effectively one of continually doing things

better. Supplemental oxygen delivery for passengers started in earnest during the early 1950s and attempts to refine and improve associated technologies has continued ever since. The development of both electronic and pneumatic capabilities in recent years have made possible optimizations in flow and pressure control on the aircraft that allows a level of delivery optimization not functionally possible 20 or 25 years ago. The technology is potentially applicable to all operational environments where supplemental oxygen might be needed. Therefore, implementation is discussed in consideration of two basic issues. First, the protective goal or requirement that must be specifically identified; second, quantification of both the capabilities needed and limitations inherent to a given technology in terms of those expectations.

Learning Objectives:

1. Readily distinguish between the basic technologies currently employed in providing passenger supplemental oxygen.
2. Understand physiological basis and basic assumptions of how each system attempts to meet the required demand.
3. Comprehension of the different characterizations of pre and post decompression applicability.

[450] MEDICAL CONCERNS WITH TEMPORARY SHELTERS IN NATURAL DISASTERS IN JAPAN

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BACKGROUND: Japan has suffered natural disasters repeatedly. The Great East Japan Earthquake struck the northeast region of Japan on March 11, 2011, claiming more than twenty thousand lives. On April 16, 2016, a great earthquakes (M 7.3) following an M 6.5 foreshock struck the Kumamoto area of Kyushu, southwest Japan. A number of temporary shelters were open for the evacuees using gymnasiums of schools or community halls. Although operation of such temporary shelters has been much improved due to the deep consideration after The Great Earth Quake in Kobe in 1995 and The Great East Japan Earthquake, there are a number of problems identified in the recent disaster in Kumamoto. **METHODS:** A systematic review of literatures for medical concerns in temporary shelters was conducted using databases including PubMed and Japan Medical Abstracts Society for papers written in Japanese. **RESULTS:** (1) Infection control in shelters. Guidelines for temporary shelters are published from WHO and Red Cross, defining minimum requirements of space per person and number of toilettes, and Japan has established the domestic guideline. But the actual situations in Kumamoto were far below the guideline and unfortunately outbreaks of gastroenteritis and pneumonia were reported. (2) Nutrition problems in shelters. Food provided in shelters was nutritionally ill-balanced. In addition to insufficiency in total calorie, the content of vitamin B and C and vegetable fiber are less than half of the requirements. It is reported that a number of evacuees suffered from stomatitis and constipation, which may be attributable to such nutritional problems. (3) Temporary pharmacy in shelters. Pharmacy kits are focused on drugs necessary for the acute phase of rescue activity of the disaster. Thus drugs necessary for chronic diseases were not included, and a number of patients with chronic diseases faced a fear of running out of their drugs such as antihypertensive agents. **CONCLUSIONS:** Although infection, nutrition and pharmacy are basic problems in temporary shelters, they still need to be improved. Further improvements are needed to save more lives in case of future natural disasters.

Learning Objectives:

1. To learn and prepare for medical relief activity for natural disasters.

[451] AEROMEDICAL LABORATORY, JAPAN AIR SELF-DEFENSE FORCE 60TH ANNIVERSARY: ACHIEVEMENTS, HISTORY AND CHALLENGES IN AVIATION MEDICINE

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The Aeromedical Laboratory (AML) of the Japan Air Self-Defense Force (JASDF) was established in November 1957. AML has conducted a wide range of studies to develop aeromedical certifications, aptitude tests, physiological training procedures, an all of the life support equipment for JASDF pilots. We have also conducted biochemical studies to understand physiological changes under stressful circumstances. The AML is almost equally comprised of officers, enlisted personnel, and civilians. The AML has divisions for research, clinical aviation medicine and physiological training. The two research divisions conduct research projects concerning cognitive science and aviation psychology, environmental physiology and occupational health. The main facilities are flight simulator, hypobaric chamber, human centrifuge, spatial disorientation simulator, physical examination, chemical and biochemical laboratories. Our investigations on pilot behavior and air accidents have contributed to the cockpit design of the T-1, T-2 and T-4 domestic jet trainers, and the C-1 jet transport. We continue our research efforts to develop futuristic aviation systems and to solve several aeromedical and human factors issues, including brain function visualization for cognitive overload or mental stress, in-flight physiological monitoring for environmental stress, advanced vision tests, futuristic life support system, and to offer support to the JASDF operations community.

Learning Objectives:

1. To understand history and futuristic research projects of the Aeromedical Laboratory, Japan Air Self-Defense Force.

[452] A NOVEL APPROACH TO TEACHING PREVENTIVE MEDICINE IN A MILITARY FIELD EXERCISE

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PROBLEM STATEMENT: Preventive medicine (PM) is a key component of military medicine, but often takes a backseat to trauma in training programs. This gap was identified in Operation BUSHMASTER, the culminating military field exercise for graduate students at the Uniformed Services University of the Health Sciences. To fill this gap, a comprehensive simulation-based PM curriculum was created to insure military medical leaders develop this competency critical to force health protection. **TOPIC:** This poster showcases the development of a simulation-based PM curriculum for Operation BUSHMASTER, a military field exercise that evaluates a medical officer's ability to function in a Role 1 treatment facility during a four-day simulated deployment to an austere combat environment. Students are placed into various role play positions and evaluated on leadership and knowledge during problem-based learning scenarios. Following a gap analysis of Operation BUSHMASTER in 2014, the student role of preventive medicine officer (PMO) was elevated to an evaluated position, and a multidisciplinary team of PM faculty was developed to evaluate students. Twenty faculty were recruited including physicians, environmental science officers, entomologists and nurses. Faculty development covered methods of student evaluation and simulation management to achieve learning objectives. PM problem-based learning scenarios included initial site establishment, daily base camp assessments, disease and non-battle injury surveillance, foodborne illness outbreak investigation and global health engagement. A pilot curriculum was done in October, 2015 in which 50% (113) of the students were evaluated. The average score was 3.58+/-0.76 on a five point scale indicating that most students performed on an average level; the experience was rated as valuable to their understanding and application of military preventive medicine. Based on this success, the full curriculum was launched in October, 2016 with all students being evaluated in the PMO role. Data analysis of student and faculty evaluations is underway. In addition to teaching PM concepts, it was observed that PM scenarios provided more evaluation opportunities of student leadership on personal, interpersonal, team and organizational levels. **APPLICATION:** Role play and problem-based learning tools used to implement a PM curriculum in a military field exercise could be utilized to teach PM concepts in other aerospace, military or civilian programs.

Learning Objectives:

1. Participants will discover role play and problem-based learning methods for teaching preventive medicine in a military field exercise with potential for application in other military or civilian settings.

[453] PROBIOTICS: CURRENT HUMAN PERFORMANCE AND AEROMEDICAL APPLICATIONS

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PROBLEM STATEMENT: There are over 1,500 human clinical trials about probiotics indexed in PubMed. However, guidance for the proper use of probiotics among aircrew has not been provided for aerospace medicine practice. For instance, within the U.S. Air Force, probiotics are not addressed by current guidance in "Official Aerospace Medicine Approved Medications" or "Over the Counter (OTC) Medications." Instead, they are left to flight surgeon discretion, as Air Force Instruction 48-123 section 6.2.1.3 specifies that "dietary, herbal, and nutritional supplements can only be used with the approval of a flight surgeon." **TOPIC:** The potential applications of probiotics are evolving and there is some uncertainty about adverse events. A proposed hierarchy of published evidence includes graded clinical recommendations from reputable sources, selected systematic reviews (SRs) and, finally, controlled trials. Additionally, the National Center for Complementary and Integrative Health is the tertiary resource for probiotic information identified by the U.S. military's Human Performance Resource Center. **APPLICATIONS:** Selected aeromedical probiotic applications include prevention of travelers' diarrhea, prevention of sick days for upper respiratory infection, and numerous neurocognitive benefits (e.g., improved memory, reduced anxiety). Currently, the level of evidence varies for these three applications, with two graded clinical recommendations and an SR supporting travelers' diarrhea prevention, an SR supporting upper respiratory infection prevention, and individual controlled trials supporting several neurocognitive benefits. Likewise, uncertainty regarding potential harms likely follows the same hierarchy, and the possibility of pervasive uncertainty across the hierarchy should also be considered. That is, adverse events appear uncommon in all probiotic applications, but may be underreported in individual trials and thus also underreported in secondary and tertiary literature. Harms during fecal microbiota transfer, on the other hand, have been systematically reviewed and are notable for 3.5% mortality, which appears mostly attributable to the baseline health of participants in fecal microbiota transfer trials. **RESOURCES:** Evidence-based clinical reviews, PubMed, and National Center for Complementary and Integrative Health. U.S. Air Force practitioners can also consider resources within the 711th Human Performance Wing including the Epidemiology Consult Service Division.

Learning Objectives:

1. Recognize applications of probiotics.
2. Evaluate the state of probiotic literature.
3. Describe how to find relevant information about probiotics for aerospace medicine practice.

[454] A COMPARISON OF TWO LEAD-BASED CARDIAC AMBULATORY RECORDING DEVICES MEASURING IN-FLIGHT R-R INTERVALS: A ZEPHYR™ BIOMODULE™ & PHILLIPS HOLTER MONITOR

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INTRODUCTION: With the advent of new technology, wireless portable devices are quickly becoming the standard to which investigators in the health sciences measure indices associated with human physical activity. The primary objective of this project was to determine if two lead-wearable ambulatory devices, the Zephyr™ BioModule™, and the Philips Digitrak™-Plus 3100A Holter monitor, can measure in-flight cardiac waveform (electrocardiography) in agreement with each other with respect to R-R interval measurement. **METHODS:** One U.S. Navy aircrew member flying in a TH-57C military training aircraft underwent simultaneous portable ECG recordings with the adhesive-patch Zephyr™ BioModule™ and the Philips Digitrak™-Plus 3100A Holter monitor. Full-length ECG recordings from the flight were uploaded to Kubios HRV for Windows then split into consecutive three-minute paired data sets yielding 35 paired mean R-R interval observations. Paired and synchronized, time-series data was entered into an Excel spreadsheet and graphically analyzed. The Pearson product-moment correlation coefficient for the set of paired mean R-R interval measurements was computed utilizing Microsoft Excel 2007. A Bland-Altman Plot Analysis was performed using MedCalc ver. 16.2.1. **RESULTS:** Time-synced electrocardiographic data from one 102-minute flight in a TH-57C helicopter was analyzed and resulted in 35 distinct three-minute comparisons, a total of 6,120 seconds of correlation, between the Philips Holter monitor and the Zephyr™ BioModule™. Statistical analysis of the paired mean R-R interval data sets resulted in a highly positive PPMCC, $r = 0.9987$, $n = 35$, $p < 0.0001$. BAP analysis of the same data revealed an equal agreement between the two devices, Mean R-R interval bias = 0.2023ms, with 97.14% of observations within the limits of agreement. The Zephyr™ BioPatch™ was found to be minimally distracting. **DISCUSSION:** These results suggest the use of the Zephyr™ BioModule™ as a cardiac ambulatory recording device is as accurate of a method for recording in-flight R-R intervals as a Holter monitor. Future studies utilizing this method of cardiac monitoring combined with the simultaneous collection of other in-flight physiologic information may yield valuable data that until now has been difficult to procure. The reliable collection of multiple simultaneous physiologic data during military flights operations has the potential to advance aeromedical research into uncharted territories.

[455] ULTRA-COMPACT ANESTHETIC GAS INHALATION AID DEVICE FOR ZERO GRAVITY AND MULTIGRAVITATIONAL ENVIRONMENTS

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INTRODUCTION: Inhaled gas anesthesia can be modulated by ventilation, which is safer and more comfortable than intravenous anesthesia. Inhaled anesthetics are non-flammable and can be recycled. The device is simple and compact, ideal for space. A new 3D printable device was developed, has the three key functions of general inhaled anesthesia machine (vaporizer, scavenger, ventilator). This anesthesia system can be safely operated and used in zero gravity environments. **METHODS:** The experiment was conducted using a hard container that had an external activated carbon filter to prevent an anesthetic gas leak. The system was tested on-board a modified MU-300 used for parabolic flights. Air was pushed through the system into an artificial lung and cleaned by an internal filter. 5cc of isoflurane and sevoflurane were vaporized independently into the system. The vaporization was monitored by a small camera inside the silicone bag. Each injection occurred at the beginning of the zero gravity portion of the flight and was repeated during the flight. Anesthetic gas concentration was monitored by an infrared detector attached to a flow analyzer. Air pollution was monitored by a badge in the container. Ventilation of the lung was driven by an air compressor and an endurance test was carried out on the ground (25-300 bpm). The device is attached upside down to a flow analyzer. **RESULTS:** Vaporizer: The infrared gas monitor detected more than 10 % of anesthetic agents within 10 Seconds. Scavenger: An insignificant leak was confirmed. Air pollution was 91 ppm of isoflurane, 240 ppm of sevoflurane. Ventilator: Cleared for more than one month of continuous operation (864000 Strokes for 1 month, record test still being performed). **DISCUSSION:** Leak of gas is insignificant and is avoided when there is no need for refill. It is necessary to use a larger syringe or a pressurized bottle for the administration of anesthetic in the weightless environment (already tested). Leak may be prevented by a series of filters. It is possible to reuse the anesthetic gas from exhaled air, it can contribute to the effective use of limited resources. The device can be used at different temperatures, with solar energy and in extreme cases, using a foot air pump. **CONCLUSION:** Our devices are useful for interplanetary and space long term missions; there will also be spinoffs for having on Earth more simple and compact ventilation and anesthesia devices, as well as its use in disasters and remote areas.

Learning Objectives:
1. To explain the function of a simple anesthesia device.
2. To show the effectiveness of a 3D printed anesthesia and ventilation device.
3. To learn about anesthesia in zero G and multi gravitational environments.

[456] DECOMMISSIONING OF THE SIMULATION WATER TANK (WETS) AT JAXA TSUKUBA SPACE CENTER

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MOTIVATION: Most of modern human spacecraft system are designed with EVA (ExtraVehicular Activities) access compatibility in view. The best method of design review today is the in-water verification by diving, where aerospace medicine is applied. For the best practice, understanding of the environment, which includes system operations, is necessary. Presented here is a case of an EVA simulation tank. **OVERVIEW:** In 1992 JAXA (JApan space eXploration Agency, ex. NASDA) started EVA compatibility verification tests of its JEM (Japanese Experiment Module, Kibo) for the ISS (International Space Station). The initial two sessions were conducted in 1992 and 1993 at NASA NBS (Neutral Buoyancy Simulator) at Huntsville, Alabama with NASA engineer and astronaut divers. JAXA constructed its own simulation tank, "Weightless Environment Test System (WETS)" in 1993-1994. Its diameter was 16 m, depth 10.5 m. The basic design followed that of NBS. To satisfy NASA's medical requirements which included five-minute access to a hyperbaric chamber for Arterial Gas Embolism, a three-person multiplace chamber with an airlock was installed on the pool deck. The author supervised its installation and medical operation. WETS saw two JEM and three HTV cargo vehicle EVA tests, six JEM procedure development runs, and four JAXA astronaut EVA training sessions through 2006. In 2009 it was used for a swimming test in JAXA astronaut selection. WETS had an anti-spill rim for earthquakes. Emergency exercises for earthquakes were conducted. However, the large earthquake of March 11, 2011 caused a leak in an external water circulation pipe, through which eventually a large part of the water was lost. Nobody was in the water then. Later inspection found slight wrinkles at the bottom of the tank. The tank was dismantled in 2013, leaving a large hollow space in the building. Maintenance of the multiplace chamber was halted.
SIGNIFICANCE: During its diving operations, at WETS we identified one case of mild Type I Decompression Sickness, and one with alternobaric vertigo. WETS was unexpectedly decommissioned, however it left a rich aerospace medicine and other operational experience legacy as well as a sturdy concrete floor and a large working space for a future project.
Learning Objectives:
1. To understand an application area of aerospace medicine.
2. How aerospace medicine operation is exercised in space program.

[457] CAROTID INTIMA MEDIA THICKNESS IN THE ASTRONAUT CORPS: ASSOCIATION TO SPACEFLIGHT

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INTRODUCTION: Carotid Intima Media Thickness (CIMT) has been demonstrated to be predictive of future cardiovascular events. Within various populations, radiation exposure, stress, and physical confinement have all been linked to an increased CIMT. Recent research discovered CIMT was significantly increased in ten long duration astronauts from pre-flight to four days post flight. The relationship between spaceflight and CIMT is not well understood and trends in CIMT within the larger astronaut population are unknown. **METHODS:** In 2010, CIMT was offered as part of the astronaut annual exam at the JSC Flight Medicine Clinic using a standardized CIMT screening protocol and professional sonographers. Between 2010 and 2016, CIMT measurements were collected on 213 NASA astronauts and payload specialists. The values used in this retrospective chart review are the mean of the CIMT from the right and left. Spaceflight exposure was categorized based on the total number of days spent in space at the time of the ground-based ultrasound (0, 1-29, 30-200, ≥200). Linear regressions with generalized estimating equations were used to estimate the association between spaceflight exposures and CIMT. **RESULTS:** 530 studies were completed among 213 astronauts with a mean of 2.5 studies (range 1-6) per astronaut over the six year period. As in other populations, CIMT was significantly associated with age; however, gender was not. While there was no significant direct correlation between total spaceflight exposure and CIMT found, astronauts with 30-200 spaceflight days and astronauts with greater than 200 spaceflight days had significantly increased CIMT over astronauts who had never flown ($p=0.002$ and $p=<0.0001$ respectively) after adjustment for age. **DISCUSSION:** Further work is needed to fully understand CIMT and its association to spaceflight. Current occupational surveillance activities are under way to study CIMT values in conjunction with other cardiovascular risk factors among astronauts as compared to the general population.
Learning Objectives:
1. Improve understanding of the association between carotid intima media thickness and spaceflight.

[458] NECESSITY OF A ROBUST PSYCHOPHARMACEUTICAL FORMULARY ABOARD LONG-DURATION DEEP SPACE MISSIONS

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MOTIVATION: Behavioral health issues are critical to the safety, well-being and performance of crew in the isolated, confined environment inherent in both human spaceflight and Antarctic exploration. Psychiatric issues are a key component of planning for long-duration missions into deep space. Experience from long-duration orbital spaceflight and Antarctic bases indicates the need for an extensive onboard psychiatric formulary on deep space missions. **OVERVIEW:** Psychiatric problems have been documented in long-duration orbital spaceflight, including symptoms of adjustment disorders and somatic symptom disorder. In Antarctica, up to 5% of wintering crew could meet criteria for psychiatric illness, including mood disorders, stressor-related disorders, sleep-wake disorders, personality disorders, and substance-related disorders. Experience from both settings indicate that psychiatric disorders on deep space missions, triggered by the rigors of spaceflight and/or trauma incurred during the mission, must be considered and anticipated. Onboard provision of psychoactive drugs is an important component to planning for the health of deep space crew. These have historically been available on orbital missions. Agents available on the International Space Station include a limited variety of anxiolytics, antidepressants, antipsychotics, analgesics, stimulants, and hypnotics. Greater variety and supply of these agents exist on Antarctic bases. The breadth and depth of a deep space psychiatric formulary will be significantly greater than that provided on orbital missions. Guidelines for a space-based formulary, published by Santy in 1987, remain valid today. Drug classes to be provisioned include anxiolytics, antidepressants, mood stabilizers, antipsychotics, and hypnotics. Each category should include several different medications, representing a diversity of pharmacokinetic and pharmacodynamic features. Pharmacogenetics could assist drug selection and dosing. Microgravity-mediated alteration of drug pharmacokinetics could be considered when dosing and administering agents. The formulary itself should be rigorously controlled, given the abuse potential of some medications. **SIGNIFICANCE:** On long-duration deep space missions, a robust psychiatric formulary could provide crew autonomy and flexibility in treating a range of psychiatric issues, from depression to acute psychosis. This will contribute to the safety, health and performance of crew, and to mission success.
Learning Objectives:
1. The participant will understand the importance of a robust onboard psychiatric formulary on long-duration deep space missions.

[459] RADIATION EFFECTS ON THE CENTRAL NERVOUS SYSTEM: BEHAVIORAL HEALTH AND PERFORMANCE IMPACTS

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PROBLEM STATEMENT: Space radiation is arguably the number one risk astronauts face as they venture beyond low earth orbit. Although radiation risk models focus primarily on the health of crewmembers, there also is increasing evidence that raises awareness for how both the type and extent of radiation exposure are associated with a cascade of effects that are likely to significantly degrade cognitive performance increasing the risk to a long-duration spaceflight mission. **TOPIC:** Ionizing radiation damages the central nervous system (CNS) which leads to fatigue, negative mood, as well as difficulty sustaining attention. In addition, there is evidence that radiation exposure results in synaptic structural changes, reduced neurogenesis, neuroinflammation, and acceleration of the pathophysiology of any neurodegenerative disease (e.g., Alzheimer's disease). In short, there are compelling clinical outcomes that serve as an "exposure analog," that are known to pose a significant threat to the brain and cognitive abilities. These clinical results have been coupled with animal data from exposures for the types of radiation such as, high-energy, high-charged (HZE) particles associated with galactic cosmic radiation. These clinical and animal findings have helped NASA increasingly recognize that deep space exploration poses an increased risk for the cognitive functions of astronauts, depending on the length and level of exposure. **APPLICATIONS:** Discussion will include an overview of the types of radiation that astronauts will encounter in deep space, as well as the levels of radiation exposure encountered by past and future missions. Relevant literature will also be reviewed with a focus on the cognitive and behavioral effects seen in irradiation rodent studies as well as cellular and molecular mechanisms proposed to contribute to this CNS impairment. The Research Domain Criteria will be used to explore this risk from the genetic, cellular, molecular, circuitry, and behavioral systems perspectives. Discussion of this topic will help inform the risks inherent to deep space exploration with regards to space radiation exposure, cognitive and human performance capability, and the risk of radiation to the cognitive abilities that may adversely influence crew health and mission. **RESOURCES:** Parihar, V., Allen, B., et al. (2016, October 10). Cosmic Radiation Exposure and Persistent Cognitive Dysfunction. *Scientific Reports, 6*, 34774. doi: 10.1038/srep34774.

Learning Objectives:

1. Comprehend the serious risk posed by space radiation to crew behavioral health and performance.
2. Analyze plausible mechanisms contributing to possible CNS degradation after radiation exposure on long-duration spaceflight.

[460] REDESIGN OF A 3D-CLINOSTAT

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INTRODUCTION: One of the great challenges of space exploration is to understand the effects that microgravity will cause by the short, medium and long term exposition, on human physiology, on the growth of plants, microorganisms as well as on biomolecular synthesis or drug permeability. For these studies, the Earth's gravity is the biggest obstacle. There are several ways to simulate microgravity. The Clinostats produce simulated microgravity by rotating an object simultaneously in one axis (2D-Clinostat) or two different axes (3D-Clinostat). Thus, the acceleration vector of the gravity is applied in all directions, resulting over the time in the cancelation or reduction of the gravity force. The Clinostats may vary in size and shape; however, use the same operating principle, i.e. the axes of the machine are coupled to electric motors, thus requiring rotary connectors for sending electricity to the axes, which increases hardware complexity. The objective of this work is to develop a new clinostat design, much simpler and equally functional, avoiding the use of these rotary connectors and joints. **METHODS:** The project involved the redesign of a traditional two axes 3D-Clinostat, avoiding the use of rotary connectors, joints, motors and wiring inside the machine. The result was the adoption of a hollow sphere of plastic material, inside which is placed the material to be subjected to the microgravity. The challenge was to move the sphere without putting the motors inside the structure. For this, the sphere was placed on a surface containing three motors separate 120 degrees to one another and inclined 45 degrees to the surface of the sphere. By combining the movements of the motors, obtaining therefore, a 3D-Clinostat much simpler and cheaper to build. **RESULTS:** The proposed Clinostat has low cost, is easy to construct, and provide greater durability due to its shape and the absence of joints and electric moving parts inside of the equipment. Furthermore, the sample object is placed inside the closed sphere, which allows the light removing or light control. The sphere used in this project was obtained with the use of a 3D printer using an ABS plastic for print. **CONCLUSION**: The equipment developed presented the proposed functionality. However, for its validation, there is the need to perform parallel experiments using the new clinostat and traditional 3D-clinostat to evaluate the results reproducibility.

Learning Objectives:

1. Develop a new Clinostat design.

[461] HAND HYGIENE ON THE INTERNATIONAL SPACE STATION

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MOTIVATION: There are ongoing efforts to characterize the nature and extent of changes to the human microbiome and pathogens during spaceflight, particularly with the advent of long-duration space missions. The results have led to an increased concern for the development of multidrug-resistant organisms and latent viral infections in microgravity. Astronauts are monitored closely for infection during all phases of flight, however hand hygiene in zero gravity remains a challenge and the efficacy of alcohol-free sanitizers is not well understood. This presentation analyzes the current evidence-base for hand sanitization in space and proposes methods for future study. **OVERVIEW:** Current hand hygiene practice on the International Space Station utilizes alcohol-free sanitization. However, the CDC recommends against the use of alcohol-free products as they may increase the risk of pathogen mutation, incomplete or inadequate pathogen coverage, and skin irritation compared with alcohol-based products. A literature review on alcohol-free sanitizers was performed using PUBMED and Google Scholar. Ten studies were identified comparing the use of non-alcohol based sanitizers to alcohol-based sanitizers or soap and water. Instant sanitizer does appear to increase adherence to washing and thus decreases disease transmission, however, the evidence is mixed as to which type of sanitization is most effective. **SIGNIFICANCE:** At this time there is no data on the efficacy of hand sanitization on the International Space Station. Current practices are based on design constraints and expert opinion. It will be important to understand how hand hygiene is altered by antimicrobial interventions, especially as we continue to study the microbiomes of astronauts. Furthermore, hand hygiene will be essential to infection control measures for anticipated long-duration missions. It is unclear how the long-term use of hand sanitizers in microgravity will affect microbial mutation and response to radiation exposure.

Learning Objectives:

1. To understand current hand hygiene practices on board the International Space Station and reflect on opportunities for further study and innovation.

[462] DEVELOPMENT OF A CAUTION AND WARNING SYSTEM FOR THE AOUDA SPACESUIT SIMULATOR DURING MARS ANALOGUE MISSION EXTRAVEHICULAR ACTIVITY

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INTRODUCTION: Conducting terrestrial analogue missions is important in preparation for crewed missions to Mars, as it allows for identification of possible challenges faced, and thus both the development of preventative strategies and the optimization of mission planning. Spacesuit caution and warning systems (CWS) have played an important safety role since the early days of human spaceflight but, to date, no such systems have been developed for use in terrestrial

analogue missions. The Austrian Space Forum (ÖWF) has completed multiple analogue missions using their Aouda spacesuit simulators on the premise that analogue missions encourage scientific research needed for planetary exploration of Mars. **METHODS:** Pseudocode algorithms were developed as the basis of a functional CWS for use in Austrian Space Forum's Aouda spacesuit simulator, with a focus placed on cardiorespiratory, thermal stress, workload, and fatigue monitoring of the suited analogue astronaut (AA). The system relies on active monitoring and analysis of helmet and blood gas levels, helmet and body temperature, as well as AA respiratory rate and heart rate. Current imposed thresholds are based on data available in the literature and from past ÖWF missions. The CWS algorithms categorize off-nominal parameter values into one of three terminal states (Advisory, Caution, and Warning), which are accompanied by a list of recommended actions designed to assist in decision-making processes of ÖWF medical personnel. **RESULTS:** Preliminary testing indicates that the system can respond quickly and efficiently to a range of scenarios, with no unnecessary temporal delays added to detection time by the system. Further manned and unmanned testing of the entire system is scheduled for January 2017 and these results will be presented. **DISCUSSION:** CWS terminal state, parameter and threshold selections are discussed, and future actions for continued system development are proposed. The ultimate goal of the system is to enhance AA safety, raise crew situational awareness, and provide insight into the functioning of a CWS within an exploratory mission context to allow for the optimization of future systems.

Learning Objectives:

1. Understand the concept of a terrestrial analog mission, and the importance of such missions before crewed exploratory missions are conducted in space.
2. Understand the importance of caution and warning systems in human spaceflight missions, as well as in terrestrial analog missions.

[463] INTERNATIONAL AEROSPACE MEDICINE TRAINING OPPORTUNITIES - OPENING DOORS WITH ROOM FOR PROGRESS

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MOTIVATION: With an increase in the need for aerospace medicine training opportunities worldwide, particularly due to the advent of commercial space flight, medical practitioners are searching for formal training in aerospace medicine in greater numbers than ever before. The United States is known to provide advanced training in this discipline via several institutions (both military and civilian), however less is often known of training programs further afield. We took to perform a search of the international training opportunities available, to both promote and identify areas of deficiency. **OVERVIEW:** Many international aerospace and aviation medicine societies exist, however formal training programs available outside of the United States are limited. The United Kingdom in 2016 accredited a formal training program in conjunction with the Royal Air Force and King's College, London. King's College also provides graduate and postgraduate studies in aviation and aerospace medicine. Australia has developed a fellowship training program in aerospace medicine, however this remains unaccredited with the Australian Medical Council at the time of writing. Formal recognition is currently being sought, potentially as a school or faculty under the Royal Australasian College of Physicians. Australia also provides formal training courses for practitioners to become Aviation Medical Examiners through Monash University, with New Zealand offering a postgraduate diploma in aviation medicine through the University of Otago. Other opportunities abroad exist in limited numbers, including those programs in Colombia and Japan. **SIGNIFICANCE:** This review attempts to raise awareness of international aviation and aerospace medicine training opportunities worldwide. This list is likely not exhaustive, but represents those most commonly known. Increased promotion of these opportunities to the international community is important to enhance education and progress. Scholarship programs and funding opportunities would be beneficial to allow increased global access for participants.

Learning Objectives:

1. To understand the international opportunities available to gain formal training in aerospace medicine.

[464] THE MOON GYM: EXERCISE CONCEPTS FOR LUNAR EXPLORATION MISSIONS

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The European Space Agency (ESA) has recently announced that the Moon will be their next target for human space exploration missions. Current mission scenarios aim at utilising the lunar surface twofold, as an operational testbed for planetary explorations to Mars and beyond and to conduct research in a unique partial gravity setting (1/6 of Earth's gravity). To date, not much is known about the physiological long-term effects of reduced gravity exposure. ESA's project 'the moon gym' seeks to better understand the human physiological consequences of prolonged exposure to reduced gravity on the lunar surface and to develop exercise concepts to counteract the anticipated physiological deconditioning. As a first step a systematic literature review following the Cochrane Collaboration guidelines was conducted to screen various databases for evidence of physiological effects of real partial gravity exposure and partial gravity analogues. The literature search comprised search terms related to the cardiopulmonary and the musculoskeletal systems as well as to biomechanics. **RESULTS:** of the systematic review revealed that not much is known about physiological long-term effects of partial gravity. However, studies on immediate effects of partial gravity suggest that the musculoskeletal and cardiopulmonary systems are likely to degenerate. Based on this assumption, concepts for exercise countermeasures for lunar exploration missions were developed and modelled in the 3D CAD software SOLIDWORKS. An exploration scenario mission utilising a small cis-lunar station (Orion) and a lunar rover was chosen. The presented exercise concepts for this mission scenario comprise two approaches. The so called 'inside the box' approach sought to follow the NASA requirements for exploration mission exercise hardware, trying to 'squeeze' a multifunctional gym into a small box. The 'outside the box' approach sought to integrate exercise hardware into the architectures of the cis-lunar station and the lunar rover. The results and considerations of both approaches will be presented.

Learning Objectives:

1. The participant will be able to understand the constraints and special requirements of long term exploration missions to the Moon and beyond from an exercise physilogy point of view.
2. The participant will be informed about the state of the art of partial gravity physiology research.
3. The participant will learn about novel concepts for exercise countermeasures to be used in a small cis-lunar module and in a lunar rover.

Thursday, May 04 ***1:30 PM***
Plaza A/B

S-087: SLIDE: HYPOXIA: THE HANGOVER PART DEUX

Chair: Michael Gallagher
Edmonton, Alberta, Canada

Chair: Leon Hrebien
Philadelphia, PA

[465] THE INFLUENCE OF HYPOXIA ON FLIGHT PERFORMANCE IN PILOTS.

Y. Steinman[1], M. van den Oord[1], M. Frings-Dresen[2] and J. Sluiter[2]
[1]Center for Man in Aviation, Royal Netherlands Air Force, Soesterberg, Netherlands; [2]Coronel Institute of Occupational Health, Academic Medical Center, Amsterdam, Netherlands

INTRODUCTION: During flight, the ability of a pilot to maintain high cognitive and psychomotor performance is essential for flight safety. Hypoxia studies performed under normobaric conditions corresponding with oxygen pressures of 10,000 to 18,000 feet, suggest a decrease in flight performance. Currently, there is no published data examining the influence of hypobaric hypoxia (HH) on pilots' flight performance. The purpose of the present study was to examine the influence of HH on pilots' flight performance during exposure to simulated altitudes of 300, 10,000, and 15,000 ft and to evaluate physiological reactions. **METHODS:** Twelve male pilots were exposed to HH while flying in a flight simulator that had been placed in a hypobaric chamber in a single-blinded counterbalanced design. Flight performance was assessed in one score by flight profile accuracy (FPA). Pilots' alertness level was assessed using the Stanford Sleepiness Scale. In addition, SpO_2, heart rate, minute ventilation, and breathing frequency were monitored. Post-hoc analysis compared the results of the 300 and 10,000 ft, and 300 and 15,000 ft conditions. **RESULTS:** A significant difference was found (P=0.039) in flight performance between the three altitudes. Post-hoc analysis showed no significant difference between 300 and 10,000 ft (P>0.05) and a trend was observed at 15,000 ft (P=0.077), suggesting worsening of flight performance at that altitude. Significantly lower alertness levels were observed at the start of the flight at 15,000 ft compared to 300 ft (P=0.014) and at the end of the flight at 15,000 ft compared to the start at that altitude (P= 0.04). SpO_2 (P=0.001) and BF (P<0.001) decreased, and HR increased (P=0.001) significantly with altitude. **DISCUSSION:** The results did not provide decisive evidence for decreased flight performance during exposure to simulated altitudes of 10,000 and 15,000 ft. Individual results revealed that in ten out of the twelve pilots flight performance was worse at 15,000 ft compared to 300 ft. The large interindividual variation in flight performance combined with the gradual decrease in alertness levels puts into question the ability of pilots to safely fly an aircraft while exposed to these altitudes without the use of supplemental oxygen.

Learning Objectives:

1. The participant will be able to beter understand the influance of hypobaric hypoxia on pilots flight perormance.

[466] HYPOXIA HANGOVER – FLIGHT PERFORMANCE AFTER NORMOBARIC HYPOXIA EXPOSURE AND EMERGENCY PROCEDURES IN HAWK SIMULATOR

T. Leino[1,2], N.O. Varis[3], J. Skyttä[4], K. Parkkola[3] and M.J. Mäntysaari[1]
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INTRODUCTION: In 2015, U.S. Navy and U.S. Marine Corps reported altogether 115 hypoxia incident cases in their Goshawk, Hornet, and F-35 fleet related to On-Board Oxygen Generating System (OBOGS) malfunction, air contamination (e.g., CO toxication) or loss of cabin pressurization (ECS malfunction) resulting in hypoxia symptoms. In 2008, normobaric hypoxia training in a tactical Hawk simulator was developed in the Finnish Air Force. The training helps pilots to recognize their individual hypoxia symptoms and refresh hypoxia emergency procedures. It also provides an opportunity for the pilots to understand the effects of "hypoxia hangover" on their flight performance during return to base (RTB). **METHODS:** The simulator flight mission is executed above 25,000 ft, including three set-ups and RTB is done during last set-up. In each set-up different concentrations of oxygen were used (8%, 7% and 6% of oxygen in nitrogen) to create different time of useful consciousness (TUC). Forehead oxygen saturation and wireless ECG is monitored during the flight mission. After hypoxia identification pilots perform hypoxia emergency procedures (100% emergency oxygen - ON, oxygen main valve - OFF and emergency descent - EXECUTE). RTB is done at low altitude in instrument weather conditions (IFR) during 3rd set-up. Three minutes after emergency procedures emptied the emergency oxygen bottle the in ejection seat is simulated by closing breathing valve. After this, pilot has to fly an IFR approach with the oxygen tube opened from vest. During the RTB, the flight instructor evaluates the flight performance (n=15) in order to evaluate short time memory capacity and decision making capability after hypoxia. **RESULTS:** Significant decrease in flight performance during RTB and IFR approach was observed. Some pilots reported fatigue, headache, memory problems, and cognitive impairment as adverse effects even 12 hours following normobaric hypoxia training. Thus, 12 hours grounding is routine after normobaric hypoxia training in Finland. **DISCUSSION:** Lesson learned from this study is that hypoxia, although emergency procedures are done without delay, has a significant effect on flight performance during RTB. Pilots need all support from the operations officer, including for example new fuel minimum calculation for alternative airfield at low altitude, to safely complete the flight mission.

Learning Objectives:

1. Cognitive decrement after hypoxia will last for hours.
2. After emergency oxygen bottle is empty, do not open mask but take off breathing tube from vest.
3. Pilots need tactical flight simulator for hypoxia training to understand the danger of hypoxia hangover.

[467] AN AUDIT OF 15 YEARS OF HYPOXIA TRAINING IN THE ROYAL AUSTRALIAN AIR FORCE: HOW MUCH HYPOXIA IS TOO MUCH?

A. Smith
RAAF Institute of Aviation Medicine, Edinburgh, Australia

INTRODUCTION. The investigation of a safety event in the Royal Australian Air Force identified the possibility that some students may emerge from hypoxia awareness training without a clear recollection of their symptoms. A review of hypobaric chamber training was conducted to characterize the depth and duration of hypoxia experienced during practical hypoxia training. **METHODS.** Chamber-based hypoxia training during the period January 2002 to June 2016 was reviewed, comprising 1294 chamber runs with 9071 students. Data from 170 normobaric scenario-based hypoxia training sessions with experienced aircrew were included for comparison. The duration of hypoxia and oximetry at the time the hypoxia was terminated were analysed. **RESULTS**. Students undergoing practical hypoxia training in the chamber recovered after a median 3.5 minutes, at a median oximetry of 64%; 24% recovered at oximetry <60%. Group means were close to (or exceeded) procedural limits of the training. Initial students recovered after 3.9 min, compared to 3.4 min for experienced aircrew (p<0.001). Initial students recovered at a median 62% compared to 66% for experienced aircrew (p<0.001). Although the differences between initial and experienced aircrew are statistically significant, the observed differences are small. By contrast, experienced aircrew undergoing normobaric hypoxia training in a simulated flight environment recovered at a mean oximetry of 78% and mean duration of 1.6 minutes (p<0.001 for both, compared to conventional hypoxia training). **DISCUSSION.** Students may have been subjected to a depth of hypoxia that could exceed their useful consciousness, undermining the benefits of practical hypoxia training. The observation that experienced aircrew can recognize hypoxia before they develop significant symptoms suggests that the training model encouraged a deeper level of hypoxia than needed to refresh memory. Australia has altered the conduct of initial and refresher hypoxia training, with greater emphasis placed on 'hypoxia recognition and recovery' than 'hypoxia symptom awareness'. This presentation will outline the changes implemented to optimize the aircrew hypoxia training experience.

Learning Objectives:

1. To appreciate that hypoxia exposure during training can negatively impact learning.
2. To understand the difference between 'hypoxia awareness' training and 'hypoxia recognition and recovery' training.
3. To understand the importance that hypoxia training focus on the early recognition of hypoxia-like symptoms in order to initiate a timely recovery.

[468] COGNITION AND PSYCHOMOTOR EFFECTS OF ACUTE MODERATE HYPOXIA

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[1]Medical Research Dept., Turkish Aeromedical Research Center, Eskisehir, Turkey; [2]Aerospace Medicine, Health Sciences University, Eskisehir, Turkey

INTRODUCTION: Hypoxia is a state of dysfunction due to oxygen deficiency in the body. Acute hypoxia symptoms start in seconds or minutes. Besides the respiratory and cardiovascular responses, acute hypoxia has cognitive and psychomotor responses that endanger flight safety in aviation. The objective of this study was to assess psychometric test scores of subjects who exposed to an acute moderate hypoxia during hypobaric chamber training. **METHODS:** 38 male pilot candidate subjects, age range 20-23, were included in this study. Go/NoGo test is used for measuring selective attention, inhibition, and vigilance functions. Rotation is generally used for reasoning, visual processing, decision making functions. Go/NoGo (P-Go, then R-Go) and Rotation psychometric tests (from PEBL-Psychology Experiment Building Language) were applied to the subjects two times; before training (BT) and during 18.000 foot equivalent pressure hypobaric hypoxia (HT) training, respectively, as a measure of cognition and psychomotor functions. Total duration of these tests were about 6-8 minutes. Reaction times and total errors of subjects on these two periods were compared statistically. **RESULTS:** Go/NoGo (P-Go) reaction times (RT) of subjects were not statistically different between BT and HT. Comparing the number of incorrect responses (errors) of subjects between the two conditions for all tests were statistically insignificant. Reaction times of Go/NoGo (R-Go) means during HT were significantly higher than BT ($P<0.05$). RT of Rotation means during HT were significantly lower than during BT ($p<0.001$). **DISCUSSION:** As expected RT of subjects were prolonged in HT for Go/NoGo test R-Go section but it wasn't same for P-Go section. The reason for lack of RT prolongation at P-Go section may be that it is the first section of psychomotor tests and hypoxia clinic has not been resided yet and compensation mechanisms were in effect. Surprisingly, RT during HT were shortened and total completion times of the subjects were shorter than before training values. Also, there were no significant increase on error numbers. That result may result from urgency of subjects to finish the tests, increased sympathetic activity, and also learning factor might be effectual.

Learning Objectives:

1. Define the relations between some cognitive and psychomotor functions and acute moderate hypoxia.

[469] THE UTILITY OF COMMERCIAL OFF THE SHELF PSYCHOLOGICAL SENSORS FOR IN-COCKPIT MITIGATION OF HYPOXIA-LIKE PHYSIOLOGICAL EPISODES.

J.B. Phillips
Biomedical Sciences, Naval Medical Research Unit-Dayton, Wright-Patterson AFB, OH

For military tactical aviation personnel, hypoxia is an insidious and potentially deadly occupational hazard. Although a substantial investment in mitigation attempts and training has been made, hypoxia-like physiologic episode (HL-PEs) incidence has not diminished, but rather has increased significantly. The need to understand these events through in-cockpit operator physiological monitoring has been identified by senior DoD leadership. The consumer and medical market has been flooded with commercial off the shelf (COTS) devices designed and advertised to provide continuous health monitoring in conditions ranging from clinical settings in non-ambulatory patients to athletes participating in extreme sports. Activity and physiology monitors like FitBit, Jawbone, and Zephyr's Bioharness are becoming increasingly popular with the more advanced models advertised to provide information on blood oxygen saturation, heart rate and other physiological measurements of interest. Senior Aviation leadership has expressed frustration surrounding the perception that such available COTS systems are not being considered for use as mitigation tools for HL-PEs. In the past several years COTS monitoring devices have been considered and tested for their utility for pilot monitoring applications. The majority of studies conclude that the tactical aviation environment significantly degrades the performance of COTS technology such that their utility is questionable. **DISCUSSION:** Pulse oximetry, fitness trackers, and bioharnesses all must isolate a specific biological signal to function properly. Vibration forces, electromagnetic interference, and gravitational forces common in tactical aviation environments make the acquisition of valid and reliable biological signals extremely challenging with previously tested COTS options. Adoption of an existing COTS solution will likely not result in a reduction of HL-PEs, but instead may inaccurately depict a significant rise based on unreliable or invalid data. Issues associated with the tactical aviation environment that argue against most available COTS solutions as suitable H-L PE mitigation tools will be comprehensively presented. This will be followed by the presentation of various DoD HL-PE mitigation development efforts to provide tools designed to work in the tactical aviation environment.

Learning Objectives:

1. Investigators believe that hypoxia like physiological episodes refer to a broad range of physiological issues that result in symptoms similar to hypoxia.
2. Comercial off the shelf technology does not perform well in the tactical aviation environment due to extreme vibration forces and electromagnetic interference.
3. Future lie support systems must achiee respritory homeostasis as opposed to just keeping the operator conscious.

[470] HIGH-PERFORMANCE AIRCRAFT RESPIRATORY STUDY II

R.S. Mayes[1] and B.A. Clapp[2]
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INTRODUCTION: In 2014, the 711th Human Performance Wing conducted the High-Performance Aircraft Respiratory Study to assess respiratory symptoms among fighter pilots. Initial results have previously been reported; no definitive conclusions were drawn from the initial analysis. In an effort to further understand the data, this effort examined multifactorial symptom etiologies using multiple analysis techniques. **METHODS:** Data were collected over 1 mo for four different airframes across five flying squadrons. Data collected consisted of (a) a retrospective questionnaire to assess each pilot's baseline experience with high-performance aircraft-related respiratory symptoms, occupational and non-occupational exposures, and symptom history; (b) a prospective questionnaire after each sortie to assess the impact of operational exposures (Gz, altitude) on respiratory symptoms; and (c) environmental and breath sampling to assess the impact of ozone and exposure to irritants. Multiple analytic methods were used. As an occupational assessment, this study did not require Institutional Review Board approval. Additionally, for some squadrons, information was collected from flight integrity data to provide more robust analysis. **RESULTS:** Analysis identified two different types of reported cough, generally split by airframe, duration, and presence or absence of chest tightness. In certain airframes, the data demonstrate a correlation between cough and altitude and also between cough and heavy G-time in certain airframes. Many variables superficially associated with cough appear to be explained primarily by the variation in exposures between airframes, and the strong variation in rates of cough between airframes, but an in-depth analysis of the squadron with the highest rates of cough revealed that high altitude and low heavy G-time are useful predictors of cough in that airframe. Finally, within-airframe, within-base analysis showed preliminary indications that cough may be negatively correlated with use of the max setting on the oxygen regulator. **DISCUSSION:** Preliminary findings from the study were briefed to the Air Combat Command in early 2015 and to AsMA in 2016. The results of the current analysis contribute to a more nuanced understanding of respiratory symptoms among high-performance aircraft pilots. These findings inform further study with additional fighter squadrons; this work has been proposed.

Learning Objectives:

1. Understand factors that contribute to respiratory symptoms among high-performance aircraft pilots/aircrew.

Thursday, May 04 ***1:30 PM***
Plaza D/E

S-088: PANEL: REMOTE COMBAT STRESS IMPACT AND MITIGATION: ISR IN THE KILL CHAIN

Chair: Alan Ogle
Langley AFB, VA

PANEL OVERVIEW: Since 2001 there has been exponential growth in the number of remote combat operations conducted, and an insatiable demand for intelligence, surveillance, and reconnaissance (ISR) from various manned and unmanned aircraft. Today, growing numbers of "deployed-in-place" ISR personnel are exposed to the stresses of remote combat and graphic media exploitation on a daily basis, the effects of which are not well understood. Psychologists embedded with the 480th ISR Wing conducted a needs assessment protocol on the effects of exposure to remote combat and graphic media (e.g. imagery, video, and audio) on psychological outcomes for ISR Airmen, including members serving in the "kill chain". The study additionally focused on strategies and techniques to prevent and mitigate negative effects of remote combat operations as an ISR Airman. The first presentation provides an overview of ISR and Distributed Common Group System (DCGS) operations, human factors challenges of this type of work and Operational Medical Element (OME) services fielded to support human performance optimization. A series of three linked presentations will then follow with results drawn from the study. The second presentation will present findings regarding the quantities of exposure to remote combat events and graphic media content experienced by personnel, and the psychological impact of certain types of events (e.g., witnessing U.S. casualties, civilian casualties, atrocities committed by the enemy). The third panelist will present findings on the psychological impact of this new type of remote warfare, including elements of PTSD, moral injury, secondary traumatic stress, and other personal and professional impact reflective of a remote combat stress injury. The final panelist will present findings regarding effective remote combat stress prevention and mitigation strategies, and efforts to implement those through selection of personnel, training, and leadership interventions. Rounding out the presentations will be a discussion of embedded medical and psychological assets to support performance and prevent injury from service in the kill chain.

[471] REMOTE COMBAT STRESS IMPACT AND MITIGATION: TRAINING

A. Ogle
480 ISRW, Langley AFB, VA

INTRODUCTION: There is established service doctrine for prevention and mitigation of combat and operational stress in ground forces, notably the U.S. Navy / Marine Corps: Strengthen, Mitigate, Identify, Treat, and Reintegrate. Prevention and mitigation of the stress of engaging in combat remotely may need distinct approaches. The presentation will include discussion of results from study of ISR analysts regarding what they find helpful, how these methods may be taught and implemented, and strategies for leadership. **METHODS:** Psychologists embedded with the 480th ISR Wing conducted an approved needs assessment study that included focus groups and a survey ratings regarding 41 strategies and techniques to prevent and mitigate remote combat stress, as well as 4 methods for preparatory training. A working group of ISR analysts synthesized results into themes and strategies for use by front line analysts as well as leaders. **RESULTS:** Of the techniques rated 37 were found to be at least a little helpful, 6 rated as moderately helpful, and 10 as very helpful. These were grouped using multiple card sorting procedures into categories: Professional Warrior Mindset (5 techniques), Unit/Crew Cohesion (8 techniques), Self-Care (17 strategies), and Use of Professional Resources (7). Approaches for leadership were also identified. Ratings were also collected regarding approaches to training resilience for exposure to remote combat and very graphic imagery/media. **DISCUSSION:** The presenter will discuss the results and implementation of training during technical school and mission qualification, drawing on Stress Inoculation Training principles for improved performance and mission-stress resiliency. Training of supervisors and other leaders in remote combat and operational stress control (RCOSC) will also be discussed. This presenter will then provide a brief summation of points from earlier panelists as well as recommendations regarding future research needs, selection, and methods for ongoing assessment and monitoring of remote combat stress for support and performance optimization of ISR personnel.
Learning Objectives:
1. Participants will gain understanding of remote combat stress prevention and mitigation measures.

[472] EFFECTS OF HUMAN FACTOR CHALLENGES ON REMOTELY PILOTED AIRCRAFT (RPA) AND THE DISTRIBUTED COMMON GROUND WEAPONS SYSTEM (DCGS) OPERATING ENVIRONMENT

A. Azad
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PROBLEM STATEMENT: The RPA/DCGS community represents a formidable high demand, global impact weapons system that has been engaged in 24/7/365 operations for more than a decade. With a 2300% increase in workload over 14 years, they have been operating at near 100% capacity for over a decade. RPA/DCGS shift workers have challenges accessing proper medical care, nutrition, and exercise. Medical evidence supports that shift workers have increased rates of cardiovascular disease, diabetes, depression, cancer and other psychological sequelae. Furthermore RPA/DCGS operators operate a weapons system that less than ergonomically optimal resulting is a dimly lit, cold environment with suboptimal instrument placement. **TOPIC:** RPA/DCGS operators are the remote equivalents of the "front end" and "back end" of an airborne platform. They engage in wartime operations on a daily basis. Contrary to popular belief, this form of warfare is very personal. The decisions they make can directly impact who lives and dies on the battlefield. Given the human factor challenges it makes this their mission more challenging. There are several isolating barriers encountered by RPA/DCGS operators. They are isolated by shift schedules, which limit formation of social networks proven to help promote resiliency. Operators are isolated by the classification of the work. They frequently cannot share events which may be causing them emotional distress with friends and family, nor their biggest successes. Given their work hours, operators have limited access to medical services, food options, child care and housing. Further, long commutes quickly turn 12 hour work days into 15 hours. **APPLICATIONS:** The RPA and DCGS operational environment represents a challenging and worthy arena for ensuring adequate medical/psychological support. The problems outlined above cannot be solved within the confines of the traditional medical system. Multiple studies have shown the effects of this type of warfare on RPA/DCGS operators.
Learning Objectives:
1. Effects of human factors challenges on the RPA/DCGS community.

[473] REMOTE COMBAT AND GRAPHIC MEDIA EXPOSURE IN ISR PERSONNEL

J. Rutland
480 ISRW, Augusta, GA

INTRODUCTION: Research has been conducted regarding the effects of exposure to combat in ground forces, both conventional as well as special operations personnel. The quantities and types of graphically violent events ISR personnel are exposed have not been empirically assessed. This portion of the panel will describe the types of events ISR Airmen view, study results regarding quantities, as well as impact of certain types of events. **METHODS:** Psychologists embedded with the 480th ISR Wing conducted focus groups and a survey on the effects of exposure to remote combat and graphic media (e.g. imagery, video, and audio) on psychological outcomes for ISR airmen, including members serving in the "kill chain". **RESULTS:** Results showed that frequency of exposure to remote combat operations and graphic media, albeit virtually, rivaled or exceeded exposure levels typical among special operations forces. As example data: 49% of participants had witnessed 10 more events of an enemy being blown up or burned alive; 27% had directed fire at the enemy 10 or more times; 18% had witnessed attacks on U.S. forces 10 or more times; 9% had witnessed torture 10 or more times. Cumulative

exposure as well as exposure to specific types of events (e.g., witnessing U.S. casualties, civilian casualties, atrocities committed by the enemy) was related to increased negative psychological impact. **DISCUSSION:** The types of ISR collection methodologies permit exposure to a great deal of information. This can include extensive details and observation over time of individuals in their family setting as part of targeting decision-making. This can also include witnessing very graphic events occur in near-real time, and protracted exposure to the aftermath of violent events as part of duty-related battle damage assessment. Witnessing certain types of events is associated with greater distress, particularly events involving women, children, and friendly forces. The "combat to cul de sac" challenges of ISR duties include experiencing such events juxtaposed with common tasks of parenting and homelife, with little transition between.

Learning Objectives:

1. Attendees will gain understanding of quantitites and types of ISR exposure to remote combat and graphic media.

[474] REMOTE COMBAT STRESS IMPACT AND MITIGATION: PSYCHOLOGICAL IMPACTS

R. Reichwald
693d ISRG, USAF, AE,

INTRODUCTION: Since 2001 there has been exponential growth in the number of remote combat operations conducted, and an insatiable demand for intelligence, surveillance, and reconnaissance (ISR) from various manned and unmanned aircraft. Today, growing numbers of "deployed-in-place" ISR personnel are exposed to the stresses of remote combat and graphic media exploitation on a daily basis, the effects of which are not well understood. **METHODS:** A multi-site, mixed-method study that included participant interviews, focus groups, and quantative survey measures was conducted with active-duty ISR airmen (n = 356) at three locations to examine psychosocial outcomes (PTSD, moral injury) associated with routine exposure to remote combat and graphic media exploitation operations. **RESULTS:** Exposure to remote combat and graphic media was related to increased symptoms of posttraumatic stress, moral injury, and other negative psychological outcomes. This study sheds new light on the emerging construct of moral injury and secondary traumatic stress - how it is experienced among ISR airmen. **DISCUSSION:** Current screening methods lack the sensitivity and specificity to accurately capture the psychological impacts associated with stresses related to ISR operations. While qualitatively distinct from ground combat, remote combat and graphic media exploitation operations present challenges to force health sustainment and performance optimization.

Learning Objectives:

1. Be able to identify some of the unique precipitants of moral injury in the ISR community.

Thursday, May 04 ***1:30 PM***
Plaza F

S-089: PANEL: SURGICAL CARE IN SPACE I -FUTURE INNOVATIONS

Sponsored by Space Medicine Association

Co-Chair: Mark Campbell
Paris, TX

Co-Chair: James Cushman
Oakland, CA

PANEL OVERVIEW: PROBLEM STATEMENT: Innovations in hardware development, new surgical techniques and crew medical officer training will enable future surgical care in space. **TOPIC:** Research innovations in surgical containment hardware, hemostasis techniques, crew medical officer training concepts, 3-D printing of surgical instruments and supplies, and hardware for diagnosis and monitoring are currently being developed and will be described. **APPLICATIONS:** Surgical innovations will enable future surgical care in space.

[475] DEVELOPMENT OF AN AQUEOUS IMMERSION SURGICAL SYSTEM FOR REDUCED GRAVITY

G.M. Pantalos
Cardiovascular and Thoracic Surgery, University of Louisville, Louisville, KY

INTRODUCTION: The ability to surgically treat trauma and other disorders in reduced gravity requires reliable wound containment. Parabolic flight testing of an aqueous immersion surgical system (AISS) to achieve this goal is reported. The AISS is a clear chamber with leak-free instrument ports that is filled with an immersion fluid (e.g. saline) to control bleeding, cleanse the wound, and maintain a clear visual field during surgical treatment. **METHODS:** During reduced gravity parabolic flight (0-G and Lunar-G), attachment of the AISS dome to a human torso was evaluated. Microprocessor driven, automated filling, purging, and emptying of a hemispherical AISS dome without air trapping was examined at filling rates of 0.5 and 1.0 L/min. Pressure regulation of the immersion fluid and the ability insert and withdraw endoscopic instruments without leakage across a range of pressures was evaluated. Staunching of bleeding by varying dome pressure was evaluated. The ability to close an incision in pigskin by suturing, tying knots, cutting suture, and stapling using endoscopic instruments inside the AISS dome was evaluated. **RESULTS:** The AISS dome could be successfully attached to a human torso in 0-G and Lunar-G using surgical drape with a leak-free interface up to 35 mm Hg. Different sized endoscopic instruments (5mm and 10 mm) could be inserted and withdrawn from the AISS dome without leakage up to 100 mmHg of dome pressure. AISS dome filled in reduced gravity without air trapping. Bleeding could be staunched by transient elevation of the pressure inside AISS. Purging of the dome with the exchange of 3 dome volumes was able to clear the view of the surgical field. Suturing, knot tying, cutting, and stapling to close an incision were all possible in 0-G with stapling being much easier and 20x faster to perform than suturing and knot tying. **DISCUSSION:** Key components of the AISS showed incremental performance progress toward the demonstration of surgical capability in reduced gravity. Reduced gravity filling of the AISS dome requires a balance among angular momentum, viscous interaction, and surface tension influenced by AISS geometry and immersion fluid inflow rate that will be optimized in future efforts. Surgical tasks can be performed given the challenges of 0-G and restrictions of the AISS dome. Integration of AISS subsystem components is anticipated with automated control of the AISS system to maximize the functionality of the AISS approach to surgical treatment.

Learning Objectives:

1. In the absence of normal gravity, operative sites or sites of trauma need to be contained and controlled for successful treatment and to avoid contamination.
2. In the absence of normal gravity, hydrostatic pressure no longer dominates the behavior of fluids in surgery. The influence of fluid surface tension, viscous interaction, and linear or angular momentum need to be considered for adequate control.
3. Adequate restraint of the surgical team, patient, supplies, and instruments are necessary to control the surgical environment.

[476] DIAGNOSTIC AND MONITORING DEVICES FOR SPACEFLIGHT

G.E. Strangman[1,2]
[1]Massachusetts General Hospital, Charlestown, MA; [2]Psychiatry, Harvard Medical School, Boston, MA

PROBLEM STATEMENT: Diagnostic and monitoring hardware is critical to being able to provide surgical care in space. **TOPIC:** On Earth, physicians deploy a broad range of tools for biomedical diagnosis and monitoring to help ensure optimal surgical procedure selection and outcomes. Spaceflight, however, places severe constraints on the available diagnostic and monitoring equipment, including strict limits on mass, power, volume and consumables of such devices. Consequent to these restrictions, certain standard-of-care capabilities may in fact be unavailable in flight, such as high-resolution MRI imaging. In addition, surgical applications will also need to share the limited available resources with all of the other, non-surgical medical problems that may be encountered during flight. We will discuss the medical device

constraints during spaceflight, the other medical issues of concern, and how these may affect the selection and conduct of surgical procedures during missions. **APPLICATIONS:** The development of new diagnostic and monitoring hardware is critical to being able to provide surgical care in space.

Learning Objectives:

1. Learn what sorts of diagnostic and monitoring tools are currently available for surgery during space missions.
2. Learn what the major constraints are for designing, deploying and using diagnostic and monitoring tools during space missions.
3. Learn how innovations in spaceflight diagnostic/monitoring tools may translate to Earth based medical care.

[477] HEMORRHAGE CONTROL IN MICROGRAVITY

K.W. Gregory
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While significant hemorrhage from injuries has not occurred in space missions thus far, with more ambitious, complicated missions involving movement of significant structural elements, it is reasonably likely that external or internal injuries resulting in hemorrhage will occur. Injuries occurring outside low earth orbit (LEO) will dramatically constrain options for management and represent a significant challenge to mission success. Given the 'anemia of space flight' with decreased red cell mass, along with relative hypovolemia, decreased ability to regenerate red cells and limited transfusion options, immediate and sustained control of bleeding to keep blood in the patient is of paramount importance. Tourniquets and manual compression using hemostatic dressings are presently available but have limited duration of use. Long term missions, outside LEO, will need new technologies such as self expanding dressings that can safely exert intra-wound hemostatic pressure and biodegradable injectable hemostatic, sealing foams. Rapid non-invasive diagnosis of the bleeding source, especially for internal bleeding will be critical. Hand held ultrasound, combined with newer artificial intelligence (AI) based image interpretation for diagnosis, treatment and triage will play a role. Magnetic resonance imaging/angiography would be ideal if technical challenges can be solved. Less invasive surgeries and procedures are possible with a crew surgeon. New blood component replacement technologies will be necessary. Treatments to suppress hemorrhagic shock and systemic inflammatory syndrome are needed for extended care. While newer AI platforms will be an important adjunct, provider training, experience and judgment may be the most important critical elements given real time communications delays at times in excess of 30 minutes which can represent a life threatening delay in proper treatment. Clearly, new technology is needed to provide the spectrum of interventions to successfully address hemorrhage for exploration class space missions that are envisioned.

Learning Objectives:

1. Understand unique challenges of managing hemorrhage in microgravity and during prolonged space travel.
2. Understand current and new technologies and techniques for managing hemorrhage during space flight or habitation.
3. Understand adjunctive issues and technologies for managing sequelae of hemorrhage during prolonged space flight.

[478] RESULTS OF A 2014 EXPLORATION CLASS MISSION SUBJECT MATTER EXPERTS (SME) TRAINING SURVEY

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PROBLEM STATEMENT: The most limiting factor in providing medical and surgical care on Exploration Class Missions will be the training and skills of the crew medical officer. **TOPIC:** Delivery of medical care to space explorers in low Earth orbit involves training of ground-based flight surgeons (FS), in-orbit crew medical officers (CMO), and physician astronauts (PA). Operational FS are physicians with medical education, training and mission experience in astronauts' health care. CMOs receive 2-42 hours of pre-assignment training and 7-26 post-assignment training. In anticipation of exploratory class missions (ECM), a 2014 NASA study offered a number of recommendations for "ideal medical training" for ECM to include: hands-on simulation training; increasing pre-mission training time to 80-120 hours; improving skill retention; protected clinical experience for PAs; and development of a pre-launch medical curriculum. A survey of 46 subject matter experts further identified training a smaller number of people in higher degree of skill set, using a NASA panel of experts plus military data to base increased training, mission-specific training, identifying areas of priority (which include surgical and behavioral) and training validation. **APPLICATIONS:** New concepts of training will be critical to optimize the limited resource of crew medical officer training time.

Learning Objectives:

1. Become familiar with key findings of the 2014 Exploration Class Mission SME survey regarding future ideas related to education and training of crew medical officers, flight surgeons and physician astronauts in preparation for autonomous medical capability in deep space.
2. Be able to compare and contrast present training methodology and potential ideas for further training based on SME input.
3. Identify several of the controversies as well as limitations related to training for autonomous medical care in deep space.

[479] AN EVALUATION OF PERCUTANEOUS CATHETER UTILITY IN THE MICROGRAVITY ENVIRONMENT USING COMPUTATIONAL MODELLING

L. Brown[1], T. Hargreaves[2], H. Ho[2], J. Windsor[1] and A. Phillips[1,3]
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INTRODUCTION: In long duration space travel minimally invasive surgical treatments including the use of percutaneous catheters are the preferred option for draining pathological fluid collections. This is due to their multi-functionality, ease of use, minimal weight, and therapeutic potential to avoid more complicated interventions. If a percutaneous catheter is to be used in a microgravity environment where fluid dynamics are altered compared to Earth, then it is imperative we understand how it can best be implemented. We undertook computational modelling to understand the difference between fluid flow within percutaneous catheters in microgravity and on Earth, to highlight points which need to be evaluated and optimised to ensure their success. **METHODS:** Using Solidworks CAD software (2016, USA), a 3D construction was made of a common clinically used 14 French, 30cm long percutaneous catheter containing six side holes. Volume flow rate (g/s) was established through the catheter using ANSYS (2016, USA) fluid dynamics software. Both Newtonian (water) and non-Newtonian (blood) fluid flows were simulated through the catheters. The simulation used Gravity at g=9.8 m/s as well as microgravity g=0 m/s. Factors of inlet and outlet pressure, temperature, catheter diameter (French) and length were individually evaluated. **RESULTS:** Volume flow rate of blood through the percutaneous catheter at 0G with inlet pressure at intra-abdominal pressure (5mmHg) and outlet pressure at atmospheric pressure was 2.6g/s. Factors which increased drainage included: increased catheter radius, reduced length, increased intra-abdominal pressure and decreased outlet pressure. The most important factor in microgravity compared to Earth was providing suction to enhance flow. Flow is reduced at 0G compared to 1G when inlet and outlet pressure are comparable. **DISCUSSION:** Specific factors involved in percutaneous catheter design can be modified to increase fluid flow and enhance pathological fluid drainage to improve patient outcome. Particularly relevant in the microgravity environment is the pressure differential across the catheter. This becomes even more important in transitional gravitational states. For example, intra-abdominal pressure is known to be reduced at 0G, and in launch and re-entry with increased Gz. Consideration needs to be given to design and manner of use of percutaneous catheters in the microgravity environment.

Learning Objectives:
1. To understand the altered fluid flow states that exist in microgravity when draining pathological fluid collections.

Thursday, May 04 ***1:30 PM***
Governor's Square 14

S-090: PANEL: RESIDENT RESEARCH AND QI/PI PRESENTATIONS: PT 1

Co-Chair: Richard Allnutt
Beavercreek, OH

Co-Chair: Mark Coakwell
Dayton, OH

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

[480] PROCESS FOR TIME AND ERROR REDUCTION IN MEDICAL REVIEW OF MILITARY STANDARDS

C.M. McLaughlin
USAF School of Aerospace Medicine, Wright-Patterson AFB, OH

MOTIVATION: The military struggles with continuity of care because of the mobility of both patients and medical providers. Because of that, significant medical conditions can occasionally fail to receive the attention they require. To ensure that all active duty Airmen meet military standards, the United States Air Force has instituted a standard work model for medical record reviews. The process is time consuming, and some treatment facilities have fallen behind in their efforts to institute the initiative. Improving this process will ensure that the Air Force identifies all Airmen who require closer medical scrutiny by way of a waiver or medical evaluation board. **OVERVIEW:** The standard form for the Air Force medical record review was evaluated and modified. The flow of the process was rearranged, extraneous steps were removed, and certain elements were automated. These efforts resulted in reduced completion times and greater patient throughput. These modifications highlighted additional opportunities for automation and systems integration. All modifications are aimed at reducing the time, resources, and errors of medical review. **SIGNIFICANCE:** This improvement has reduced the completion times for medical record review and increased the number of patients evaluated. In the short term, these efforts will reduce the number of medically significant events within the Air Force, such as inappropriate deployments or aircraft mishaps. In the long term, integrating automation within the military's electronic medical records system may provide a medical early warning system. While each service, nation, and civilian aviation agency is subject to different medical privacy guidance, similar processes can in some way be applied.
Learning Objectives:
1. Understand the significance of standard work and process automation in medical encounters.

[481] FUNDING FOR THE CERTIFIED PHYSICIAN EXECUTIVE PROGRAM FOR RESIDENTS IN AEROSPACE MEDICINE: A QUALITY IMPROVEMENT PROJECT

C.G. Mahakian
Residency in Aerospace Medicine, USAF School of Aerospace Medicine, Wright-Patteson AFB, OH

MOTIVATION: The Residency in Aerospace Medicine (RAM) at the U.S. Air Force School of Aerospace Medicine (USAFSAM) trains Air Force physicians for leadership roles. By integrating certification as Physician Executives, RAM graduates will be identified as possessing leadership and management skills, increasing eligibility for further command opportunities. **OVERVIEW:** The Certified Physician Executive (CPE) Program is designed to train and certify physicians in leadership and management areas. Currently the Air Force Medical Service offers one centrally funded scholarship for the CPE Program, which includes 150 h of management education, culminating in 3.5-d capstone conference. If a physician has a graduate management degree, then the 150 h of coursework is not required, reducing the cost of the program from $25K to $5K. The RAM at USAFSAM includes earning a Master of Public Health, which may qualify as a management degree. The residents would meet the requirements to attend the capstone conference, completing the certification at a lower cost. Because there is a lack of hard data concerning the CPE, a panel of senior USAF leaders from a variety of corps was gathered and discussed the importance of certification and if funding should be provided.
SIGNIFICANCE: Based on the discussion, a position paper was developed, outlining a plan to enable current and future RAMs to complete the certification. This ensures that an Air Force RAM has the opportunity to become a CPE while still in training, certifying that he or she possesses these skills. This will assist the RAM in assuming more management positions in a healthcare organization, shaping policy and practice. This plan could be incorporated into any RAM program, civilian or military.
Learning Objectives:
1. Understand the process to fascilitate U.S. Air Force Residents in Aerospace Medicine meeting the requirements to become Certified Physician Executives.

[482] DELIVERING CRITICAL SOCIAL SUPPORT TO FAMILIES OF UNMANNED AERIAL SYSTEMS AND INTELLIGENCE, SURVEILLANCE AND RECONNAISSANCE OPERATORS

S. Watkins-Nance
USAFSAM, Wright-Patterson AFB, OH

MOTIVATION: Aerospace medicine specialists have greatly benefitted from well-established social support groups while caring for family members and their deployed service members. To date, no comparable support groups exist for our unmanned aerial systems and intelligence, surveillance and reconnaissance military operators who are "deployed in garrison." A systematic model developed to provide mission critical family social support to these family members is needed to increase overall psychological well-being. **OVERVIEW:** Evidence-based medicine has proven that strong social support increases the likelihood of spouses' positive adjustment to deployment. Conversely, limited support leads to struggles with isolation, increased vulnerability to stress, and increased psychological distress. All services understand that a healthy family unit is integral to service member readiness, retention, and performance. It is also well recognized that spousal support plays an important role in the resiliency of military families; therefore, a family's well-being is essential to the effectiveness of military operations. A comprehensive literature review asserts that a multi-level therapeutic approach focusing on coping skills and problem solving may be the most effective method to deliver social support. Suggested interventions include a communication workshop and group counseling sessions. Using this research as the basis for our proposed model, a pilot program was developed to be launched in the near future. This program consists of an informational session describing specific unique stressors and the introduction of self-efficacious tools, followed by a group counseling session led by a clinical psychologist, chaplain, and flight surgeon.
SIGNIFICANCE: There is a recognized need to target spouses to improve family relationships, as the status of these relationships plays a key role in mission accomplishment. The way forward involves the creation of a standardized model that efficiently delivers mission-critical social support developed from feedback from pre- and post-program evaluations. Such a useful model will prove to be indispensable to both military and civilian aerospace medicine practitioners, since the number of active duty, Reserve, and Guard families will only increase as asymmetrical warfare continues its dominance.
Learning Objectives:
1. Identify specific psychological stressors unique to the unmanned aerial systems (UAS) and intelligence, surveillance and reconnaissance (ISR) military operator.

2. Recognize the need for social support for the families of unmanned aerial systems (UAS) and intelligence, surveillance and reconnaissance (ISR) military operators.
3. Define our role, as aerospace medical professionals, in process improvement programs dedicated to the mental health wellness of our unmanned aerial systems (UAS) and intelligence, surveillance and reconnaissance (ISR) military operators and their families.

[483] EVALUATION OF CURRENT LITERATURE REGARDING PHYSICAL EXAMS DURING THE ANNUAL HEALTH ASSESSMENT

M.R. Milner
USAFSAM, Wright-Patterson AFB, OH

MOTIVATION: While the periodic health assessment (PHA) is a standard part of every military member's life, the components have not always been standardized. This presentation looks at current evidence to determine appropriate periodic and occupational exams for our operational service members, specifically pilots, firefighters, and security forces. **OVERVIEW:** The PHA is essentially an assurance to many entities regarding the health of the operator. The Military Health Service expects the PHA to help maintain readiness of the armed forces during military operations, while the commander expects his or her troops to "Fight Tonight" for the Marine Corps or "meet [deployment] requirements" for the Air Force. At the same time, studies have shown the patient expects to have a history taken and an exam performed to provide a sense of health status. The provider, on the other hand, sees the PHA or annual exam as an opportunity to counsel on healthy habits and perform age-appropriate health checks while establishing long-term rapport with the operator. Modern technology is often touted as superior to current practice, while old habits can die hard. Executive health exams are offered at most large commercial health organizations (Mayo Clinic, University of California, Los Angeles) despite a lack of evidence showing any benefit for many performed evaluations. A cursory literature review finds a balance of pros and cons for the annual health assessment; however, these tend to be expert opinion at best. An in-depth literature review for occupational and annual exams reveals old data and conflicting information. **SIGNIFICANCE:** Physical exams are a time-consuming event that are assumed to meet many expectations. The ability to review this process and apply evidence-based findings to the annual assessment is pertinent to any physician, but especially those who care for operational service members.

Learning Objectives:

1. The audience will be able to create a framework within which they can improve the efficacy and efficiency of their practice while maintaining safe, patient-centered care.

Thursday, May 04 ***1:30 PM***
Governor's Square 15

S-091: SLIDE: OPERATIVE PERFORMANCE IN AEROSPACE INTERFACE OPERATIONS

Co-Chair: Stefan McAllister
Stone Mountain, GA

Co-Chair: Philippe Souvestre
Vancouver, British Columbia, Canada

[484] COMMUNICATION IN MULTI-TEAM SYSTEMS ON LONG DURATION EXPLORATION MISSIONS: DEVELOPMENT OF TRAINING INTERVENTIONS FOR BOUNDARY SPANNERS

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

MOTIVATION: Future long-duration exploration missions (LDEMs) will involve personnel and teams from multiple nations and their space agencies. This will result in a dynamic and complex multi-team system (MTS) where efficient communication and coordination will be essential to mission success. Because teams in this spaceflight MTS will need to liaise with each other, crossing multiple team boundaries, a critical role is that of the "boundary spanner," or those who connect each team together. Prime examples are the CAPCOM and RIO roles at NASA Mission Control. **OVERVIEW:** Because the successful collaboration of various teams in the MTS is crucial for mission safety and success, efforts to improve how the MTS communicates, coordinates, and operates for future LDEMs are needed. This challenge is further heightened by expected communication delays between crews and the larger MTS on Earth (~ 20 min one-way). Similar delays have created frustration, stress, and decreased communication effectiveness during simulated delays in space analogs (Fischer & Mosier, 2016). Due to these concerns, the need for effective boundary spanners, and improved MTS communication technologies, will be greatly increased. To better understand the LDEM MTSs, this paper will first describe and model the overall MTS used during Shuttle and ISS missions, identifying the key boundary spanners. Next, we will present an optimal model of the LDEM MTS, again focusing on who (e.g., what roles) will be the most critical boundary spanners in this model. Third, we will offer a potential training protocol for those in the boundary spanner role based on extant literature from other MTSs in extreme environments (e.g., military operations). These training recommendations are theorized specifically for a LDEM MTS scenario, reflecting interventions based around multi-cultural, multi-lingual, and temporal concerns – both teams across different time zones and with communication delays. **SIGNIFICANCE:** The model for LDEMs provides a thorough overview of the complexity and interdependence of various sub-groups in this MTS. This organizational understanding, coupled with training recommendations geared towards specific barriers key boundary spanners will face, will provide a significant benefit to planning future LDEMs and support effective collaboration between the hundreds of individuals who will comprise the MTS.

Learning Objectives:

1. To develop an understanding of a potential LDEM MTS model, and the complexities inherent in this type of mission.
2. To learn the critical role of boundary spanners and be able to identify characteristics of these roles in other organizations.
3. To understand suggested training techniques specific to boundary spanners in order to improve communication.

[485] EFFECT OF HUMAN-MACHINE INTERFACE DEGREES OF FREEDOM ON PERFORMANCE IN SPACE TELEROBOTICS

S.A. Hall and L. Stirling
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INTRODUCTION: There are many potential human-machine interfaces for controlling complex robotics. However, restrictions in hardware, software, or human capability may pose limits on the input device degrees-of-freedom (DoF). This study examined the human factors of input device DoF, hypothesizing that different limitations on interface DoF would affect operator performance and technique. **METHODS:** Experiments used a Canadarm2 simulator with a dual-joystick interface that was adapted to operate under limited DoF conditions. Four interfaces were compared – full multi-axis (FM), limited rotation (RL), limited translation (TL), and without simultaneous translation/rotation or "non-bimanual" (NB). Fifteen participants age 18-36 (12 M, 3 F) were trained on operating the Canadarm2 to approach and grapple a moving cargo vehicle within a ninety-second time limit. Participants had 14 practice trials followed by 13 experimental trials for each condition. Workload was assessed objectively through a secondary task (responding to a message indicator) and subjectively via the NASA TLX. Spatial ability was assessed using the Vandenberg Mental Rotation Test. One male subject failed to complete training and was disqualified from participation. This study was approved by the MIT Committee on the Use of Humans as Experimental Subjects. **RESULTS:** No significant difference was seen between FM and RL in task time or grapple success, and both were significantly different from TL ($p<<0.001$). NB exhibited significantly increased task time from FM and RL ($p<<0.001$), but no significant difference in grapple success rate. Order effects in workload measures were observed ($p<<0.001$). When rotating, participants increased time spent using multi-rotation for NB over FM ($p<<0.001$). **DISCUSSION:**

Similar performance between FM and RL suggests that restricting rotation may be preferred for interfaces with DoF design limits. For the NB condition, there was a decrease in task performance combined with an increase in multi-rotation even when tasks did not require multi-rotating, highlighting that NB generated poor operation strategies. The effect of order on differences in workload and multi-axis technique indicate potential for designing robotic training. This study suggests that the ability to have simultaneous rotation and translation inputs is an important contributor to controlling robotics in large environments with time-constraints.

Learning Objectives:

1. To understand how interface DoF design choices impact robot operator performance and system use.

[486] PROCEDURES: LESSONS LEARNED FROM A NASA ANALOG

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

PROBLEM STATEMENT: This report describes lessons learned from NASA Extreme Environment Mission Operations (NEEMO) 21 and highlights the significance of procedural deficiencies. **BACKGROUND/ LITERATURE REVIEW:** Although the science and practice of training on systems and technology has been extensively explored, an important element often neglected is the associated procedures. Suggested to reduce error, procedures are defined as the detailed, written instructions required when the task cannot be completed without them to achieve uniformity of the performance of a specific function. They are particularly important in extreme environments, especially long-duration spaceflight. Because space exploration is becoming more dangerous due to distance from Earth, and tasks in extreme environments require more independence of the crew, the key to success and safety is understanding the task and providing intuitive procedures that can be executed autonomously. **CASE PRESENTATION:** Students at Embry-Riddle Aeronautical University and engineers at Micro Aerospace Solutions designed a free-space optical communication system (FSOC) to send data between two or more arrays. This system was deployed during the NEEMO 21 mission, which took place at the Aquarius facility—a small habitat operated by Florida International University, located approximately 19 m underwater off the coast near Key Largo, FL. The primary goal was to deploy and test the FSOC with three key objectives: 1) to design an FSOC and conduct tests on range/strength of data link between two arrays to establish optimal and maximum distances; 2) to employ an iterative design process to design, test, and redesign the procedures, and 3) to administer training to the crew and provide support during the mission. Although system deployment and testing was a success, missing information and discrepancies in the procedures produced inefficient time-management, deviations, and a lack of confidence in the task. **OPERATIONAL RELEVANCE:** Given the criticality and risk associated with long-duration spaceflight, this case highlights the importance of procedures. Procedures will have to be more effective by including a risk assessment and frequency count of step(s) in order to reduce the likelihood performance errors and increase safety. This case study exemplifies the necessity of procedures in extreme environments in order to maintain success and safety of the mission.

Learning Objectives:

1. Indicate and illustrate the importance of procedures in an extreme environment.

[487] A LONGITUDINAL MULTICENTER STUDY ON THE EFFECT OF CREW RESOURCE MANAGEMENT ON SAFETY CLIMATE IN HEALTHCARE

M.H. Haerkens[2,1], W. van Leeuwen[3], M. Kox[2], P. Pickkers[2] and J.G. van der Hoeven[2]
[1]Wings of Care, Vught, Netherlands; [2]Intensive Care, Radboud University Medical Center, Nijmegen, Netherlands; [3]Center for Man in Aviation, Royal Netherlands Air Force, Soesterberg, Netherlands

INTRODUCTION: Human factors account for the majority of adverse events in both aviation and medicine. We determined whether implementation of a Human Factors awareness training entitled "Crew Resource Management (CRM)" is associated with improved safety climate. **METHODS:** An observational 6-year study in 19 critical clinical departments in three university and seven teaching hospitals in the Netherlands that participated in a CRM intervention. To assess changes in safety climate, all personnel were invited to fill out the Safety Attitudes Questionnaire (SAQ-NL) before the CRM-training (baseline measure, n=1412), one year after receiving CRM training (post-implementation measure, n=558), and two years after training (follow-up measure, n= 270). Furthermore, factors for successful CRM implementation were analyzed and we evaluated points for improvement healthcare professionals wanted to implement after receiving initial CRM training, and possible existing barriers to transfer of the CRM training to the work floor. **RESULTS:** The overall response rates averaged 68.7%, 41.0% and 77.7%, respectively. There was a positive effect of CRM training on all six SAQ-NL domains over time ($p<0.001$), with a medium effect size. The success factors 'strong clinical leadership' and 'participation of 90-100% of managers in the training' were associated with a positive effect on the Perceptions of Management domain. The availability of a complication registration was associated with improved Working Conditions domain scores. Furthermore, integration of simulation training into CRM implementation was related to improved Safety Climate, Perceptions of Management, and Working Conditions domains. The results from points for improvement and process observations revealed that clinical professionals perceive the need for mandatory (de)briefings and more structured patient handovers, as well as improved individual leadership/ followership and performance feedback skills. **DISCUSSION:** Our data indicate an association between CRM implementation and an improved safety climate, and we identified factors that are important for successful CRM implementation. This could facilitate further optimization of healthcare CRM implementation, and increase awareness of possible barriers.

Learning Objectives:

1. The participant will be able to understand the impact of a CRM culture intervention on safety climate in the critical care environment.
2. The participant will be able to identify success and fail factors of CRM implementation in Healthcare.

[488] FORM MEETS FUNCTION: DETERMINING CONTENT AND DESIGN FOR MEDICAL CHECKLISTS

A.L. Clebone[2] and B. Burian[1]
[1]Human Systems Integration Division, NASA Ames Research Center, Moffett Field, CA; [2]University of Chicago School of Medicine, Chicago, IL

PROBLEM STATEMENT: An understanding of human factors principles is necessary to create a useful medical checklist. **TOPIC:** Creating a medical checklist is an involved process that includes addressing a number of human factors principles. At a minimum this includes determining if a checklist is the correct tool needed and if so, determining its content and design, validating and testing it, induction, training, implementation, and ongoing evaluation and revision. This presentation will focus on the second step of the checklist development process: determining content and design. **APPLICATIONS:** Checklist content is driven by its intended use. Unnecessary content decreases checklist effectiveness especially since the use of the checklist itself may interfere with workflow. Multiple methods may be used to determine content, including literature reviews, focus groups, Delphi consensus, task analyses, subject matter interviews and personal experience. A checklist's design must reflect and support its use. For example, some crisis checklists, similar to aviation checklists, imply that physicians should begin with the first item and proceed step-by-step, such as numbering each step in order and placing the word 'Start' at the top of a list of items. However, physicians may first use their existing knowledge to try solve the problem, referring to a checklist only later in a crisis for further ideas or specific information, such as drug dosages. Our research group deemed this type of checklist use "sampling" and it represents a distinct methodological and philosophical change from the way that critical event checklists are used in aviation. Checklists designed for use in a stepwise fashion do not readily support this specific kind of information-seeking behavior. Medical checklists that too closely follow an aviation-oriented design may therefore be ineffective or even disruptive. **RESOURCES:** Burian, B., Clebone, A., Dismukes, R., Ruskin, K. More than a

Tick Box: Medical Checklist Development, Design, and Use. Submitted for Publication.

Learning Objectives:
1. To understand the steps for creating a medical checklist.
2. To examine specific design principles for medical checklists.

Thursday, May 04 ***1:30 PM***
Governor's Square 12

S-092: PANEL: IMPACT OF AEROMEDICAL EVACUATION ON PATIENTS

Co-Chair: Raymond Fang
Baltimore, MD

Co-Chair: Catriona Miller
Baltimore, MD

PANEL OVERVIEW: This panel represents an overview of the results of multiple studies on the impact of aeromedical evacuation on combat casualties. Casualties undergoing aeromedical evacuation face numerous additional stressors, including noise, acceleration exposure (g-forces, vibration), changes in tempearture, and changes in pressure (hypobaria, hypoxia) and little is known about the effects of these stressors. The first presentation, from C-STARS-Baltimore and University of Maryland presents the results of the impact of aeromedical-evacuation (AE) relevant hypobaria and hypoxia on mild traumatic brain injury (TBI) in a rat underbody blast model. The second presentation, from Naval Medical Research Center, investigates the impact of AE hypobaria and hypoxia in a model more representative of combat casualties utilizing a large animal polytrauma (TBI and hemorrhagic shock) model. The third presentation, presents an overview of preclinical research in progress at C-STARS Baltimore and University of Maryland on the effects of AE hypobaria and hypoxia, going beyond the TBI and polytrauma models to include additional combat casualty complications such as sepsis and the impact on other vital organs, such as the gut intestinal lumen. In the final presentation from the USAF School of Aerospace Medicine Aeromedical research department, patient-centric vibration profiles on C-130H airframes is characterized, with the aim of developing hypotheses regarding possible mechanisms for secondary insult due to exposure during AE.

[489] AEROMEDICAL EVACUATION-RELEVANT HYPOBARIA WORSENS AXONAL, CEREBROVASCULAR, AND NEUROLOGIC INJURY CAUSED BY UNDERBODY BLAST-INDUCED HYPERACCELERATION

G. Fiskum[4], Y. Hsieh[4], J. Proctor[4], W. Fourney[5], F. Tantchou[4], C. Miller[2], A. Puche[3], R. Rosenthal[6] and R. Fang[1]
[1]U.S. Air Force, Baltimore, MD; [2]Department of Aeromedical Research, U.S. Air Force School of Aerospace Medicine, Baltimore, MD; [3]Anatomy and Neurobiology, University of Maryland School of Medicine, Baltimore, MD; [4]Anesthesiology, University of Maryland School of Medicine, Baltimore, MD; [5]University of Maryland College Park, College Park, MD; [6]University of Maryland Baltimore, Baltimore, MD

INTRODUCTION: Occupants of vehicles targeted by IEDs often suffer TBI and are air-evacuated (AE) to a military medical center within a few days post-injury. This study tested the hypothesis that exposure of rats to AE-relevant hypobaria worsens white matter axonal injury and cerebrovascular injury caused by underbody blasts. **METHODS**: Rats were exposed to an explosive blast with a peak acceleration (G-force) of 100G within 2 msec. Rats were exposed to normobaria or hypobaria (8000 ft) for 6 hr, starting at 6 hr, 1, 3 or 6 days after blast exposure with either 21 or 100% oxygen. At 7 days post-blast, brains were analyzed for evidence of axonal fiber injury (de OImos silver staining) and cerebrovascular injury (von Willebrand Factor (vWF) gene expression and immunoreactivity). Animals were also used for neurobehavioral assays at 14 days post-blast. **RESULTS:** The number of silver-stained axonal fibers in the internal capsule was significantly, two-times greater in animals (n = 10/group) exposed to 100G blast than in shams. Animals exposed to 6 hr hypobaria at 6, 24, 72 hr and 6 days after blast all exhibited significantly more silver-stained fibers than normobaria. Rats exposed to 100% O_2 during hypobaria displayed significantly greater silver staining than those exposed to 21% O_2. The % of the cortical area occupied by vWF immunoreactivity was over ten-times greater in blast/normobaric animals or blast/hypobaric animals than shams. Quantitative rtPCR indicated a 10-fold increase in vWF gene expression at 7 days post-blast. The number of foot-faults during the balance beam test at 14 days post-blast was significantly greater in blast/hypobaric (100% O_2) animals compared to shams, or blast/hypobaric (21% O_2) animals. **CONCLUSIONS:** Exposure of rats to a blast-induced acceleration load of 100G increases markers of cerebrovascular injury at 7 days and was exacerbated by AE-relevant hypobaria at 24 hr post-blast. Blasts increased axonal fiber injury in the internal capsule, which were further elevated by exposure of rats to hypobaria within 6 hrs and up to 6 days. Exposure to 100% O_2 during hypobaria at 24 hr post-blast resulted in greater axonopathy than 21% O_2. The increase in markers of brain injury caused by exposure to AE-relevant hypobaria raises concerns about when it is safe-to-fly following even mild TBI. Our results also suggest that inspiration of very high levels of oxygen can exacerbate the deleterious effects of hypobaria on the brain following TBI.

Learning Objectives:
1. The learning objective is to understand the potential complications of aeromedical evacuation of patients with traumatic brain injury.

[490] C-STARS BALTIMORE PRECLINICAL RESEARCH ON EFFECTS OF AEROMEDICAL EVACUATION-RELEVANT HYPOBARIA ON TRAUMATIC BRAIN INJURY, HEMORRHAGIC SHOCK & SEPSIS

C. Miller[2], G. Fiskum[3], R. Fang[1], A. Cross[4], D. Stein[4], T. Coksaygan[4], A. Puche[4] and R. Kozar[4]
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INTRODUCTION: Previous studies using either impact- or blast-induced traumatic brain injury (TBI) indicate that exposure of rodents to aeromedical evacuation (AE) relevant hypobaria within 1-3 d after injury worsens neurologic outcome. Hypobaria also exacerbates cellular inflammatory reactions, cerebrovascular injury, damage to axonal fibers, and neuronal death. Moreover, exposing animals to 100% oxygen (O_2) during hypobaria further worsened outcomes in comparison to hypobaria under 28% O_2. **METHODS:** Considering the potential clinical importance of these findings, new studies are in progress to determine if hypobaria worsens mortality, systemic inflammation, and damage to other vital organs in rat models of polytrauma (TBI plus hemorrhagic shock) and sepsis (cecal ligation and puncture). Damage to the gut following polytrauma is being analyzed as early as 3 h post-injury, since early release of gut-derived factors from the shocked gut can enter the mesenteric lymph, activate neutrophils, and potentiate the development of multiple organ dysfunction syndrome. At 24 h following polytrauma or cecal ligation and puncture, rats are either maintained under normobaric conditions or exposed to 6 h hypobaria equivalent to 8,000 ft cabin pressure. The effect of hyperoxia on survival and other outcome measurements is based on comparisons between animals exposed to hypobaria under 21-28% vs. 100% O_2. Brain and other tissues are analyzed at 48 h, 7 d, and 30 d post-injury for evidence of inflammation, oxidative stress, and cell death. Mitochondria are isolated from both brain and heart tissue to assess the degree of metabolic dysfunction. Animal behavior is observed and quantified for up to 28 d as a clinically relevant measure of traumatic and septic encephalopathy. **RESULTS:** These studies are in progress. Updated results will be presented at the time of the meeting. **DISCUSSION:** Results from animal models of TBI followed by exposure to AE-relevant hypobaria are sufficient to raise concern about the potential deleterious effects of AE on the injured brain within at least a few days post-injury. Other combat-relevant animal models are in progress to characterize the effects of hypobaria during en route care following more complex injuries, including hemorrhagic shock, sepsis, and TBI, both alone and in combination.

Learning Objectives:
1. The learning objective is to understand the potential effects of aeromedical evacuation relevant hypobaria on trauma patients.

[491] CHARACTERIZATION OF PATIENT VIBRATION EXPOSURE DURING AEROMEDICAL EVACUATION ON THE C-130H

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INTRODUCTION: Of the aeromedical evacuation (AE) stresses of flight taught, vibration remains the most inchoate in terms of knowledge regarding its potential hazardous impact to patient comfort, health, and outcomes. Military and international standards set limits to reduce risks for fatigue and back/neck pain due to exposure to whole-body vibration; however, these are based on occupational exposures to healthy individuals. This is the first study to date to characterize patient-centric vibration profiles on airframes, with the aim of developing hypotheses regarding possible mechanisms for secondary insult due to exposure during AE. **METHODS:** A crosssectional study was conducted to obtain vibration profiles for simulated seated and litter patients onboard a C-130H Hercules during eight training flights supported by the 375th AE Squadron and the 123rd Air National Guard. Vibration data were collected using the REVER data acquisition system with sensors fixed to the subject's head, torso, legs, and seat/litter points of contact. Collection occurred during all stages of flight (taxi, take-off, climb, level flight, descent, and landing) and for patient positions across the aircraft (i.e., left/right side; fore, mid, and aft for seats and litters; middle and lower tiers for litters only). Unweighted power spectral densities and root mean square acceleration magnitudes were computed in MatLab, and weighted point vibration total values were compared to ISO 2631-1 guidance for health risk assessment. **RESULTS:** Observed vibration data fell into two frequency bandwidths depending on source: peaks at 68 Hz corresponding to the blade-pass-frequency and sub-10 Hz corresponding to aircraft turbulence and perturbation. Within the 68-Hz bandwidth, root mean square vibration magnitudes ranged from < 0.1 ms^{-2} to > 1.2 ms^{-2}, with the greatest amplitudes observed for forward stanchions on the left side of the aircraft, in the lateral (y-axis) direction. High variability was observed within the sub-10-Hz data set, although these vibrations had the greatest transmissibility to the head. **DISCUSSION:** The results confirm the anecdotal evidence for the C-130: vibration is strongest in the forward compartment and slightly stronger on the left side. The specific magnitudes and directionality data will drive future investigations into the effects on physiology; additionally, they provide criteria for future equipment design recommendations.

Learning Objectives:
1. Describe the methods being used to characterize litter and seated patient vibration during simulated aeromedical evacuation.
2. Describe the differences in patient vibration exposure at different locations in the C-130 aircraft.
3. Recognize the higher frequency multi-axis vibration exposures occurring during C-130 medical evacuations.

[492] BRAIN TISSUE OXYGENATION WAS REDUCED IN POLYTRAUMA SWINE DURING SIMUALTED AEROMEDICAL EVACUATION

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INTRODUCTION: The rapid aeromedical evacuation of combat casualties to definitive care is current standard practice in the military and in civilian rural areas without higher level trauma centers. Little is known about the effects of long range aeromedical evacuation in hypobaric environments on trauma patients. Casualties are often "stabilized along the continuum of care," rather than "stable" prior to evacuation. These patients may be more vulnerable than healthy passengers to the physiological challenges of altitude. We investigated the effects of hypobaria during aeromedical evacuation on systemic and neurologic physiology in a swine polytrauma model of traumatic brain injury (TBI) and hemorrhagic shock (HS). **METHODS:** After fluid percussion TBI and controlled hemorrhage (40% estimated blood volume), anesthetized swine (n=6/group) were stabilized followed by a 4 hour aeromedical evacuation simulated in a hypobaric chamber with atmospheric pressure equivalent to an altitude of 8000 ft. (HYPO). Control animals were kept at normobaria. Systemic and neurophysiologic data were collected. Blood was analyzed for complete blood count, arterial gases, and electrolytes. Data were analyzed with repeated-measures ANOVA; $p<0.05$ was considered significant. **RESULTS:** Baseline parameters, including arterial oxygen pressures, were similar in both groups. Brain tissue oxygenation (% change over time) was significantly lower ($p=0.021$) and arterial lactate was significantly higher in the HYPO group ($p=0.003$). Two hours into flight, mean arterial pressure, mean pulmonary artery pressure and heart rate were increased in HYPO animals while cerebral perfusion pressure decreased in those animals, but did not reach statistical significance compared to the beginning of flight. However, a subgroup analysis of those parameters after 115 min demonstrated a significantly elevated MAP ($p<0.001$) and MPAP ($p=0.047$) in HYPO animals. **DISCUSSION:** In this study, prolonged hypobaria resulted in adverse systemic and neurologic physiology despite stable arterial partial pressures of oxygen. Particular attention needs to be given to casualties two hours into flight. These findings suggest that hypobaric conditions have the potential to destabilize polytrauma patients during aeromedical evacuation. Further studies are indicated to simulate other en route care scenarios and possibly re-evaluate casualty evacuation guidelines.

Learning Objectives:
1. The learning objective is to understand the potential complications of prolonged hypobaria on combat casualties.

Thursday, May 04 ***1:30 PM***
Governor's Square 11

S-093: SLIDE: CARDIOVASCULAR DISEASE AND RISK FACTORS

Co-Chair: Denise Baisden
Keller, TX

Co-Chair: Jeb Pickard
San Antonio, TX

[493] THE NATURAL HISTORY OF CORONARY ARTERY DISEASE IN UNITED STATES AIR FORCE AVIATORS - BENEFITS OF LESS TESTING & MORE EXERCISE, COFFEE, AND ALCOHOL

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INTRODUCTION: Atherosclerotic cardiovascular disease (CAD) is the leading cause of denial or loss of licensure in both civilian and military aviators. For pilots and other military aviators, the various modes of presentation (sudden cardiac death, myocardial infarction (MI), unstable and stable angina, and ischemic arrhythmias) are of paramount concern because of possible sudden incapacitation or performance decrement. A retrospective review of known CVD in aviators was analyzed to evaluate for possible strategies to prevent sudden incapacitation. **METHODS:** The U.S. Air Force (USAF) School of Aerospace Medicine's Clinical Sciences Database contains over 1.2 million cardiac studies on over 283,000 aviators, with 172 unique aviators with CVD to include 33 with myocardial infarctions and 76 revascularizations. This retrospective data was used to evaluate prevalence, baseline risk factors, presenting symptoms, and outcomes of aviators with CVD. **RESULTS:** Annual cardiac event rates in apparently healthy USAF aviators are approximately 0.15% per year for males aged 35-54 years.

Stress test screening in the unselected aviator population yielded a positive predictive value of 13% for significant CAD on angiography and an event rate (death, MI or revascularization) of 0.5%. In those requiring revascularization, the most common presenting symptom was myocardial infarction (MI) at 34%, followed by chest pain at 30% while screening only found 13%. At 10 years follow-up there was no recurrent MI or death, however there was a 14.3% progression rate to severe CAD. Rates of cardiovascular outcomes (primary and secondary) were lowest in those that performed moderate exercise and drank coffee and alcohol regularly. **DISCUSSION:** Military aviators have a much decreased yet still significant risk of CAD compared to the civilian population. However, retrospective analysis suggests most cases of myocardial infarction and revascularization in USAF aviators would have not been detected by cardiac stress testing even with nuclear imaging. Fortunately, aviators appear to have much better outcomes status post CVD diagnosis with decreased morbidity and mortality than most published non-aviator literature. Exercise and regular coffee and alcohol use appears to decrease cardiovascular risk.

Learning Objectives:

1. Understand the prevalence of coronary artery disease in the military aviator.
2. Fully recognize the short and long term risk of Coronary Artery Disease in the aviator.
3. Understand fully the risks and benefits to screening for coronary artery disease in the aviator population which will allow an informed decision by both the aeromedical examiner and aviator.

[494] TEN YEARS OF HEART TRANSPLANTS: FAA EXPERIENCE

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INTRODUCTION: A history of heart transplantation remains specifically disqualifying for FAA airman medical certification. McGiffin analyzed data from 6510 transplant patients with up to 12 years follow-up (J Heart Lung Transplant 2005;24:259-69), showing that there is a subset of heart transplant patients with low risk for incapacitation similar to the general population. In September 2006, risk assessment criteria were adopted to consider pilots with heart transplants for special issuance (SI) of third-class (general aviation) medical certificates. The objective of this current study was to review the FAA medical certification experience with heart transplantation from 2006-2016. **METHODS:** The Medical Appeals Branch cases database was queried for all heart transplant cases from 2006-2016, and pertinent de-identified data was extracted. **RESULTS:** 14 male airmen were reviewed with: mean age 61.2 yrs (21-74); mean months since transplant was 66 (13-264), median flight hours was 1270 (0-25,000). At initial review, 2 were denied for unrelated non-cardiac conditions, and 12 were special issued. In 318 person-months observation: no known flight events have been reported. Only 1 transplant-related complication has been reported (malignancy). Currently, 4 airmen remain certificated; 7 airmen allowed SI to lapse without explanation; and 1 airman had SI withdrawn for failure to provide information on a non-cardiac issue. **DISCUSSION:** Study limitations include small sample size, relatively short follow-up, and 7 airmen allowing their SI's to lapse without explanation or further follow-up. The available evidence suggests that current strict selection criteria have thus far allowed safe certification with low risk for adverse medical events. The single possible transplant related event was a benign malignancy; but the airman was later reissued after resolution with no changes in immunosuppressive therapy. The high unexplained lapse rate hinders interpretation of the outcome data and is a barrier to considering expansion of the program to first- or second-class certification. Current policy remains supportable, but may be considered if supported by additional case follow-up and evidence-based advances in heart transplant treatment and prognosis.

Learning Objectives:

1. Understand the current experience of the FAA with medical certification of pilots post heart transplant.
2. Understand how criteria were developed for risk assessment of airmen with heart transplants, and how future FAA experience and heart transplant science and practice may guide future policy.
3. Understand the implications of the FAA heart transplant certifications selection experience to protocols for other solid organ transplantation.

[495] CARDIOVASCULAR AND NEUROLOGICAL OUTCOMES IN U.S. AIRMEN WHO HAVE A STROKE AND ATRIAL FIBRILLATION

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INTRODUCTION: Atrial fibrillation (AF) is considered a disqualifying aeromedical condition that requires a special issuance for a pilot to receive medical certification. Epidemiologic studies of AF are limited within the aviation arena, with most studies restricted to case reviews of individuals for fitness to fly as the best means of assessing risk of future medical events. This study was the first to examine adverse outcomes in high risk pilots with previous history of both AF and stroke. **METHODS:** All airmen who had an exam and an initial stroke or transient ischemic attack (TIA) between 2002 and 2012 were included in this study. In addition, the airman must have also had AF at some point during his medical history. All records were individually reviewed to determine stroke and AF history, medical certification history, and recurrent events. Each airman was followed from the date of his stroke through February 28, 2016. Variables collected included medical and behavioral history, stroke type, gender, BMI, medication use, and the cardiovascular and neurological outcomes of interest. Major recurrent events included stroke, TIA, cerebrovascular accident or other major events. **RESULTS:** Of the 141 airmen, 14.2% experienced a recurrent event. Of these 20 events, 13 were recurrent strokes, while the remaining 7 were classified as other major adverse events. There were no myocardial infarctions or deaths noted among these airmen. The average duration that the airmen was in the study was 4.1(SD = 3.2) years. Of the 141 airmen, only 52 airmen were followed for at least 5 years. At 6 months, the recurrent rate was 5.8% with 85% of the airmen still in the study. At 1 year, the recurrent rate was 7.4% with 81% of the airmen still in the study. The overall 3-year recurrent event rate was 8.5% with 79 airmen remaining in the study. The 5-year rate was 17% with 52 airmen remaining in the study; the overall rate was 27% but only 20 airmen remained in system at the end of the study. There was no statistical difference between the groups by CHA_2DS_2-VASc scores. **DISCUSSION:** We found use of anticoagulation therapy was the only significant factor concerning risk of recurrent event. One possibility of our apparent lack of significant associations is that $CHADS_2$ and CHA_2DS_2-VASc scores are not appropriate tools for stratifying risk in a general aviation population, but further studies are needed to validate our findings and determine an appropriate tool for the aviation community.

Learning Objectives:

1. Atrial fibrillation and it's risks from an aeromedical standpoint as well as the pitfalls of some risk stratification tools.
2. Appropriate treatment of atrial fibrillation in an airman.
3. Findings from original research about atrial fibrillation and stroke in the FAA pilot population.

[496] HYPERTROPHIC CARDIOMYOPATHY IN AN ASYMPTOMATIC PARACHUTIST – A CASE REPORT

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PROBLEM STATEMENT: This case report describes a middle-aged parachutist, very well trained, asymptomatic, who was diagnosed at his annual medical exam with hypertrophic cardiomyopathy (HCM). **BACKGROUND:** Adequate natural history data of HCM, with studies of large numbers of subjects and long-term follow-up, are lacking in paratroopers. Aeromedical concerns are related mainly to the risk of sudden death which is reported in middle-aged adults, even without prior symptoms. However, most studies do not underline nonfatal events that can be aeromedically quite important, potentially incapacitating events (atrial fibrillation, peripheral embolization, syncope, chest pain, dyspnea, lightheadedness). Furthermore, a common dilemma is differentiation of athlete's heart from HCM. **CASE PRESENTATION:** The studied subject was a 46-yr old Romanian parachutist. He performed his annual medical exam at N.I.A.S.M, Bucharest. The subject had no pathology in his medical history, had no relative with known significant disease or sudden death. He can perform intense physical

training. Clinical exam was normal (no systolic murmur).Laboratory testing was normal, except for a mild hypercholesterolemia. ECG revealed q waves laterally, negative T waves anterolaterally, increased left ventricular voltage (note: ECG records in previous years were normal).Doppler echocardiography showed important left ventricular hypertrophy with diastolic dysfunction and a mild mitral regurgitation. Stress echocardiography emphasized a significant dynamic left ventricular outflow tract obstruction, no symptoms and exaggerated blood pressure response. Holter ECG 24 hours revealed rare isolated premature ventricular beats. Cardiac magnetic resonance imaging confirmed obstructive hypertrophic cardiomyopathy and revealed a mild dilation of ascending aorta. Differential diagnosis was with athlete's heart and Fabry disease. After completion of medical investigations, the parachutist was disqualified and received therapy with beta blockers. Familial screening was undertaken. **CLINICAL RELEVANCE:** This case highlights the possibility to diagnose a rare disease in a middle-aged asymptomatic parachutist, apparently healthy and the importance of serial monitoring for diagnosis and evidence of disease progression and complications. We need larger studies to better understand the influences and potentially harmful effects of high-level strenuous activities on parachutists with HCM to subsequently help prevent heart injury.

Learning Objectives:

1. Discuss the positive, differential diagnosis and prognosis of hypertrophic cardiomyopathy.
2. Review the imaging tests in hypertrophic cardiomyopathy.
3. Discuss the aeromedical implications of hypertrophic cardiomyopathy in asymptomatic paratroopers.

[497] PREVALENCE OF IMPAIRED FASTING GLUCOSE IN U.S. NAVAL AVIATION PERSONNEL

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INTRODUCTION: The aim of aerospace medicine is to ensure safety of flight. The USN requires an impaired fasting glucose (IFG) waiver for aviation duty as outlined in the Aeromedical Reference and Waiver Guide (ARWG). Recent guideline changes in IFG values can now encompass up to 25% of the general population. How IFG affects safety of flight is unclear. We performed this retrospective chart review to define IFG prevalence in USN aviation personnel. **METHODS:** An IRB-approved retrospective chart review was performed. Using ICD codes, we identified all initial IFG waiver requests submitted to NAMI during years 2011-2015; these included active/reserve duty and all classes of aviation personnel. IFG was defined as fasting blood glucose ≥ 100mg/dl on more than one testing. We then used standard Medicare reimbursement rates and ARWG-required tests to calculate IFG waiver cost to the government during study period. Descriptive statistics were used to describe our study population. **RESULTS:** 207 initial waiver requests were identified during study period. Our study population had the following characteristics: average age of 35 years, 63% officers, 43% pilot, 94% male, and 72% Caucasian. IFG prevalence was 0.49%, considerably lower than the approximately 25% prevalence reported in general population. Direct medical costs of waiver submission and continuation for the 207 personnel were estimated at over $99,000. **DISCUSSION:** IFG in USN aviation personnel is 1/50th what it is in the general population. Clearly, the two populations are different; the USN population is generally healthier with fewer chronic medical conditions. Further, the cost to the government is not insignificant, estimated at over $99,000 over 5 years. This value is thought to be an underestimate since it is based on Medicare reimbursement values and because it does not include indirect costs such as time away from the workplace. IFG represents a pre-disease state with few, if any, aeromedical implications. Based on our data, the authors recommend deferring IFG management to member's primary care manager and a change in USN aeromedical policy - remove IFG as a condition disqualifying for aviation duty in order to reduce waiver administrative burden and cost to the government. **Disclaimer:** The views expressed in this abstract are those of the authors and do not necessarily reflect the official position of the Department of the Navy, Department of Defense, nor the U.S. government.

Learning Objectives:

1. Understand the aeromedical implications of impaired fasting glucose.

[498] CONTINUOUS GLUCOSE MONITORING AND ISSUANCE OF FIRST CLASS MEDICAL CERTIFICATE

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INTRODUCTION: Insulin-treated diabetes mellitus (ITDM) has always been a cause for concern in the aviation medicine community. In the general population the incidence of hypoglycemia is high even in those on stable insulin regimens. Due to incapacitation risks, the Federal Aviation Administration (FAA) has only recently begun to consider certification for commercial pilots carrying passengers or cargo. Advances in continuous glucose monitoring (CGM), however, may be able to reduce the risk of hypoglycemia as well as hyperglycemia to a level acceptable for issuance of a first class medical certificate. **METHODS:** The current literature regarding safety and efficacy of CGM devices was reviewed as well as manufacturer information and current applications for first class medical certificates. The regulations of Transport Canada and the FAA were reviewed. **DISCUSSION:** There remain many obstacles to certification of ITDM pilots. The majority of data is in young type 1 diabetics and the primary endpoint of most of the early research is improved glucose control, not prevention of hypoglycemic episodes, both of which are important departures from our population and goal. There is no standard for reporting CGM data, making interpretation and comparison of data difficult. The current technology also requires frequent calibration of the devices with fingerstick glucose monitoring which may be impractical during flight operations. Interestingly, while the FAA will issue a third class medical certificate for an ITDM pilot, Transport Canada will only issue a first class medical certificate with the stipulation that it is only valid for dual pilot operation. This conflict raises the question of whether the implicit added risk of an ITDM pilot is acceptable for commercial aircraft requiring two pilots for all operations. While all these issues complicate the matter, the technology is progressing rapidly. Future developments include glucose trending to prevent hypoglycemia, integration with insulin pumps to have automatic shutoffs, and less reliance on fingersticks for calibration. These types of advancements could make the first class medical certificate for ITDM pilots a reality in the near future.

Learning Objectives:

1. Understand the current advances in continuous glucose monitoring.
2. Understand the challenges that need be overcome before ITDM pilots can be issues a first class medical certificate.

Thursday, May 04 ***1:30 PM***
Exhibit Hall

S-094: POSTER: CLINICAL AND OPERATIONAL AEROSPACE MEDICINE

Co-Chair: Christine Cloutier
West-Vlaanderen, Belgium

Co-Chair: Nora Johnson
Austin, TX

[499] HOW CONFIDENT ARE BRITAIN'S GENERAL PRACTITIONERS IN THE FIELD OF AVIATION MEDICINE?

M.K. Cairns
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INTRODUCTION: In the United Kingdom, general practitioners (GPs) provide a staggering 90% of National Health Service (NHS) contacts with the British population. With the population making an estimated 65.7 million flights abroad during 2015, these interactions are likely to be a notable contributor to the decision about a person's fitness to fly. The knowledge and self-reported competence of GPs is therefore potentially of considerable significance, particularly if providing incorrect or inaccurate information which may cause risk to patient or flight safety. **METHODS:** A short survey was created using the SurveyMonkey website and data collected from qualified doctors through local (CCG/trainer groups) and online methods (private online forum). This assessed whether they had any training in aviation medicine, their confidence in giving information on fitness to fly and where to direct patients to with queries they felt unable to answer. **RESULTS:** Survey respondents who were fully-qualified GPs composed 56.7% of the total (n=88). The average self-reported confidence of GPs on an ordinal scale from 1-10 (1 – least confidence, 10 – most confidence) was 3.8 (SEM 0.354). Non-GPs & trainees mean self-reported confidence was 3.5 (SEM 0.427). Doctors who had completed formal training in aviation medicine reported mean confidence of 6.0 (SEM 1.47). Knowledge regarding where to signpost patients to was also generally poor amongst doctors without formal training. **DISCUSSION:** The Royal College of General Practitioners curriculum contains no demonstrable competencies relating to knowledge of aviation or travel medicine. Whilst it may be desirable that patients with specific questions regarding their fitness to fly communicate directly with their airline, the patient's GP is likely to be the first point of call; additionally medical aviation services may struggle if GPs were unavailable to answer them on an informal basis or unsure where to signpost to as is suspected to be happening currently. In light of the findings from this study, clearly there is a need for further analysis of how to improve the confidence and teaching of aviation and travel medicine in the GP curriculum.

Learning Objectives:

1. Despite the high number of Briton's travelling by air, their GPs receive no formal training in aviation medicine in the RCGP curriculum and report low confidence in advising patients regarding their fitness to travel and where to signpost them to.

[500] EVALUATION OF CLINICAL STEREOPSIS TESTS FOR USE IN AIRCREW MEDICAL ASSESSMENT

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INTRODUCTION: An ongoing research project seeks to evaluate methods of vision testing for Royal Canadian Air Force (RCAF) aircrew. In the present study we evaluated clinical tests of stereopsis, with the goal of identifying the most effective methodology for aircrew assessment. The study was conducted by Defence Research and Development Canada (DRDC) in collaboration with United States Air Force School of Aerospace Medicine (USAFSAM). **METHODS:** Sixty subjects participated in two experimental sessions. Within each experimental session, subjects completed a battery of clinical stereopsis tests in a random order, including the Stereo Butterfly, Randot, TNO, Random Dot 3, Frisby, and Optec 5500 Stereo plate. Subjects also completed the basic ophthalmological screening items in the Optec 5500, as well as the Howard-Dolman test and a computer-based stereoacuity thresholding procedure developed by USAFSAM. Subjects with corrected binocular acuity of less than 6/6 were excluded from the study. The protocol was approved by the DRDC Human Research Ethics Committee. **RESULTS:** Accuracy of the clinical tests was assessed in terms of agreement with the stereoacuity values obtained from the Howard-Dolman and computer-based thresholding tests. Outcome correlations between the first and second sessions were used as measures of test-retest reliability. Preliminary analysis of the data indicated that test-retest reliability was moderate for all clinical tests, and the clinical tests tended to show stronger agreement with the Howard Dolman test than the computer-based tests. **DISCUSSION:** Differences between the clinical tests in terms of accuracy and reliability will be discussed in the context of aircrew medical assessment. When taken together with other factors such as ease of use and control over testing conditions, these findings will help to identify a methodology for aircrew stereopsis assessment.

Learning Objectives:

1. Acquire familiarity with various clinical tests of stereopsis.

[501] NGAL (NEUTROPHIL GELATINASE-ASSOCIATED LIPOCALIN) URINARY LEVELS IN HIGH PERFORMANCE AIRCRAFT MILITARY PILOTS

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INTRODUCTION: Several studies showed transient proteinuria onset after centrifuge rides and aerial combat maneuvers in high performance aircraft, due to a reduced renal perfusion given by +Gz related stagnant hypoxia. However, proteinuria is a gross and late parameter to detect any renal damage. Urinary and plasmatic NGAL has been demonstrated to be an early marker of renal injury. The goal of our study was to detect urinary NGAL levels modification in high performance military jet pilots. **METHODS:** Urine samples at T0 (baseline, prior to fly a training sortie), T3 (3 hours after landing) and T24 (24 hours after landing) were collected. They underwent NGAL and NGAL/creatinine ratio dosage with ELISA kit. **RESULTS:** Data from 17 male Italian military pilots (no known allergy, no smoking) were recorded. 10 pilots were selected from the Italian Air Force aerobatic display team "Frecce Tricolori" (FT group, +Gz exposed); 8 were selected from an air transport squadron (Control group, no +Gz exposure). NGAL and NGAL/creatinine ratio at T3 were higher than T0 in both groups, with a statistical significance only in the FT group (23.2 vs 62.4 ng/ml, $p<0,05$). Furthermore, we merged the two groups and found that NGAL and NGAL/creatinine ratio were higher at T3 than T0 with an even stronger statistical significance ($p<0,03$). As expected, T24 values went back to almost T0 (baseline) levels in any measurement. **DISCUSSION:** Although the small number of pilots limits the significance of the study, our results show that +Gz acceleration provokes renal injury detectable by dosing urinary NGAL and NGAL/creatinine ratio as early as 3 hours after flight. Furthermore, the T24 values almost similar to baseline (T0) can suggest that renal injury is transient. It's worthwhile to notice that we discovered a mild increasing in T3 vs T0 NGAL NGAL/creatinine ratio even in the control group. We can't explain this finding, but we are planning to compare NGAL and NGAL/creatinine ratio with non-flying personnel in order to understand if there is any cause other than +Gz involved in the NGAL release in flight environment. Further studies are required to correlate NGAL NGAL/creatinine ratio with +Gz levels recorded during flight sorties.

Learning Objectives:

1. Outline that +Gz accelerations produce transient renal injuries.
2. Demonstrate that +Gz related renal injuries can be very early detected by NGAL and NGAL/creatinine ratio in urine sample.

[502] CARDIAC OUTCOMES IN U.S. FIRST CLASS AIRMEN WHO UNDERWENT A STENT OR CABG PROCEDURE

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INTRODUCTION: Although previous studies have determined the effectiveness of drug-eluting stents (DES) compared with bare-metal stents (BMS) in specific population subsets, methodological issues exist. Furthermore, no studies have closely examined revascularization events in U.S. civilian airmen. This study sought to determine outcome trends in revascularization events among first-class medically-certificated airmen who underwent surgery for a stent or CABG. **METHODS:** All first-class airmen who had an exam and had an initial stent or coronary artery bypass graft performed between 2005 and 2012 were included in this study. Records were individually reviewed to determine date of procedure, medical certification status, and potential recurrent events. Each airman was followed from the date of procedure through December 31, 2015. Variables collected inlcuded number of vessels treated, type of

procedure, type of stent, gender, BMI, history of diabetes, history of hypertension, valvular disease, family history of coronary artery disease, ejection fraction pre and post catheterization, LDL pre and post catheterization, cholesterol pre and post catheterization, smoking and alcohol history, medication use, and the cardiac revascularization outcomes of interest. Major adverse cardiac events were defined as death, MI, and repeat revascularization. **RESULTS:** Of the 417 airmen who received a stent, 89 (21.3%) were noted as having a major adverse cardiac outcome after their initial stent. The rate of events is not statistically different between those who had a BMS vs those who had a DES, 25.6% vs 20.9% respectively (p=0.4738). Of the 564 airmen undergoing either a CABG or stent, 113 (20%) were noted as having a major adverse cardiac outcome after their initial stent or CABG. The event rate is not statistically different between those who had a stent vs those who had a CABG, 21.3% vs 16.3% respectively (p=0.1914). Importantly, while CABG patients appear to be in worse health before treatment, they appear to achieve the same level of outcomes from treatment as the stent group. **DISCUSSION:** While our revascularization rates are similar to the other published studies, our population is younger and overall healthier than those in the other studies. By policy, we may provoke more retreatment than would be observed by relying on airmen presentation of symptoms alone. Further review and analyses on this subject would be required to determine policy effectiveness.

Learning Objectives:

1. Decribe the population of U.S. first-class airmen that recieved a stent or CABG and the associated outcomes of these procedures.

[503] DEVELOPMENT OF A PROOF-OF-CONCEPT MOBILE PAIN ASSESSMENT APPLICATION FOR EN ROUTE PATIENT CARE

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INTRODUCTION: The austerity of aeromedical transport, which limits opportunities to assess and provide adequate interventions for acute pain relief, combined with the stresses of flight, creates an environment where pain will be exacerbated. Missed periods of elevated patient pain and a lack of standard mechanisms for electronic medical documentation are detrimental to astute decision support during en route care (ERC). A mobile pain application (app) for ERC would enable electronic documentation of acute pain scores, location, and history; allow patients to record their own pain data, and to partially self-manage their plan of care; promote opportunities for the providers to focus on other mission priorities; provide pain education to the user; and incorporate additional functionality, such as multimodal pain interventions, both non-pharmacological and supplementation to their existing pharmacological plan. **METHODS:** A multi-phased approach was used to develop an interactive, mobile pain assessment app for ERC. Following a market review of current pain management apps, feedback was garnered from subject matter experts (SMEs) to assess user requirements and influence the development of graphical user interface (GUI) templates in Excel to establish the baseline content and flow of the app. The Delphi method was used to provide structured feedback on the various aspects of the app from an interdisciplinary team of five SMEs encompassing anesthesiology, industrial and human factors engineering, flight nursing, patient staging, and bioinformatics. **RESULTS:** A proof-of-concept GUI and app storyboard were developed to provide the initial content for the app. Initial SME feedback has been provided for the following aspects of the app: essential components and features, recommended improvements, and implementing the app in an ERC environment. **DISCUSSION:** The creation of this proof-of-concept GUI provides the foundation for an acute pain app capable of providing ERC patients pain management education and recommendations for how they can self-manage pain and enables electronic documentation of pain for future app development. Additional rounds of questionnaires will continue to be distributed to SMEs and users until the final version of the GUI templates will be used to develop a fully functioning mobile pain assessment app for the ERC environment.

Learning Objectives:

1. Recognize at least two current issues associated with pain assessment and documentation throughout the en route care environment.
2. Identify at least two benefits of implementing a mobile pain assessment application throughout the en route care environment.
3. Identify future capabilities of the mobile pain assessment application for en route patient care.

[504] PRICE OF A CABIN ALTITUDE RESTRICTION WHEN PRESCRIBED FOR AEROMEDICAL EVACUATION

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INTRODUCTION: Cabin altitude restriction (CAR) is prescribed by the validating flight surgeon to counter the effects of an aeromedical evacuation flight on an ill/injured patient. Most likely, it mitigates the hypoxia and hypobaria associated with standard military cabin altitude (8,000-10,000 ft). In contrast to its presumed salutary clinical effect, CAR is generally thought to have an adverse operational effect on the mission (e.g., increased flight duration, increased fuel consumption). **METHODS:** Flight data including aircraft, flight duration, mission miles, mission route, fuel consumed, and fuel cost were obtained from the Tanker Airlift Control Center and merged with mission altitude as found in the U.S. Transportation Command Regulating and Command and Control Evacuation System. Descriptive analyses were performed followed by comparison of CAR to non-CAR flights concentrating on flight duration and fuel cost differences. Subset analyses looking at specific CARs (4,000, 5,000, 6,000 ft) were also executed. **RESULTS:** In the CAR vs non-CAR comparison, there was no difference in flight duration, mission mileage, fuel consumed, or fuel cost. In addition, there was no statistical difference in gallons per mile (6.90 vs. 6.88), fuel cost per mile ($20.52 vs. $20.45), or fuel cost per hour ($7,817 vs. $7,623). Comparing individual CAR levels was significant for gallons per mile, fuel cost per mile, and fuel cost per hour. **DISCUSSION:** Conventional wisdom suggests considerably negative operational effect with the imposition of a CAR; however, this study does not confirm this wisdom. Indeed, it supports the notion that the CAR does not have serious operational impact.

Learning Objectives:

1. To understand the operational impact of a cabin altitude restriction on both mission completion and resource expenditure.
2. To see how cabin altitude restriction flights' costs (eg, flight duration, fuel cost) compare with matched unrestricted flights' costs.
3. To apply this data-driven cost comparison to the prescribing of cabin altitude restriction for patients being aeromedically evacuated.

[505] EVALUATION OF COMBAT ARMS EXPOSURE TO EMISSIONS FROM COPPER-BASED FRANGIBLE AMMUNITION

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INTRODUCTION: Copper-based frangible ammunition can produce fume containing particulates upon firing. Upper respiratory irritation, metallic taste, and nausea may result from copper fume inhalation. Due to health concerns expressed by Security Forces Combat Arms (CA) instructors, we developed a web-based survey to characterize self-reported health concerns. Survey results were used to investigate potential exposures and health outcomes related to frangible ammunition emissions. **METHODS:** The survey design captured symptomology and diagnoses of current CA instructors and those who served since 2004 (adoption of frangible ammunition) within active duty personnel. **RESULTS:** were evaluated to determine an appropriate case definition based on survey analysis principles of construct, criterion, and content validity. Self-reported symptoms occurring within 4 h of shooting were evaluated using step-wise logistic regression model building to determine associations with self-reported medical diagnoses of interest. **RESULTS:** Of the 946 CA personnel receiving the survey, 419 (44.3%) responded. Furthermore, 152 survey respondents (36.3%) reported being diagnosed by a healthcare provider with at least one condition (asthma, chronic bronchitis, sleep-related breathing disorder, etc.) after becoming a CA instructor compared to 10 (2.4%) who were diagnosed prior to instructor duty. We constructed two case definitions for risk factor determination. A

possible case is defined as a CA instructor self-reporting any medical diagnosis related to breathing difficulties or any symptoms within 4 h of shooting. A probable case is a CA instructor self-reporting at least one of the three empirically validated symptoms (cough, metallic taste, or difficulty breathing) within 4 h of shooting. In all, there were 169 possible cases (40%) and 125 probable cases (30%). **DISCUSSION:** Survey results and review of existing literature provide a basis for designing a case definition. This research will present a retrospective cohort study, comparing Security Forces, not serving in a CA position, to those serving in a CA position at any point in time from January 2004 through May 2016. Calculated measures of association (relative risk) will be presented. This study design will provide a more definitive description and analysis of the health concerns experienced by the CA community.

Learning Objectives:

1. To better understand health risks associated with copper-based frangible ammunition use at U.S. Air Force combat arms firing ranges worldwide.

[506] NOT JUST A WINDOW SEAT: TRANSCONTINENTAL FLIGHT INDUCED OLFACTORY WINDOW

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PROBLEM STATEMENT: Flight-related atmospheric pressure change enhancement of olfactory ability, in those with olfactory dysfunction, has not heretofore been described. **BACKGROUND/LITERATURE REVIEW:** In normosmics, a decrease in atmospheric pressure reduces olfactory ability (Altundağ et al, 2014), whereas increase in atmospheric pressure enhances olfactory ability (Kuehn et al, 2008). **CASE PRESENTATION:** A 60 year old male with a 45 year history of type 1 diabetes mellitus, presented with eight years of gradually worsening sense of smell, resulting in anosmia. Immediately after deplaning, while walking past a Starbucks, he experienced an olfactory window of coffee for approximately a minute. This resolved after he left the area in which the coffee shop was located, with no olfactory windows occurring since then. **RESULTS:** Abnormalities on Physical Examination: Neurologic: Cranial Nerves (CN): CN II: Fundoscopic: vessels appear narrow with cotton wool spots OD. CN III, IV, VI: right ptosis. Motor: Drift: mild right pronator drift. Reflexes: 3+ brachioradialis and biceps bilaterally, absent ankle jerks. Chemosensory: Olfaction: Dirhinous: Alcohol Sniff Test: 6 (anosmia). Brief Smell Identification Test: 8 (hyposmia). Pocket Smell Test: 1 (anosmia). Monorhinous: Phenylethyl Alcohol Snap and Sniff test: Left > -2.0, Right > -2.0 (anosmia). Olfactometer Identification Test: L 6.00, R 6.00 (anosmia). Retronasal Olfactory Testing: Retronasal Smell Index: 1 (abnormal). Gustation: Propylthiouracil Disc Taste Test: 9 (normogeusia). Other: CT scan with and without infusion: normal. Fiberoptic endoscopy: normal. **OPERATIONAL/CLINICAL RELEVANCE:** During flight, there is lower pressure and humidity; thus after landing, there is a relative increase in humidity and pressure at the location of the Starbucks. The increase in humidity may have induced a greater water-odorant combination concentration, enhancing binding at the olfactory receptor sites. Such humidity-induced increase in atmospheric odorant saturation may have provided a greater substrate for the olfactory receptors (Kuehn et al, 2008). Alternatively, this may be due to the warm coffee vapors affecting the erectile tissue in the nose, and thus enhancing the amount of odorant that reaches the olfactory epithelium (Altundağ et al, 2014). This patient's experience suggests that treatment with hyperbaric oxygenation and ambient humidification may be worthy of consideration for treatment in those with smell loss.

Learning Objectives:

1. To understand the potential influence of atmospheric pressure on olfactory ability in those with chemosensory dysfunction.

[507] ALTITUDE INDUCED CHANGES TO THE BLOOD BRAIN BARRIER'S PERMEABILITY ADVERSELY IMPACT PATIENT SAFETY IN AEROMEDICAL EVACUATION

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INTRODUCTION: The cumulative effects of flight during aeromedical transport are of great interest to all nations engaged in contingency operations, and especially to the U.S. Air Force, the sole provider of U.S. aeromedical evacuations (AE). Key factors impacted by flight and impacting clinical outcome include the optimal choice of pain management strategies, the relative efficacy of medications en route and, most importantly, the safety of such medications. Here, we investigated the potential for neuroactive and non-neuroactive drugs to enter the brain at common AE cabin altitudes. **METHODS:** The human blood brain barrier was simulated using porcine brain extracts in the parallel artificial membrane permeability assay (PAMPA) arrangement. Multi-well PAMPA plates were exposed to a simulated cabin altitude of 8,000 ft mean sea level (MSL) in a hypobaric chamber with an identical plate held constant at 800 ft MSL (Wright-Patterson AFB, OH). Drugs were added to a single side of the membrane prior to exposure and drug concentrations post-exposure were analyzed using liquid chromatography mass spectrometry. Flight profiles represented 2 hour and 12 hour AE missions. **RESULTS:** The average ratio between altitude and ground on the brain side for 2 hours was 0.61±0.49 versus an average ratio of 1.25±0.37 after 12 hours (n=17 drugs, p=0.00062). After 2 hours, only 3 drugs had altitude to ground ratios above 0.8, whereas after 12 hours only 1 drug was below 0.8 and 13/17 (76%) were above 1. **DISCUSSION:** The altitude-induced permeability increase of numerous drugs that are not normally neuroactive poses a clear safety risk. Furthermore, a potentially even greater threat to patient safety is posed by pharmaceuticals that are normally active in the brain but are dosed at low levels to account for their activity. When present at higher levels, brain functions can be slowed to dangerous levels. The pilot study here demonstrates that a systematic investigation of additional cabin altitudes and more drugs will improve patient outcomes during and after transport. Such outcomes can be realized through development of a clinician-friendly "app" for use in routine and emergency transports.

Learning Objectives:

1. Determine cabin altitude restrictions for AE transport using evidence-based medicine.

[508] A COMPARISON OF COCKPIT UV EXPOSURE IN SEVERAL MEDIUM ALTITUDE AIRCRAFT

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INTRODUCTION: Ultraviolet radiation exposure of aircrew in aircraft cockpits are not well characterized. Crew positioning, time of day, and altitude are all factors of UV exposure. Here, we describe the relative cockpit exposures of six different aircraft. **METHODOLOGY:** Aircraft surveyed included the Beechcraft 1900C, the BAe Hawk, the C-130J, the BAe RJ, the Dornier Alpha Jet, and the Grob G115. These aircraft represent a diverse portfolio of capabilities, and most of them operate at medium altitudes where UV exposure becomes a concern. Each of these aircraft were measured in at least two different locations and both total energy and wavelength of the radiation were characterized. Most of the aircraft values were measured with a point UV source on the ground, and total transmittance of the UV energy was evaluated. In one aircraft, a volunteer pilot wore an attachable UV device and placed it on various predetermined areas on his body and around the cockpit. **CONCLUSION:** For all of the aircraft tested with transmittance, there were areas of the cockpit which received over 50% of the total UV energy that would have been experienced outside of the aircraft. Our data suggests that in each of these aircraft there are areas of the cockpit which should be shaded or avoided by crewmembers. Compared to UV measurements taken on the ground, airborne cockpit exposures were on average 10-15% of the exposure a person on the ground would experience. It is clear from this data that UV exposures in modern aircraft constitute a real lifetime risk of UV-related disease in aircrew who are not properly protected. We endorse specific preventative measures and education tailored on the type of aircraft which the crew members may be operating.

Learning Objectives:

1. To present the occupational risk of cockpit UV exposure.

[509] AN ANALYIS OF ONDANSTRON USE ON COMMERICAL AIRLINES

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INTRODUCTION: Previous research has shown that nausea and vomiting are the third most common complaints of passengers who have an inflight medical event. Nausea and vomiting made up 9.5% of total inflight medical events and resulted in 4.9% of aircraft diversions. Ondansetron can be supplied as a 4mg oral dissolving tablet. In 2015 one large U.S. airline began carrying Ondansetron in its Emergency Medical Kit (EMK), while another large U.S. airline did not carry any anti-emetic medication. This study will compare inflight medical events of nausea and vomiting and diversions between the two airlines. **METHODS:** This was a retrospective cohort study. One year of data was reviewed. Both airlines are large U.S. commercial carriers with over 700 aircraft. Fitness to fly or gate screening consults were excluded. The date range was from Jan 1 2015 to Dec 31 2015. Data collected included Date, Airline, Age, Sex, Medical Category, and Outcome of Medical Consult. This research study was approved by the University of Pittsburgh Institutional Review Board. **RESULTS:** Airline A had 206 inflight consultations for nausea and or vomiting. Age range was 2 to 81 years. There were 1950 total infight consultations (10.5%). Ondansetron was recommended 59 times (28.6%). Age range of Ondansetron recommendation was 5 to 78 years. Of the 59 infight events where ondansetron was recommended there was one recommended diversion (1.6%). Of the 147 flights where Ondansetron was not recommended, there were 7 diversions (4.7%). Airline B does not carry Ondansetron or any other anti-emetic. Airline B had 193 inflight consultations for nausea and vomiting. There were 2286 total inflight consultations (8.4%). Age range for Airline B passengers with nausea and vomiting was 1 to 88 years. There were a total of 7 diversions (3.6%). **DISCUSSION:** The rate of diversion between Airline A and Airline B when ondansetron was not administered was the same. The rate of diversion where ondansetron was administered was 1.6%. The rates of diversion where ondansetron was not administered were 4.7 and 3.6% respectively. The diversion rate did appear to be markedly lower in the cases where ondansetron was recommended. This decrease in diversion rate was apparent even though ondansetron was only recommended in 28.6% of all inflight consults for nausea and vomiting. Further study to determine if the rate of ondansetron recommendation has increased would be helpful.

Learning Objectives:

1. To understand a comparison between an airline that carries an anti-emetic medication and one that does not with respect to infight medical events of nausea and vomiting.
2. To understand a comparison of the differences when Ondansetron was used and not used on commercial flights where a passenger complained of nausea and vomiting.
3 To understand any difference in diversion between the two groups.

[510] EPIDEMIOLOGICAL ASSESSMENT OF INCIDENT POST-DEPLOYMENT MENTAL HEALTH PROBLEMS IN AIR FORCE MILITARY MEDICAL PERSONNEL

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INTRODUCTION: This study assessed the association between incident post-deployment mental health (PDMH) conditions and healthcare utilization, pharmacotherapy use, and performance-related outcomes (fitness test scores and duty/mobility physical restrictions) in the population of Air Force Medical Service personnel on duty during the period from 2003-2013. It was hypothesized that individuals with PDMH conditions would have increased healthcare utilization and pharmaceutical use and decreased performance. **METHODS:** This study was a descriptive, correlational study that reused data from a prospective cohort study of 24,409 participants without a mental health disorder diagnosis prior to deployment. Various statistical learning algorithms (e.g., boosted decision trees) were used to determine whether an association existed between incident PDMH conditions and healthcare utilization, pharmacotherapy, and performance-related outcomes. Outcomes of interest were incident PDMH condition diagnosis, risk/protective factors for mental health conditions, pharmacologic drug use, duration of time from deployment to mental health diagnosis, Air Force fitness test elements, and profile conditions. **RESULTS:** Preliminary results indicate an association between a subject presenting with a PDMH diagnosis and an increased incidence of healthcare utilization and polypharmacy. **DISCUSSION:** Information obtained about utilization patterns could provide recommendations to adjust current case management guidelines. Utilization patterns can better focus the assessment and management of the impacts of PDMH conditions. It is also recommended that future research look at PDMH within the larger population of Airmen.

Learning Objectives:

1. Various statistical learning algorithms (e.g., boosted decision trees) were used to determine whether an association existed between incident PDMH conditions and healthcare utilization, pharmacotherapy, and performance-related outcomes.

[511] INTRANASAL SCOPOLAMINE SPRAY PROVIDES MOTION SICKNESS PROTECTION WHILE DEMONSTRATING RAPID ABSORPTION RATES AND NO IMPACT ON COGNITIVE PERFORMANCE

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BACKGROUND: Motion sickness (MS) is a problem for military operations. Scopolamine is one of the most effective anti-MS medications; however, the most common administration routes (transdermal and oral) have significant drawbacks, including delayed onset of action and dose-related side effects. Low dose, intranasal scopolamine (INSCOP) administration is an alternative which promises rapid absorption and fewer side effects. Here, we report the complete Pharmacokinetic (PK) and Efficacy results. **METHODS:** In the PK phase (n=19), subjects received 0.2 mg INSCOP followed by eight hours of monitoring. In the Efficacy phase (n=23), subjects underwent two counterbalanced sessions of mechanical rotation 40-50 minutes after receiving 0.2 mg INSCOP or placebo in double-blinded fashion. During rotation, subjects performed paced head tilts, with rotation speed accelerating each minute to a maximum of 40 rpm. Self-reported symptomology data were collected prior to, during, and following rotation. Blood samples, vitals, cognitive performance and subjective fatigue levels were collected. **RESULTS:** Peak plasma concentrations were reached by one hour post-dose for all but one subject in the PK phase. Although cognitive performance had small but significant decreases and sleepiness increased throughout the assessment periods, it is unlikely INSCOP was the cause since these changes were similar between treatment and placebo conditions. A paired samples *t*-test revealed a significant effect of INSCOP, $t_{(21)} = 2.48$, $p < .01$, indicating subjects were able to tolerate 19% more head tilts with INSCOP compared to placebo (Mean Difference = 30.37, *SE* = 12.41, p = 0.01). Pending analysis of Efficacy phase blood samples will determine any relation between INSCOP plasma levels and head tilts tolerated. No serious adverse events were noted in either phase. **DISCUSSION:** INSCOP is rapidly absorbed, lacks the cognitive deficits and side effect profiles seen in other administrative routes, and improves capability to tolerate provocative motion. Further research examining multi-dose usage is needed. The next step is to conduct Phase III clinical trials examining multiple use INSCOP spray in both operational and laboratory settings. Depending on the results of those trials, INSCOP spray could well provide the armed forces with a MS countermeasure that is fast acting, highly effective, field expedient, easy to administer, and compatible with operational settings.

Learning Objectives:

1. Examine the pharmacokinetics of intranasal scopolamine.
2. Examine the efficacy of intranasal scopolamine as an anti-motion sickness medication.
3. Examine the side effects of intranasal scopolamine administered at a lower than conventional dose.

[512] EPIDEMIOLOGY OF PHYSICAL ACTIVITY AND SPORTS INJURIES AMONG FRENCH MILITARY AIRCREWS: A RETROSPECTIVE OBSERVATIONAL STUDY IN 1056 AIRCREWS

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INTRODUCTION: Sports injuries are the main cause of professional downtime in military. Military aircrews are subject to specific constraints related to the aerospace environment. They require physical training to improve the tolerance to these constraints and are thus exposed to sports injuries. We provide the results of an epidemiological study to determine the prevalence and types of injuries related to physical activity and contributing factors among French military aircrews. **METHODS**: All military aircrews that came for their periodic medical visit in the AeroMedical Centers between August and November 2015 had to fill in an anonymous questionnaire. It included anthropometrical, lifestyle and sport practice data including the Baecke questionnaire. 14 questions assess sports injury, their circumstances and consequences. **RESULTS**: 1056 aircrews, 36,6 ± 9,07 years old, completed the study. 91% of them had regular physical activity. The most popular sport was running (69.9%). 44.2% of respondents claim to have suffered a sport injury (54.6% of them several times). The most common injuries were sprain (44.2%) before fracture (17.5%), tendinopathy (15.8%), dislocation (10.4%) and muscle injury (7.8%). Soccer was the most high-risk activity with 25.4% of injuries, followed by running (19.4%), rugby (7.9%) and skiing (6%). Team sports were responsible for 42.6% of all injuries while military activities for only 3.9% of injuries. The most serious injuries resulted in interruption of sports in 92.4% of cases (mean of 66.7 days), interruption of flying in 40.4% of cases (31 days), temporary work incapacity in 27.7 % of cases (69.6 days) and hospitalization in 13.2% of cases (8.6 days). The aircrews injured during sports had a sporting activity index calculated according to the Baecke questionnaire significantly higher than the non-injured ($p<0.01$). Army aircrew had significantly more injuries (57.5%) than those of Air Force and Navy ($p<0.01$). **DISCUSSION:** Almost half of the military aircrews have suffered a sports injury with a significant impact on professional availability. Team sports and high-intensity sports favor the occurrence of injuries. Prevention could involve limitation of team sports in worktime, application of known recommendations of the international literature such as interval training, and monitoring by sports medicine doctors. Realistic and adapted prevention methods are proposed, and their impact need to be evaluated in further studies.

Learning Objectives:

1. Our study describes sports injuries in the French military aircrew members. Sports injury represents the main cause of professional downtime in military involving half of the French military aircrew members.
2. This study shows that team sports and a high-level sport practice are the main factors of occurrence of sports injuries in the French military aircrew members. We can have prevention means on sport practice.
3. We suggest recommendations for prevention of sports injuries such as interval training, limitation and adaptation of team sports, monitoring aircrews involved in sports by sports doctors in order to maintain a safe physical activity in military aircrews.

[513] USING EOS, A 3D X-RAY IMAGING SYSTEM FOR POTENTIAL RELEVANT ORTHOPAEDIC DISEASES IN THE SELECTION OF THE SWISS AIR FORCE MILITARY PILOTS

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INTRODUCTION: EOS is a 3D-imaging X-ray system, derived from a Nobel prize awarded invention. It is used for diagnosis and evaluation of scoliosis and other relevant orthopaedic problems. EOS produces high quality images with less irradiation than standard imaging techniques. The procedure is fast, stress-free and you can directly view and evaluate the recorded 3D-images. **METHODS:** In the screening period from May 2013 to July 2016 we have examined 195 candidates (n=195) for the Swiss Air Force military pilots. All candidates were white male, with the average age of 20.5 years. A major focus in the medical examination was put on the constitution of the spine. The following criteria were checked: scoliosis (Cobb ankle), Humpback, Hyperlordosis. Hyperkyphosis, adolescent kyphosis, block vertebra, Spondylolisthesis (anterolisthesis and retrolisthesis), Morbus Bechterew, state after compression fracture and rheumatological disorder. Three standard X-rays were made of cervical, thoracic and lumbal spine to support and evaluate clincal findings. Subsequent to identifications of critical parameters, the candidates were examined by external orthopaedic specialist using the EOS imaging system. **RESULTS:** From a total of 195 (100%) candidates, 44 (22.6%) had a potential relevant orthopaedic problem and therefore were checked by an external orthopedic specialist using EOS. Out of the 44 candidates, 7 (6,3%) did not pass the screening process. The main criteria leading to the negative decision were major Spondylolisthesis in L5/S1 and severe scoliosis in the lumbar and thoracic spine. **DISCUSSION:** EOS is an efficient tool for the evaluation of major orthopaedic problems. In comparison to the standard X-ray, EOS provides additional analysis of the whole spine and very precise medical diagnosis. Further studies need to be performed to asses if EOS might also help to support therapy plans based on highly precise medical data.

Learning Objectives:

1. Comparing the standard X-ray from separate multiple parts of the spine where defective position can pretend scoliosis, the EOS provides very precise medical diagnosis of the whole spine in one image.

[514] FACT SHEET ZIKA VIRUS DISEASE FOR AIRLINE CREW

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PROBLEM STATEMENT: Zika Virus Disease means a serious threat in areas with active Zika transmission. Much is still unknown and scientific knowledge increases every day. Public knowledge subsequently airs through many standard and social media, but is not always easy to value. Airline crew is a special group of travellers who need clear, current and simple recommendations to minimize the risk of disease and transmission. A fact sheet might meet that condition. **METHODS:** Literature review. Main sources: CDC, Medscape, PubMed, U.S. National Library of Medicine. **RESULTS**: Preliminary recommendations to prevent infection and/or transmission and warnings to prevent mosquito bites. Zika virus disease can be transmitted by bites of an infected mosquito and by sexual intercourse. Zika virus can be present in blood, saliva, urine, tears and semen. Areas with active Zika Transmission (AZT) are currently updated by CDC: www.cdc.gov/zika/geo/index.html. **DISCUSSION:** Possible Zika Virus Exposure (PZE) is defined by travel to or residence in an AZT or sex without a condom with a partner who travelled to or lives in an AZT. Aircrew members who want to conceive in the near future: 1) should avoid nonessential travelling to AZT; 2) women with PZE should wait at least 8 weeks to attempt conception; and 3) men with PZE should wait at least 6 months to attempt conception. Aircrew members who fly to an AZT and want to prevent transmitting Zika virus sexually: 1) Women with PZE should avoid unprotected sex for at least 8 weeks after PZE; 2) Men with PZE should avoid unprotected sex for at least 6 months after PZE; and 3) Sexual partners with PZE of pregnant women should practice safe sex for at least the duration of the pregnancy.

[515] PROFILES AND DUTY LIMITING CONDITIONS: TWO NEW CLINICAL MODELS TO STANDARDIZE PROVIDER DECISION-MAKING AND INCREASE SERVICE MEMBER AVAILABILITY

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Webility Corporation, Wayland, MA

PROBLEM STATEMENT: Illness, injury and aging (and their sequelae) predictably occur during military service. They can alter functional capabilities of Service Members (SMs), either temporarily or permanently. In that case, healthcare providers must provide operational medical guidance to commanders so they can manage risk in assigning appropriate duties to affected SMs. Most clinicians have little or no prior

training or experience in this domain and receive little formal training in the military. In general, clinicians feel forced to make guesses because they lack both the conceptual framework and the practical knowledge of military work environments required to formulate accurate and helpful guidance. Informal military studies have shown wide variability in the appropriateness of clinician determinations. Rarely, the consequences can be severe: failure to recognize hazards coupled with inadequate protective restrictions exposes service members to excess risk, jeopardizes individual and unit mission performance. More often, over-limitation and delayed recognition of deployment- or service-disqualifying conditions reduces availability of necessary human assets, decreases productivity across the force, and may create logistical challenges. Lastly, research has shown that individuals with common health problems such as musculoskeletal pain or depression/anxiety who receive sub-optimal guidance about activity are more likely to end up excessively impaired, lose their jobs, and end up living on disability. **TOPIC:** Two new models were developed for military clinicians to use in making determinations regarding duty-limiting and potentially disqualifying conditions: (1) a single step-by-step process to guide clinical decision-making which can be repeated until the presenting issue has resolved completely; and (2) a case categorization schema which enables appropriate and efficient allocation of clinical resources as well as more standardization of resolution strategies and management plans in similar situations. This session will walk attendees through the two models, using several brief clinical scenarios to illustrate each one. Questions and feedback from attendees are encouraged because these models may be refined prior to wide implementation. **APPLICATION:** Models similar to these are anticipated to be rolled out in a later phase of the Base Operational Medical Clinic concept now being implemented across the U.S. Air Force. **RESOURCES:** AF Medical Home and BOMC CONOPS.

Learning Objectives:

1. As a result of attending this session, participants will be able to list the major cognitive work steps that should always be taken when determining whether service member is fully available for military duty and what, if any, limitations need to be prescribed and for how long.
2. As a result of attending this session, participants will be able to compare the two models that have been discussed with their current ad hoc methods, and analyze the advantages and disadvantages of adopting the two models.
3. As a result of attending this session, participants will be familiar with and able to give constructive feedback about the models, which will increase user acceptance adoption rate when these tools are incorporated into the Base Operational Medical Cell implementation.

[516] AIRSICKNESS OR SPATIAL DISORIENTATION? SCC DEHISCENSE SYNDROME AND VESTIBULAR DYSFUNCTION DISQUALIFY MILITARY STUDENT PILOT: A CASE REPORT

B.E. Organ and J. Dreibelbis
U.S. Air Force, Laughlin AFB, TX

PROBLEM STATEMENT: This case report describes a military student pilot who experienced prolonged and bizarre effects of presumed airsickness, prompting further evaluation and diagnosis of semicircular canal dehiscence syndrome - a disqualifying medical condition which eliminated the student from pilot training. **BACKGROUND/LITERATURE REVIEW:** The inner ear contains the labyrinthine system: the motion-and-gravity-detecting sense organ. Each vestibular apparatus consists of two distinct structures, the vestibule proper housing the otolith organs, and the semicircular canals. Although these organs provide important cues for basic orientation on the ground, they often provide misleading information during flight. The formation of a superior semicircular canal dehiscence can cause an individual to experience disorientation and vertigo-like symptoms. **CASE PRESENTATION:** A 30-yr old male student pilot in the first stages of military pilot training experienced airsickness on his first several flights in the T-6A Texan II aircraft. Airsickness is common among student pilots in the early stages of flight training, however the subject pilot's symptoms lasted well beyond the normal 24 hours, and included vertiginous symptoms lasting hours or days after his last sortie. His Flight Surgeon recommended he be held out of training for further evaluation. Comprehensive vestibular and audiological testing were normal, however a CT scan of the temporal bones showed a left superior semicircular canal dehiscence, and he was diagnosed with left labyrinthine fistula as the cause of his vertigo. Treatment required surgery that could not guarantee resolution of symptoms, and the patient elected not to proceed. He was medically eliminated from pilot training and permanently disqualified from USAF flying duties. **OPERATIONAL/CLINICAL RELEVANCE:** Spatial disorientation remains one of the deadliest factors related to aircraft mishaps every year. In this case, an abnormal presentation of airsickness that prompted further evaluation may have prevented a dangerous situation in the air. In standard airsickness the goal is to keep the pilot flying to expedite adaptation, so this case highlights the importance of distinguishing between normal airsickness and a spatially disorienting medical condition.

Learning Objectives:

1. Distinguish between symptoms of airsickness and more concerning symptoms of vestibular dysfunction, and know when to refer for further evaluation.
2. Review the physiology of spatial disorientation and how it translates to the aviation environment to better prepare our pilots to combat this deadly phenomenon.

Thursday, May 04 ***3:30 PM***
Plaza A/B

S-095: SLIDE: PERSONALITY AND MENTAL HEALTH SCREENING AND SUPPORT

Chair: David Schroeder
Oklahoma City, OK

Chair: Charles Mahakian
Wright-Patterson AFB, OH

[517] SCREENING FAA AIR TRAFFIC CONTROL SPECIALIST APPLICANTS FOR PSYCHOPATHOLOGY, TIER 1

R. King, C.M. Front and H. Wright
FAA, Washington, DC

INTRODUCTION: There are two flavors of personnel selection: select-in, which assesses aptitude, and select-out, which is a medical process to identify disqualifying conditions. We present two papers that explore the select-out process currently used by the Federal Aviation Administration (FAA) to ensure the psychological/psychiatric fitness of Air Traffic Control Specialists (ATCSs). **METHODS:** ATCS job applicants who have successfully negotiated the select-in process are tendered a tentative job offer letter, as required by the Americans with Disabilities Act, which then permits the FAA to conduct medical examinations, including psychological testing. The FAA uses the Minnesota Multiphasic Personality Inventory-2 (MMPI-2) as a screening method to assess the mental health of ATCS candidates. Those who produce valid test protocols and achieve testing results within normal clinical limits are considered "cleared" and, assuming there are no "red flags" such as a driving while intoxicated incident or a psychiatric diagnosis, are considered medically qualified from a psychiatric/psychological perspective. **RESULTS:** To date, 14,089 job applicants have been screened with the MMPI-2; 2,329 applicants have been referred to further assessments, termed a "Tier 2 assessment" which is described in the accompanying abstract, for a referral rate to a Tier 2 assessment of 16.53%. A major cause for being deemed "not cleared" at this stage is producing a "defensive invalid" profile consequent to overzealous attempts at positive impression management (conscious or unconscious response distortion). **DISCUSSION:** No applicant is denied employed based on their performance on one psychological test. Rather, psychological testing is used as a screening method to determine which applicants need a more comprehensive assessment. As will be demonstrated in the accompanying abstract, the majority of applicants who are referred will be ultimately medically cleared. Due to the high stakes of public safety, however, the threshold for a referral is relatively low.

Learning Objectives:

1. Participants will understand the difference between select in and select out.

[518] SCREENING FAA AIR TRAFFIC CONTROL SPECIALIST APPLICANTS FOR PSYCHOPATHOLOGY, TIER 2

C.M. Front, R. King and H. Wright
FAA, Washington, DC

INTRODUCTION: As outlined in the yoked abstract, those ATCS applicants who do not clear the initial psychological screening process are offered the opportunity to undergo a thorough psychological assessment. **METHODS:** ATCS job applicants who do not clear the initial screening with the MMPI-2 are afforded the opportunity, at the FAA's expense, to undergo an assessment that includes review of records, psychosocial/clinical interview, mental status examination, and re-administration of the MMPI-2 (to include specialized instructions for those who rendered invalid profiles), administration of the Personality Assessment Inventory (PAI) and/or the Millon Clinical Multiaxial Inventory-III (MCMI-III), and whatever other assessment instrument(s) the assessing psychologist deems appropriate. At the outset of the Tier 2 assessment, it is established with the job applicant that the FAA is the assessment client. The completed assessments, to include all raw data, are reviewed by a FAA clinical psychologist who makes a recommendation concerning the job applicant's fitness according to FAA standards, as delineated in the Air Traffic Control Specialist Health Program (FAA ORDER 3930.3B), which incorporates Diagnostic and Statistical Manual (DSM) diagnostic entities. **RESULTS:** To date, 1,791 Tier 2 assessments have been completed, with 316 (17.64%) resulting in a recommendation of "Not Medically Qualified," from a psychiatric/psychological perspective in accordance with FAA ORDER 3930.3B. **DISCUSSION:** The FAA has a robust screening and assessment program that balances the needs of public safety and the rights of job applicants. Considering the Tier 1 data presented in the companion abstract, the total percentage of applicants who are ultimately deemed to be "Not Medically Cleared" stands at 2.24% but this figure is fluid due to pending assessments and also does not take into account those applicants who elect to withdraw from the process. Finally, appeals and administrative actions, based on careful consideration of new evidence, reverse a small minority of cases.

Learning Objectives:

1. Applicants will appreciate the difference between psychological testing and assessment

[519] EMOTIONAL REACTIONS TO KILLING AMONG U.S. AIR FORCE DISTRIBUTED COMMON GROUND SYSTEM INTELLIGENCE OPERATORS

E. Skinner, W. Chappelle and L. Prince
USAF School of Aerospace Medicine, Wright-Patterson AFB, OH

INTRODUCTION: As part of U.S. Air Force weapon-strike operations, Distributed Common Ground System (DCGS) intelligence operators have a key role in the targeting, decision making, and elimination of enemy combatants, while bearing witness to the direct consequences of their actions through live video feed and imagery. Although the demand for intelligence operations remains constant across global regions of conflict, the emotional impact of real-time exposure to death and destruction of combat-related operations remains unclear. The purpose of this study is to identify the range of emotions and disruptive reactions among DCGS intelligence operators who have directly participated in remote-combat weapon-strike operations with confirmed kills. **METHODS:** Participants included DCGS intelligence operators (n = 100) from multiple squadrons conducting global around-the-clock operations. Individual interviews were conducted and self-reported emotional responses were identified following weapon strikes. Negative self-reported emotional responses were further categorized as acute vs. chronic, disruptive vs. non-disruptive, and resolved vs. unresolved reactions. Demographic and operational predictors of disruptive emotional reactions were identified. **RESULTS:** The results of this study revealed intelligence operators simultaneously experience a wide range of positive and negative emotional reactions with variability in depth and breadth following weapon strikes with confirmed killing of enemy combatants. Approximately 43% of operators reported disruptive, negative emotional reactions that led to noticeable changes in social and/or behavioral functioning and 22% reported having unresolved emotional difficulties. Demographic and operational variables were identified (age, specific exposures) elevating risk for disruptive emotional reactions. **DISCUSSION:** The results of the study identify the salient and complex emotional reactions that intelligence operators experience in response to their direct involvement in weapon strikes and killing of enemy combatants. The implications of study findings include, but are not limited to, the following: the expansion of proactive measures to psychologically prepare and support DCGS intelligence operators, reprioritizing operational medicine and mental health support requirements to focus on the highest risk areas, increasing post-mission socialization following weapon strikes, and improving post-kill leadership engagement and support.

Learning Objectives:

1. The participant will gain insight related to the depth and breadth of the emotional experience of Air Force intelligence analysts involved in weapon strike operations.
2. The participant will gain knowledge of the prevalence and predictors of disruptive negative emotional experiences among USAF intelligence operators contributing and bearing witness to weapon strike missions targeting enemy combatants.

[520] GENDER DYSPHORIA IN CANADIAN ARMED FORCES AIRCREW

A. Minkley, M. McCormack and R. Hannah
Canadian Forces Health Services, East St. Paul, MB, Canada

PROBLEM STATEMENT: This case report describes the aeromedical decisions allowing four Canadian Forces aircrew members to fly during treatment for Gender Dysphoria. **BACKGROUND/LITERATURE REVIEW**: In 2011, the Commander of Military Personnel Command ordered the accommodation of transsexual members taking into consideration health and safety of CF members and the public. Treatment for Gender Dysphoria may include counselling, hormone therapy, cosmetic or gender reassignment surgery. The aeromedical risks depend on the choice of treatment but can include disrupted crew cohesion, venous thromboembolism, heart failure and increased total mortality. In 2016, the Canadian Forces Aeromedical Authority approved an approach to Gender Dysphoria and allowed three of four aircrew members to continue to fly during and after treatment. **CASE PRESENTATION:** Case #1 is a 46-year-old male RW pilot who transitioned to female using hormone therapy, facial, throat and gender reassignment surgery. She was originally grounded for two weeks at the onset of therapy and returned to flying without event. She underwent vaginoplasty requiring two months of sick leave, but has returned to flying with restricted duration. Case #2 is a 53-year-old transport pilot on hormone therapy transitioning male to female. She was grounded four weeks at initiation of therapy and has returned to flying with or as copilot. Case #3 is a 37-year-old aeromedical evacuation crewmember transitioned male to female. Six months into therapy she experienced pre-syncopy and was grounded until symptom resolution and normalization of hormone levels. Case #4 is a 23-year-old female student navigator. He started testosterone therapy two weeks before flight training and has experienced no adverse events. All four aircrew had psychiatric evaluations before initiating therapy. **OPERATIONAL/CLINICAL RELEVANCE**: With government mandates to accommodate transgendered individuals, these four cases highlight the need for a risk stratified approach to Gender Dysphoria in aircrew. The Canadian Forces has approved the following guidelines: Grounded 4 weeks on initiation of treatment. Psychiatric evaluation. Cardiovascular risk stratification and consult from physician experienced in Gender Dysphoria. Flight surgeon follow-up every 1-3 months. Physiologic hormone levels. Grounded three months following surgery. Pilots to fly with or as copilot.

Learning Objectives:

1. Understand the aeromedical risks associated with Gender Dysphoria treatment in aircrew.
2. Develop a treatment plan with acceptable risk stratification for aircrew with Gender Dysphoria.

[521] PSYCHOSIS IN COMMERCIAL PILOTS - PRESENTING FEATURES, DIAGNOSES AND OUTCOMES IN EIGHT CASES

R.A. Cocks
Accident & Emergency Medicine Academic Unit, Chinese University of Hong Kong, Hong Kong

INTRODUCTION: Mental illness in commercial pilots is currently a matter of major concern to the Aviation Industry, yet there is limited information available from the research literature to assist in the identification of those at risk. This detailed analysis of eight cases was undertaken to try to identify features of possible predictive value. **METHODS:** A case review of eight commercial pilots presenting with psychotic symptoms over a 10-year period. Outcome measures included final diagnosis, certification status, history features of possible predictive value, and prognosis. **RESULTS:** All eight pilots were male, with an age range of 28-51 years (median 42 years). Four pilots (50%) had a previous psychiatric history, including three (37%) who had experienced a previous brief psychotic episode that they had not declared to their AME or the regulator responsible for their medical certification. Three pilots (37%) had experienced significant periods of sleep deprivation prior to the psychotic episode. Two pilots (25%) experienced toxic psychosis (one related to alcohol abuse) and both were eventually returned to flying status. The remaing six pilots were denied medical certification. **DISCUSSION:** Non-declaration of a previous major psychiatric illness appeared to be predictive of a future risk of psychosis in this small series. The relationship between non-declaration of significant medical history and antisocial or borderline personality disorders is discussed. An association between psychotic episodes and prolonged wakefulness has been previously reported and was confirmed in this study.

Learning Objectives:

1. To review the diagnostic criteria for psychosis and related conditions.
2. To examine the hazards to air safety posed by pilots with psychotic symptoms, and review the features of past and present medical history which may assist in identifying those at risk.

Thursday, May 04 ***3:30 PM***
Plaza D/E

S-096: PANEL: OVERVIEW FOR HEARING RISK AND PROTECTION IN MILITARY AVIATORS AND SUPPORT CREW

Chair: William Ahroon
Ft. Rucker, AL

PANEL OVERVIEW: The history of noise-induced hearing injuries is discussed with special emphasis on military populations. The value of noise reduction and improved communication is emphasized. The presentations from the panel include: 1) Promoting Active Hearing Protection Combined with Communication Capabilities to Improve Situational Awareness and Safety on the Airfield; 2) Acoustical Assessment of the MH-60 Direct Action Penetrator (DAP) Weapon Systems; 3) Assessment of MIL-STD 1474E, the AHAAH model; 4) Reflexive and anticipatory middle ear muscle contractions for impulsive sounds.

[522] PROMOTING ACTIVE HEARING PROTECTION COMBINED WITH COMMUNICATION CAPABILITIES TO IMPROVE SITUATIONAL AWARENESS AND SAFETY ON THE AIRFIELD

H. Jones[1,2], N.T. Greene[1,3] and S. Hollonbeck[1]
[1]Auditory Performance and Protection Division, U.S. Army Aeromedical Research Lab, Ft. Rucker, AL; [2]Laulima Govt. Solutions, Orlando, FL; [3]The Geneva Foundation, Tacoma, WA

PROBLEM STATEMENT: Modern-day aircraft produce high noise levels, resulting in a degraded communication environment, and can cause noise-induced hearing loss in military aircrew and passengers. **TOPIC:** Hearing is critical to the performance of personnel and integral to speech communications during airfield operations. Aircraft engines and subsystems are major sources of noise, which impairs communication between pilots, ground crews, and on/off boarding passengers. One population of military personnel routinely exposed to hazardous noise conditions includes aircraft ground support and maintenance crews. As it is not possible to reduce the source of the aircraft noise for these personnel, protection from excessive noise levels, as well as promotion of communication abilities and situational awareness, are important for increasing safety to military personnel on airfields. Hearing protection devices (HPDs) are considered either passive or active, depending on the method implemented by the device to reduce sound energy entering the ear. Passive technologies include HPDs that simply block sound, such as common earmuffs or foam ear inserts. While passive devices can provide sufficient hearing protection, they severely reduce the ability to communicate. Active technologies are typically comprised of a passive component (i.e., an earmuff or ear plug) that contains a miniature microphone, earphone, and signal processing components. These active elements provide audio communication and/or reduce, via active noise cancellation, the noise levels present in the ear canal. Many warfighters are unaware of either the consequences of prolonged noise exposure, or the advances in hearing protection technologies available. Surprisingly, a large number of aircrew personnel choose not to wear double hearing protection, dramatically increasing the possibility of nose exposure related hearing loss. **APPLICATIONS:** Providing active hearing protection devices that also have communication capabilities to individuals proximal to aircraft should be considered a standard requirement on all airfields to minimize injury risk. Hearing protection teams in the DOD are pushing for maximum speech intelligibility and hearing protection throughout the Services, including as many common components for helicopter, jet, and flight deck personnel as possible. This presentation is broadly applicable for reducing hearing health risk associated with military and civilian airfields.

Learning Objectives:

1. Identify the risks to hearing for aircraft ground crew, and the potential benefits of active hearing protection.

[523] REFLEXIVE AND ANTICIPATORY MIDDLE EAR MUSCLE CONTRACTIONS FOR IMPULSIVE SOUNDS

G.A. Flamme[3], S. Tasko[3], k.K. Deiters[3], N.T. Greene[1,2] and W. Ahroon[1]
[1]Auditory Performance and Protection Division, U.S. Army Aeromedical Research Lab, Ft. Rucker, AL; [2]The Geneva Foundation, Tacoma, WA; [3]Speech Pathology and Audiology, Western Michigan University, Kalamazoo, MI

PROBLEM STATEMENT: Hearing is a major contributor to warfighter survivability and lethality. Warfighters with hearing impairments are no longer eligible for unrestricted duty, and this compromises the investment in the advanced training and experience developed by the warfighter. Auditory damage is the largest component of compensable injury for the U.S. Veterans Administration. The MIL-STD-1474E is an acquisition standard that has implications for warfighter safety, and has been proposed by its developers as a Damage-Risk Criterion and Health Hazard Assessment method. The Auditory Hazard Assessment Algorithm for Humans (AHAAH), which is one method included in MIL-STD-1474E, proposes that if an individual expects an impulse, a middle ear muscle contraction (MEMC) will occur in the listener in anticipation of the impulse. To date, there are few studies that systematically examine reflexive MEMC in response to impulsive acoustic and non-acoustic stimuli and/or anticipatory MEMC in response to expected impulsive noise. **TOPIC:** This presentation describes the methods for laboratory and field studies designed to address these limitations. MEMC are detected using click train stimuli as probes. Reflexive MEMC are elicited using tones, noises recorded gunshots, and non-acoustic stimuli including air puffs to the face and voluntary closure of the eye. Anticipatory MEMC are assessed using a variety of conditioning stimuli and levels of distraction. These studies will include an assessment of anticipatory MEMC during live-fire exercises with rifles. **APPLICATIONS:** The results of this work will provide a fundamental understanding of sound transmission through the middle ear. This knowledge can inform Damage-Risk Criteria and Health Hazard Assessments for people exposed to impulse noises.

Learning Objectives:

1. Identify the tools in use in current studies of the effects on hearing of middle ear muscle contractions.

[524] ASSESSMENT OF MIL-STD 1474E, THE AHAAH MODEL

N.T. Greene[1,3], H. Jones[1,2] and W. Ahroon[1]
[1]Auditory Performance and Protection Division, U.S. Army Aeromedical Research Lab, Ft. Rucker, AL; [2]Laulima Government Solutions, Orlando, FL; [3]The Geneva Foundation, Tacoma, WA

MOTIVATION: The new MIL-STD-1474E includes a model of the sound transmission pathway through the ear for estimating the risk to hearing from a sound exposure. Here, we summarize results of recent research aimed at assessing several key assumptions of this model in human subjects. **OVERVIEW:** Evidence-based damage risk criteria are vital for hearing preservation efforts. In order to accurately predict the risk of hearing loss in response to high level sound exposure a model of the sound transmission pathway through the ear (the Auditory Hazard Assessment Algorithm for Humans; AHAAH) has recently been implemented in MIL-STD-1474E. The AHAAH is an electrical equivalence model of the human ear designed to reproduce sound transmission through the ear in order to predict potential hearing injury from a given sound exposure; however, several key assumptions of the model have not been validated in humans. In particular, several AHAAH model components were developed from measurements in cats reported in the literature, thus are inappropriate for use in a model of human hearing. Similarly, the AHAAH model presumes that the effect of middle ear muscle contractions (MEMCs) are powerful (i.e., a 20 dB decrease in transmission) and effective at all frequencies, although their prevalence in humans has been questioned, and it has long been known that MEMCs generally has a high-pass filter effect on sound transmission through the middle ear. We will discuss recent research aimed at updating components and validating assumptions contained within the AHAAH model. These results will be presented with particular emphasis on the differences with the current implementation of the AHAAH model. **SIGNIFICANCE:** Accurate estimates of the risk to a given sound exposure are vital to protect the hearing and function of both aerospace personnel and the general population. **RESULTS:** of this recent research, in addition to complementary research validating additional components of the model, provide the quantitative results required to update this model. The next step will be to implement these results into an improved model of the risks to human hearing, and implement this updated model in military and civilian standards and damage risk criteria. This work is of broad interest to professionals interested in protecting hearing and improving human performance in noisy environments.

Learning Objectives:

1. Identify the results of recent research aimed at assessing assumptions in the AHAAH model.

[525] ACOUSTICAL ASSESSMENT OF THE MH-60 DIRECT ACTION PENETRATOR (DAP) WEAPON SYSTEM

E.R. Reeves and M. Chen
U.S. Army Aeromedical Research Lab, Ft. Rucker, AL

PROBLEM STATEMENT: This case report describes the acoustic assessment of weapon systems on an Army helicopter as it relates to risk of noise induced hearing loss and other physical symptoms. **BACKGROUND/LITERATURE REVIEW:** A U.S. Army Aviation Unit utilizes an armed variant of the Sikorsky UH-60 known as the MH-60 Direct Action Penetrator (DAP). This aircraft carries several weapon systems that produce very high noise levels and are located in close proximity to crewmembers. In addition to auditory hazards, crewmembers have described a variety of physical symptoms that they believe to be associated with use of the aircraft and weapon systems (nausea, headaches, etc.). Therefore, the sound levels produced by the weapon systems needs to be accurately quantified. **CASE PRESENTATION:** An acoustic assessment has been performed to determine the sound levels generated by the weapon systems on board the MH-60 DAP aircraft so noise exposure of flight crewmembers and risk of noise induced hearing loss can be determined. Four transducers were installed on board the aircraft. The transducers were distributed about the interior of the aircraft, with one transducer located to the side and slightly behind the head of each pilot, one transducer located in the approximate center of the rear portion of the aircraft cabin, and one transducer located to the left-hand side of the rear aircraft cabin. Testing was performed at a firing range during training. The aircraft was flown through a number of engagements on targets at the range. During an engagement, various weapon systems were fired individually, and both Mini-guns were fired simultaneously. Measurements were performed with the pilot and crew doors either installed or removed. A post-flight survey was given to flight crewmembers to gather information regarding health symptoms related to DAP weapon firing. **OPERATIONAL/CLINICAL RELEVANCE:** This case highlights the fact that prolonged exposure to higher levels of impulse noise can potentially lead to hearing loss or tinnitus, as described in post-flight surveys, which can affect communications between pilots and crewmembers. Additionally, the sound pressure levels reached from firing these weapons cause pilots and crewmembers to surpass the daily noise Permissible Exposure Limit (PEL) during typical training routines. It also demonstrates that the implementation of noise controlling devices, when practical, can reduce the level of noise exposure.

Learning Objectives:

1. Understand the potentially damaging effects that repeated exposure to weapons fire can have on the auditiory system of pilots and aircrew members.

Thursday, May 04 ***3:30 PM***
Plaza F

S-097: PANEL: SURGICAL CARE IN SPACE II - SURGICAL TECHNIQUES

Sponsored by Space Medicine Association

Co-Chair: Jay Buckey
Dartmouth, VT

Co-Chair: Mark Campbell
Paris, TX

PANEL OVERVIEW: PROBLEM STATEMENT The ability to perform a surgical procedure in weightlessness presents several unique difficulties which need to be solved to be capable of providing surgical care in space. **TOPIC** The papers in this panel will provide an understanding of the technical problems of performing a surgical procedure in space including the control of bleeding, restraint issues, crew medical officer surgical training and the difficulties of providing anesthesia and post-operative wound healing. **APPLICATIONS** Problems in performing a surgical procedure, providing anesthesia and research in post-operative wound healing will need to be further investigated to enable effective surgical care in space.

[526] SURGICAL CARE IN SPACE - ROBOTICS AND HISTORICAL IMPLICATIONS

C.R. Doarn[1], T. Broderick[4], G.M. Pantalos[2] and M. Campbell[3]
[1]Family and Community Medicine, University of Cincinnati, Cincinnati, OH; [2]University of Louisville, Louisville, KY; [3]private practice, Paris, TX; [4]Wright State University, Dayton, OH

PROBLEM STATEMENT: Robotic surgery has many limitations in its present usage but holds great future potential in facilitating surgical care in space. **TOPIC:** As missions in space have grown in duration, complexity, and cost, we must continually reassess the medical and surgical capabilities in support of the astronauts in-flight. While surgical care, as we currently practice terrestrially, is not a significant component of the International Space Station (ISS) healthcare system, there has been significant advances in surgical knowledge and technology over the past several decades. Many challenges have been identified and resolved, but many remain. Nascent technologies in sensors, computing power, imaging, telecommunications, robotics and three dimensional printing provide capabilities to address clinical issues that a generation ago seemed elusive. While exploration class missions may be on the near horizon, much work remains in identifying appropriate systems, protocols, and requirements; all of which are impacted by continuous improvements in technology. This presentation provides a review of previous work in robotic surgery and forecasts how disruptive technologies such as robotics can play an important role in future space medical care systems. **APPLICATIONS:** The future of robotic surgery has potential benefits to facilitate surgical care in space.

Learning Objectives:

1. Review the develoment of robotic surgery and how is has been evaluated in support of human spaceflight.
2. Gain an appreciation for NASA's efforts over the past 30 years in the evaluation of tools for surgical care in space.
3. Review the challenges and opportunities that advancing technology pose for conducting surgery in space.

[527] MINIATURE SURGICAL ROBOTS FOR EXTRA-ORBITAL SURGICAL CAPABILITY

M. Morien[1], N. Bills[2], S. Farritor[3] and D. Oleynikov[2]
[1]College of Public Health, University of Nebraska Medical Center, Omaha, NE; [2]General Surgery, University Nebraska Medical Center, Omaha, NE; [3]Mechanical Engineering, University Nebraska, Lincoln, NE

Surgical robots are not used in remote medical care situations due to large size, weight, and power requirements. Technology becomes more practical by miniaturizing the hardware. As NASA increases mission length and distance from Earth, lifesaving surgical treatment is not available to the crew, Level of Care 5 is suggested. It is essential that an on-board medical system include surgical capability. Research efforts continue to provide surgical solutions in reduced gravity. Spaceflight surgical platforms must be small, light-weight, and intuitively controlled to be practical. To prepare for a spaceflight surgical emergency, we developed unique reliable, low mass mini-surgical robots. This new technology has been extensively tested; 1 parabolic flight and over 80 bench top and animal terrestrial experiments. Currently there is no surgical capability for missions of any length. Further development of mini robots capable of operation in μ-gravity will broaden the scope of future missions. These small lightweight portable robots enable complex general surgery procedures to be done in space. They are an affordable replacement for the only existing FDA approved surgical robot, the *da Vinci* Surgical System, which is not portable, and expensive. Mini robots decrease payload mass, and have multipurpose functionality, operating in small spaces where precise manipulation is required for intra- or extra-vehicular tasks. Mini robots provide a novel solution to the challenges of surgery in space including ease of use, reusability and minimal mass. Surgical robots are controlled with a small surgical console using an electronic buffer, enabling surgeons to operate in microgravity securely. Built-in haptics and smart diagnostic systems allow robot end-effectors to be used for palpation and diagnostics. By manipulation of remote arms, these mini-robots operate similar to other spacecraft equipment, reducing skill level, training time and retention of basic surgical skills. A virtual reality surgical trainer for the mini-surgical robots would allow operators a continuous in-flight training experience. The surgical trainer would grant spaceflight crew capability to practice a library of simulated subtasks and surgical procedures enabling skill acquisition and retention during long-duration missions and providing a virtual assistant for emergent surgeries. Surgical robots become more feasible in remote medical care systems with the miniaturization of surgical robotic hardware.

Learning Objectives:

1. To illustrate the need for an economical, efficient and practical option to surgery during long-term space flights. Providing the virtual reality robot simulator as practical solution to initially training astronaunts as well providing attainable skill retention capabilities.

[528] WOUND HEALING IN EXPLORATION AND COLONIZATION SPACE FLIGHT

K.W. Gregory
Center for Regenerative Medicine, Oregon Health Sciences University, Portland, OR

Despite a remarkable safety record for manned spaceflight missions, missions beyond low earth orbit (LEO) raise new challenges for astronauts with injuries from trauma or who require surgery. Traumatic injury could occur during orbital assembly and stochastic events such as collisions with micrometeorites or equipment malfunction. Medical contingency planning is currently based on rapid medical evacuation, which is not a viable option for more distant missions. Astronauts suffering traumatic injury during lunar missions could face up to 6 days until terrestrial return, and astronauts on a Martian mission, 400 to 900 days. Physiologic responses to micro-gravity: bone demineralization, hypovolemia poor perfusion, excessive fibrosis, exposure to deep space radiation, pancytopenia, and reduced immune function could predispose astronauts to poor healing, inflammatory injury, shock and risk of infection. Direct evidence includes investigation of gastrocnemius muscle crush injury (Strauber, 1991), fibular osteotomy (Kirchen, 1995), and growth factor response (Davidson, 1998). The paucity of direct research makes conclusions tentative. The majority of normal wound healing and tissue regeneration is provided by bone marrow and tissue stem and progenitor cells. It is known that these cell lineages and function are depressed in microgravity. Development of new means of stem and progenitor enhancements, transplantation and countermeasures to protect or stimulate endogenous stem cell niches may provide improved wound healing in microgravity. Assays of crew member stem and progenitor function and wound healing over the course of missions, cell banking impervious to space radiation and technologies to transfer cell mediated healing enhancements are needed. Alternatively, technologies to permanently seal and heal wounds in the face of endogenous defects in wound healing should be considered. Challenges to wound healing need to be further addressed and solutions validated prior to missions beyond LEO.

Learning Objectives:

1. Understand potential challenges for healing wounds in prolonged space travel.
2. Understand adverse effects of microgravity on stem and progenitor cells.
3. Learn new approaches to promote healing from injuries or surgical interventions during prolonged space travel.

[529] ANAESTHESIA IN AUSTERE ENVIRONMENTS: LITERATURE REVIEW AND APPLICABILITY FOR SPACE EXPLORATION-CLASS MISSIONS.

M. Komorowski[1], M. Mawkin[2] and S.E. Fleming[3]
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PROBLEM STATEMENT: The ability to provide anaesthesia for a surgical procedure in weightlessness presents several unique difficulties which need to be solved to be capable of providing surgical care in space. **TOPIC:** Future exploration class space missions will take humans far beyond low Earth orbit, where medical evacuation and real time tele-medical support will not be possible. Anaesthetic techniques will be important on these long duration missions as there will be a risk of severe medical events requiring surgical treatment. Knowledge and experience of such procedures during long-term space missions is currently extremely limited. We have conducted a literature search on anaesthesia in austere and remote environments and evaluated research articles, review articles and case reports from Pubmed, Scopus and the Cochrane databases. We have also examined guidelines and publications from space agencies, military and humanitarian medical organisations. We will present how specific questions have been addressed in relevant settings, such as the quality and training of healthcare providers, pre-operative patient assessment, the recommended anaesthesia equipment and drugs, what regional and general anaesthesia protocols are suggested, guidelines for perioperative care and some aspects of hygiene and infection control. We will discuss how these factors could be applied to the unique environment of an exploration class mission. This literature review will provide information that will be important to the design of the on-board health care system and protocols for future space exploration missions. **APPLICATIONS:** Problems in providing anaesthesia will need to be further investigated to allow surgical care in space. **RESOURCES:** Norfleet W. Anesthetic Concerns of Spaceflight. Anesthesiology. 2000; 92:1219-1222.

Learning Objectives:

1. The audience will learn what analog environments can be used to help design medical protocols for anesthesia during space missions.
2. The audience will learn what protocol could be recommended for performing a general anesthesia on a microgravity exposed patient.
3. The audience will learn what is the minimal equipment recommended to perform an anesthetic procedure.

[530] EVOLVING FROM CMO TO EXPLORATION CREW MEDICAL OFFICER (ECMO): IMBEDDED TRAINING IN A CIVILIAN SURGICAL CENTER?

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PROBLEM STATEMENT: The most limiting factor in the surgical capabilities of Exploration Class Missions will be the surgical skills and

training of the crew medical officer. **TOPIC:** A three-tiered model to describe projected level of surgical capability training for exploratory and colonization spaceflight is described. The degree of complexity; time allowance for training; and the training objectives are stratified according to three (3) tiers: not difficult, fairly difficult, and most difficult. In the first tier, analogous to current training methods, 10 hours of pre-mission training should suffice for objectives that include IV/IO access, focused physical exam and ultrasound exams, closure of simple wounds. Second and third tier complexity involves imbedded training in an ACGME-accredited surgical program for 1-2 weeks and 2-3 weeks respectively, similar to the described military (USAF) model of C-STARS. Achieving "most difficult" training objectives in a small group of Exploration Crew Medical Officers (ECMO) would be a natural progression of present CMO training. It would prepare the provider for autonomous surgical capability during ECM, and lend itself to simulation exercise on the International Space Station. **APPLICATIONS:** Crew medical officers can be shown to achieve practical surgical skills with focused training.

Learning Objectives:

1. Consider dividing surgical training into a three-tiered model based on complexity of tasks (and hence training) being asked of the crew medical officer or physician astronaut. The tiers would be "not so difficult", "fairly difficult", and "most difficult". In each of these tiers, what would we want or expect the capability to include, and how would we train the CMO's?
2. Describe how recent subject matter experts (SME's) recommend we change the current paradigm of CMO training to prepare for deep space missions and contingencies.
3. Identify several specific changes in training techniques (e.g. time, number of individuals trained, etc.) that are being suggested as possible methods.

[531] CURRENT STATE OF 3D PRINTING IN PROVIDING AS-NEEDED HARDWARE FOR SPACEFLIGHT SURGERY

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INTRODUCTION: Providing surgical equipment to support surgery in space is a significant engineering and logistics challenge balancing the amount of resources needed for surgery against the limited mass and volume constraints on a space flight vehicle. Continued advancements in 3D printing allow for more durable and functional surgical hardware to be fabricated faster and as-need that could alleviate stowage and resupply concerns. **METHODS:** In the limited literature evaluating 3D printed surgical equipment, consensus is that usage of 3D printed surgical tools is workable, but there are physical and functional limitations to the hardware mainly due to the quality of the equipment's fabrication. Evaluations have focused on surgical tools and durables and have not been extended to more complex surgical hardware systems that have electronics; air/fluid separation and containment; drug delivery; and sterile field maintenance. **RESULTS:** The capacity and capability of 3D printers is rapidly advancing. Commercial 3D printers have a minimum horizontal and vertical print resolution of 20 microns. Print duration of surgical tools is on the order of hours. Available constituent materials are expanding further to include plastics, titanium, nylon, glass, electrically conductive copper, etc. Multi-constituent 3D printers are available that allow for fabrication of hardware with multiple materials. **DISCUSSION:** 3D printing technology is a valuable asset in providing surgical resources on space flight missions. The selection of materials that are available for 3D printing is increasing. Couple that with 3D printers that have multiple extrusion heads, more complex hardware systems can be fabricated that may be deployed for the space surgery community. 3D printing speed will need to improve as print durations are too long for emergent care but could be practical for resupply. Durability requirements for surgical equipment will need to be finalized so as to not over-engineer hardware that will likely be single-use.

Learning Objectives:

1. The participant will be informed of the current state of 3D printing technology as an asset in providing as-needed hardware for spaceflight surgery.
2. The participant will be informed of the level of functionality and durability of 3D printed surgical hardware in performing surgical tasks.

Thursday, May 04 ***3:30 PM***
Governor's Square 14

S-098: PANEL: RESIDENT RESEARCH AND QI/PI PRESENTATIONS – PART 2

Co-Chair: Richard Allnutt
Beavercreek, OH

Co-Chair: Mark Coakwell
Dayton, OH

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

[532] VIRTUAL PATIENT SIMULATION: A POSSIBILITY TO IMPROVE FLIGHT SURGEON SKILLS

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MOTIVATION: Research has demonstrated the effectiveness of using a live-actor standardized patient to educate medical students. Extrapolating from this success, several specialty organizations utilize virtual patient simulation to evaluate board-certified providers. In the Air Force, physicians receive an initial 11-wk class to learn the fundamentals of aerospace medicine before they receive their flight surgeon certification. However, there is limited formal continuing medical education requirements unless that flight surgeon completes a residency in aerospace medicine and becomes board certified. This process improvement project examines the potential for using an internet-based, virtual standardized patient (VSP) simulation platform (USC SimCoach Standard Patient Studio©) to allow flight surgeons a method to review aerospace cases and receive feedback on their interview and assessment skills. **OVERVIEW:** The USC Standard Patient project developed a VSP platform that 1) emulated a live patient encounter, 2) provided automated structured feedback, and 3) allowed for rapid case development using standardized taxonomy. Prior research using this platform demonstrated significant improvement in diagnostic interviewing skills. For this process improvement project, Air Force flight surgeons were invited to examine a simulated decompression sickness case and evaluate the VSP platform to determine if this system could be useful to improve flight surgeon skills. **SIGNIFICANCE:** Nineteen evaluations were received after two rounds of requests to voluntarily participate in the VSP case (21.5% response rate.) Sixteen of the participants were either graduates of the residency in aerospace medicine or current residents. Just under half of the participants felt the VSP platform was unrealistic for a patient encounter. Thirteen agreed it was easy to use and navigate. A majority were very or moderately likely to use the platform to learn new or to review topics (15 and 17 of 19, respectively). Most participants agreed this would be a useful program to teach skills in the initial flight surgeon course or for continued education for basic or senior flight surgeons. Further research is needed to determine the effectiveness of this platform in flight surgeon education, but the feedback from this process investigation suggests there could be benefits.

Learning Objectives:

1. The participant will be able to understand the concept of a virtual patient simulation platform and the principles it employs to teach adult learners.
2. The participant will be able to weight the potential pros and cons of using a virtual patient simulation platform to enrich flight surgeon skills.

[533] INCORPORATION OF AN OPERATIONAL MEDICINE CURRICULUM INTO EXISTING GME PLATFORMS: A QI PROJECT TO SAVE COSTS, SHORTEN TRAINING, AND BOOST UNIT STAFFING

P. DeFlorio and A.M. Timboe
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MOTIVATION: Each year a cohort of U.S. Air Force (USAF) aerospace medicine professionals enters flight medicine billets directly after graduating from military family medicine (FM) and emergency medicine (EM) residency programs. The majority require 3 or 4 mo of additional training to become fully mission qualified. By integrating a structured operational medicine elective curriculum within FM and EM residencies, this additional post-graduate training time could be avoided, clinics better staffed, and money reallocated. The feasibility of and faculty support for integrating such pre-operational training into existing residency curricula were assessed via literature search and faculty survey. This presentation highlights the results of these structured interviews and proposes a curriculum template for an operational area of sub-concentration based on common Accreditation Council for Graduate Medical Education (ACGME) competencies. **OVERVIEW:** While the USAF has traditionally left operational medicine training until after completion of graduate medical education, we developed a theoretical framework to integrate such training into FM and EM residencies. We first reviewed the core ACGME competencies of medical knowledge, patient care, interpersonal skills and communication, professionalism, practice-based learning, and system-based practice; we found that required operational training was fully compatible with these requirements. We next reviewed the literature to identify strategies to help craft an elective curriculum and to generate a set of testable milestones. The real-world feasibility of implementing such an elective curriculum was then assessed by a structured interview of USAF FM and EM teaching faculty. This feedback was incorporated into a finalized operational medicine elective curriculum for implementation at USAF FM and EM residency sites. Finally, current limitations and barriers to implementation were reviewed. **SIGNIFICANCE:** The successful deployment of this process improvement could have significant benefits. Every three residents receiving operational training within their residencies would save enough training time to equal one full-time post-graduate physician. The implementation of this elective curriculum could therefore reduce cost, save training time, and boost medical unit staffing. If successful in the USAF, this process could be generalizable to USAF internal medicine programs and to similar Army or Navy training pipelines.

Learning Objectives:

1. The participant will be able to understand a new approach to increasing USAF flight surgeon recruiting by a model that incorporates preparatory training into existing GME pipelines.

[534] USE OF OXYGEN TISSUE CALCULATOR AND CABIN ALTITUDE RESTRICTION DURING AEROMEDICAL EVACUATION

A. Mitchell
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MOTIVATION: Altitude can impede tissue oxygen delivery (DO_2) via hypoxia and hypobaria; thus, while a patient may be "stabilized" on the ground, the actual flight environment may induce unforeseen physiological insult and risk. This presentation will show how a validating flight surgeon can potentially improve patient outcomes through the application of cabin altitude restrictions (CARs) determined with the use of a calculated DO_2 application. **OVERVIEW**: Today, military combat medical care is the best it has ever been. There are a number of reasons for this spectacular success: care is more forward than in times past; care is of higher technical skill and has a higher level of technological support than previously; the Critical Care Air Transport Teams have enabled movement of "stabilized," albeit very sick, patients in numbers never before seen; and aeromedical evacuation (AE) has become more elastic than ever before. In fact, regulated AE of ill and injured service members via fixed wing aircraft often takes them to definitive care within 24-72 h. There is growing clinical research that supports the notion that altitude can impede DO_2 via hypoxia and hypobaria and that this has the potential to affect clinical outcomes. In the U.S. Air Force AE system, a validating flight surgeon has the ability to prescribe a CAR below 8,000 ft to potentially mitigate the drop in DO_2 during AE. Despite much discussion, little data exist to validate a process or approach to determine when and at what level to apply a CAR. This is an initial attempt at applying DO_2 calculations within the AE environment by retrospectively comparing the calculated DO_2 of patients with and without a CAR to a data set of patients flown during Operation Iraqi Freedom. **SIGNIFICANCE**: This look at the predictive usefulness of DO_2 in AE offers a process of determining when and how a CAR can be prescribed prior to an AE. This work is of broad interest to any professional who may have operational AE concerns or is involved with transporting critically ill or injured patients.

Learning Objectives:

1. Potential validating flight surgeons prescriptions to address the stressors of flight and unique challenges of hypoxia and hypobaria on patients during aeromedical evacuation.

[535] IMPROVING THE 24-HOUR AEROMEDICAL DISPOSITION PROCESS

J. Rojas
RAM, U.S. Air Force, Dayton, OH

MOTIVATION: Flight surgeons are required to review all flyer encounters seen outside of flight medicine within a 24-h period. Both the flyer and flight surgeon are responsible for identifying any possible factor that would negatively affect the flyer's ability to perform his/her flying duties. Once the outside physician completes a note, the flight surgeon reviews and documents his/her decision on whether or not the pilot is cleared to fly. There are multiple factors that may impact the quality of the aeromedical dispositions: the ease and utility of Armed Forces Health Longitudinal Technology, how the encounter is presented to the flight surgeon in the electronic health record, the promptness with which the physician completes the disposition, and the loss of non-dispositioned encounters. The 24-h disposition process is determined on the base level, causing variations in procedure. This lack of standardization increases the possibility of missed or delayed aeromedical dispositions. Oversight and review of the 24-h disposition process are completed by peer review and base-wide inspections, but neither is able to produce feedback in a timely manner. **OVERVIEW:** We attempted to simplify the 24-h disposition log to allow for better continuity, accountability, and ease. We used the "tasker" function in Armed Forces Health Longitudinal Technology to assign a patient encounter to a specific flight surgeon, which immediately notified him/her of a pending 24-h aeromedical disposition. This tasker populated the "Task" function in the physician's queue until she/he reviewed the note, placed an aeromedical disposition, and closed the task. An incomplete note that exceeded the 24-h time limit did not fall off the task list. Instead, it prompted the support staff to contact the clinic with the open encounter and request the completion of the note in a timely manner so that a flight surgeon could prioritize the review and disposition. **SIGNIFICANCE:** By simplifying and standardizing a procedure for 24-h dispositions, we kept the aeromedical responsibility within the flight medicine clinic, decreased missed aeromedical dispositions, and decreased the steps required for a flight surgeon's review. Correct and timely aeromedical dispositions prevent unfit flyers from performing flying duties.

Learning Objectives:

1. To introduce a standard in the review and completion of the 24 hour disposition log.

Thursday, May 04 ***3:30 PM***
Governor's Square 15

S-099: SLIDE: TESTING & EQUIPMENT IN AEROMEDICAL ENVIRONMENTS

Co-Chair: Kirk Nailling
Grandview, TX

Co-Chair: Marian Sides
Grayslake, IL

[536] AUDITORY STIMULATION THERAPY FOR PTSD

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[4]*Retired, Air Force Research Lab, San Antonio, TX*

PROBLEM STATEMENT: Clinical success has been documented for rhythmic auditory stimulation therapy for PTSD. Now, rigorous scientific inquiries into the reliability and neuroanatomical mediation of this therapeutic approach are needed. **BACKGROUND/LITERATURE REVIEW:** The human body generates many internal rhythmic processes and is affected by several external rhythms. Intense musical emotion is associated with brain regions thought to be involved in reward, motivation, and arousal: the ventral striatum, the amygdala, the midbrain, and regions of the frontal cortex. The Bio- Acoustical Utilization Device (BAUD) has been used successfully for rhythmic auditory stimulation therapy for post-traumatic stress disorder (PTSD) in a clinical method called Reconsolidation Enhancement by Stimulation of Emotional Triggers (RESET Therapy). **CASE PRESENTATION:** In one of many cases, RJL, a Vietnam vet gunner dealt for 50 years with such problems as "sleep disorder, drug use and overwhelming anxiety..." After one RESET treatment, the patient's wife reported that "He went home, slept well, didn't jerk awake, didn't jump up awake slamming, screaming, looking like someone was going to kill him." In another case, there was similar relief for Afghan vet WR, tormented by memories of an IED explosion that killed and injured children. Quantitative EEG brain mapping of WR before RESET Therapy indicated lack of cortical control over the limbic system, left frontal lobe hyper-activation in the speech regions, and evidence of disrupted executive functioning ability. These indications were completely absent in the post-therapeutic qEEG map. Evidence for the functional neuroanatomy that may mediate these remarkable effects is present in two lines of investigation. Auditory steady state evoked potential (SSEP) research suggests that "through the acoustical pathway we are able to directly modulate neural activity in the amygdalo-hippocampal circuit during memory retrieval and reconsolidation." Studies of auditory fear conditioning indicate that auditory stimulation, fear, the medial geniculate nucleus of the thalamus, and the basolateral complex of the amygdala are intertwined. **OPERATIONAL/CLINICAL RELEVANCE:** The clinical successes with RESET Therapy need applied research attention. There is a promise here of relief from disabling PTSD symptoms for combat veterans and for active duty personnel.

Learning Objectives:

1. Clinical success has been documented for rhythmic auditory stimulation therapy for PTSD.
2. Through the acoustical pathway in the CNS we are able to directly modulate neural activity in the amygdalo-hippocampal circuit during memory retrieval and reconsolidation.
3. Rigorous scientific inquiries into the reliability and neuroanatomical mediation of RESET Therapy for PTSD relief are needed.

[537] LOW LEVEL SPECIFIC AIR CONTAMINANT GAS SENSOR DEVELOPMENT FOR REAL-TIME AIR QUALITY SENSOR SUITE

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INTRODUCTION: Isopropyl alcohol (IPA) was identified as a compound present in unexpectedly higher concentrations (high ppb to low ppm levels) than other potentially hazardous compounds in previous studies by our group on pilot air supplies in aircraft utilizing On-board Oxygen Generation Systems (OBOGS). While a variety of alcohol sensors are readily available as commercial products, there are currently no commercial off-the-shelf sensors (COTS) which can effectively discriminate low level IPA (at ppb or low-ppm levels) from other molecules. By mimicking nature's olfactory system, we have shown that a bioinspired capture element acting as the "sensing material" can selectively bind to the target of interest (IPA), and may prove to be a good candidate to enhance the sensitivity and selectivity of an electronic sensor. **METHODS:** A polymer olfactory sensing element is being developed using poly-vinlypyrrolidone (PVP), an FDA approved material. A previous academic research proved the PVP film can selectively respond to liquid IPA. Here, the IPA selectivity of the polymer is being tested on nanomaterial based electronic devices. PVP films, olfactory receptor-like coatings, are coated on the surface of devices obtained from single-wall carbon nanotubes (SWNT) using various coating methods including spin-coating, drop-casting, and dip-coating, and tested for their response to the target IPA vapor. **RESULTS AND DISCUSSION:** Contrasting to traditional COTS requiring heating elements, heat management systems, and large housings, the nanoelectronic SWNT sensors enable one to achieve high performance sensing at near zero operating power in a highly miniaturized platform. The PVP-functionalized SWNT nanotransducers have shown selectivity toward the gaseous IPA without noticeable response to the interfering Isoprene and Acetone vapors. In parallel testing to the nanotube sensor, a high sensitivity COTS device was shown to have a non-IPA-specific response. In future work, a custom-designed chemical exposure chamber with precise control of compound concentration, flow rate, and pressure is planned to be used to test the sensor performance under simulated flight conditions. Ultimately, the final product from this research will be utilized to add real-time IPA sensing capability for monitoring aircraft breathing air quality as part of a sensor suite designed to enhance aircrew health and safety.

Learning Objectives:

1. Strategy to build low level volatile sensor.
2. Role of nanomaterial/nanotube as sensitive sensing platform.
3. Designing biomimetic target selective receptor element.

[538] HYPOBARIC HYPOXIA PROVOKES ALTERATIONS IN IMMUNE RESPONSE

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BACKGROUND: Hypobaric hypoxia during airline travel induces several (patho-) physiologic reactions in the human body. Whereas severe hypoxia is investigated thoroughly, very little is known about short- and long-term effects of moderate hypoxia, e.g. during airline flights. The aim of the present study was to analyze changes in serum protein expression and activation of signaling cascades of human subjects staying 30 minutes in a simulated altitude equivalent to airline travel. **METHODS:** After approval of the local ethics committee, N=10 human subjects participated in the experiment. Duration of moderate hypoxia (simulation of 2,300 m) was 30 minutes in the hypobaric chamber (2 subjects per run). Before and after hypobaric hypoxia in the hypobaric chamber, serum was drawn and centrifuged at 5000xg for further analysis. Serum was analyzed by two-dimensional gel electrophoresis (2D-DIGE) followed by peptide mass fingerprinting using mass spectrometry to compare gel-pairs (before vs. after hypoxia). Statistical analysis was performed with DeCyder 2D (GE Healthcare; $p<0.01$). Biological functions of differential regulated proteins were studied using functional network analysis (GeneMania and STRING software). **RESULTS:** 9 male and 1 female subjects (182±7 cm and 85.2±9.3 kg) participated in the trial. Mean altitude was 2,300 m during the 30 minutes experiments. Oxygen saturation of the subjects decreased from 98.1±1.3% to 89.2±1.8% during hypoxia. Expression of 10 proteins was significantly altered. All proteins were identified by MALDI-TOF: Serum albumin (ALB), Phosphoglycerate kinase 1 ()PGK1, Apolipoprotein E (APOE), Glyceraldehyde-3-phosphate dehydrogenase (GAPDH), Complement C1q subcomponent subunit A (C1QA), Complement C1q subcomponent subunit B (C1QB), Catalase (CAT), Carbonic anhydrase 1 (CA1), Prothrombin (F2), and Clusterin (CLU). Bioinformatic analysis with GeneMania and STRING software revealed an association of the altered proteins found with the signalling cascades of (1) humoral response immunity, (2) regulation of hemostasis, and (3) leukocyte mediated immune response. **CONCLUSIONS:** Even though hypobaric hypoxia was short and hypoxia was moderate and comparable to an airliner flight, analysis of serum protein expression in human

subjects revealed an association to immune response and hemostasis. According to these results, even moderate hypobaric hypoxia seems to influence the human immune system.

Learning Objectives:

1. Moderate hypobaric hypoxia influences protein expression.
2. After short exposure, comparable to an 30 minutes airline flight, protein expression is altered.
3. Affected proteins are: Serum albumin (ALB), Phosphoglycerate kinase 1 ()PGK1, Apolipoprotein E (APOE), Glyceraldehyde-3-phosphate dehydrogenase (GAPDH), Complement C1q subcomponent subunit A (C1QA), Complement C1q subcomponent subunit B (C1QB), Catalase (CAT), Carbonic anhydrase 1 (CA1), Prothrombin (F2), and Clusterin (CLU).

[539] A THREE PHASE STUDY INVESTIGATING THE VIABILITY OF THE NEUROPTIC PUPILLOMETER FOR MONITORING BRAIN INJURED PATIENTS DURING AEROMEDICAL EVACUATION

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INTRODUCTION: The Royal Air Force Critical Care Air Support Team are responsible for the aeromedical evacuation of the critically ill, this includes brain injured patients. Objectively assessing, monitoring and managing patients with brain injuries remains a challenge due to the inability to use invasive intracranial pressure (ICP) monitoring and the subjectivity of current techniques that include pupil size and reactivity monitoring with a pen torch. The NeurOptic Pupillometer potentially offers a more objective tool and warranted further investigation. NeurOptic created an algorithm, the Neurological Pupil index (NPi), which has shown a promising inverse correlation with ICP in early published studies. **METHODS:** Phase 1; Assessed the Neuroptic Pupillometer functionality at ground level and simulated altitudes. Phase 2; Analysis of 400 sets of normative pupil parameter measurements obtained from 100 healthy military volunteers. Phase 3; Investigation of whether altitude affected pupil parameters in 10 military volunteers. A repeated measures cross over design was used to measure pupil parameters at ground level and a simulated altitude of 8,000ft, before, during and after the performance of the Valsalva Manoeuvre (VM) (a forced expiration usually performed against a closed glottis), which is a recognised method of raising intracranial pressure. Approval to conduct this study was granted by the Ministry of Defence Research Ethics Committee. **RESULTS:** Phase 1 established that the Pupillometer was unaffected by altitude, producing non-significant results ((X^2)2 = 0.375, p = 0.945), laying the basis for Phase 2 and 3. Phase 2 provided the first normative pupillary parameter values for NPi. The mean NPi was 4.26 (SD ± 0.18) range 3.0 - 4.9. In phase 3 the VM decreased the NPi score at altitude, this was statistically significant ((X^2)2 = 13.041, p = 0.015), but not at ground level ((X^2)2 = 8.103, p = 0.15). **DISCUSSION:** This is the first study that identifies the relationship between altitude and the VM on pupil parameters. It is likely that the VM in conjunction with hypobaric hypoxia reduced the NPi scores of the participants, which suggests a rise in intracranial pressure when VM is performed at altitude. The Pupillometer offers a more objective measurement of pupil parameters than the current subjective technique but further research is required before recommendations can be made regarding its use as a non-invasive ICP monitor in the aeromedical environment.

Learning Objectives:

1. The participant will be able to understand how early identification of rising intracranial pressure through objective pupil assessment may facilitate improved outcomes for brain injured patients.
2. The participant will be able to understand that the null hypothesis was rejected in this study because pupillary response as determined by the Pupillometer was significantly different statistically at a pressure altitude of 8000ft in comparison to ground level.
3. The participant will understand the clinical significance of the study; that an already compromised brain injured patient who is aeromedically evacuated is potentially at a higher risk of a secondary insult to the brain.

[540] A SYSTEMATIC REVIEW OF RECOMMENDATIONS ON DIABETES MELLITUS MANAGEMENT DURING AIR TRAVEL

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BACKGROUND: Complications of diabetes management during air travel are common, often related to disruption of medication dosing, especially when crossing time-zones. We performed a systematic review of the literature for recommendations on diabetes management during air travel to summarize current management recommendations, assess the quality of the evidence, and identify areas needing further research. **METHODS:** PUBMED and MEDLINE databases were queried for all English articles published between January 1980 and June 2016 using combinations of search terms including "travel", "air travel", "airline", "diabetes", "diabetes mellitus", "insulin", "insulin pump", "continuous subcutaneous insulin infusion device", and "glucometer". All studies providing recommendations regarding general travel advice, oral medication and insulin adjustments, and use of insulin pumps or blood glucometers at altitude were included. **RESULTS:** Forty-eight publications were identified (34 expert-opinion, 8 observational studies, 1 case report, and 5 device studies). General travel advice was relatively uniform, with evolving attention to pre-flight security. Oral agent adjustments varied from no change to holding doses during eastward travel; there were no recommendations on novel agents or information on complications not related to hypoglycemia. Most insulin adjustments involved reducing total dose during eastward travel and increasing or splitting it for westward travel. Specific dosing adjustments were variable. Recommendations regarding changes in pump settings conflicted in terms of timing of time-zone resetting and with regards to basal rate adjustments during flight. Insulin pumps theoretically deliver excess insulin at altitude but few case reports exist. Data supports use of glucometers during flight and at altitude despite enzymatic reliance on oxygen. **CONCLUSION:** Recommendations for diabetes management during air travel are based mostly on expert opinion and observational data. Well-designed, large observational studies and controlled clinical trial data are needed to identify safe and effective approaches to diabetes management during air travel.

Learning Objectives:

1. Describe the incidence and outcomes of diabetic complications during commercial airline travel.

[541] COMPARISON OF DIFFERENT COLOR VISION TEST IN SWISS AIR FORCE: CURRENT EXPERIENCE WITH CAD (COLOR ASSESSMENT AND DIAGNOSIS) TEST

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INTRODUCTION: Approximately 4% of the human populations are hereditarily colour deficient preferring males with 8-10% are comparing to females with 0.4%. Medical examination process contains screening of colour vision deficiency in professional military and civilian aviation pilots. **METHODS:** Over a period of 18 month (January 2015-June 2016) a total of 524 applicants (i.e. pilots, air traffic controller, parachutists) were screened for a potential colour vision deficiency at persons the Aeromedical Center of the Swiss Air Force. Ishihara plates, Spectrolux, the Heidelberg Anomaloscope and the CAD test were used for screening. **RESULTS:** Further examination using Spectrolux, Anomaloscope and CAD was realized in 54 applicants with suspicious Ishihara test (10.3%) revealing 36 applicants with deutan deficiency, 6 applicants with protan deficiency and 12 applicants with no colour deficiency. Using the Anomaloscope as the gold standard 97.8% of the CAD diagnosis was comparable. In terms of aeromedical fitness out of 46 colour deficient applicants 11 deutan (23.9%, mean threshold: 3.81) and 2 protan (4.3%, mean threshold: 9.4) were within the CAD limits for professionals and passed. In terms of colour deficiency, successful CAD examination qualifies for commercial and air traffic medical license in Switzerland. **DISCUSSION:** The CAD is a valuable additional test to examine colour deficiency. In our investigation 2 protan and 11 deutan (4.3% and 23.9%) fulfilled the medical requirements in regard to the colour deficiency using

CAD test. Different factors such as fatigue, medication and lack of concentration should be taken in account evaluating the CAD results.
Learning Objectives:
1. Important results in colour assessment.
2. CAD is a valuable additional test.
3. Each test has its own specificity and sensitivity.

Thursday, May 04 ***3:30 PM***
Governor's Square 12

S-100: PANEL: JOURNAL SEMINAR: WRITING AND SUBMITTIING A PAPER TO AEROSPACE MEDICINE AND HUMAN PERFORMANCE

Chair: Frederick Bonato
Montclair, NJ

PANEL OVERVIEW: Peer-reviewed journals such as *Aerospace Medicine and Human Performance (AMHP)* publish formal reports on scientific studies, review and clinical observations. Publication in a journal like AMHP is a worthwhile achievement, but many potential authors are unfamiliar with the journal requirements or have been disappointed by having manuscripts rejected. The first hour of this presentation will provide authors with a systematic overview to writing an informative, readable manuscript and submitting it to AMHP using our web-based system, Editorial Manager. The journal staff will discuss the requirements for various article types as set forth in the Information for Authors. They will explain how the author can avoid problems as a manuscript passes through three sets of hands: the editorial office for review of content, the publishing office for copy editing, and the printer for conversion and typesetting. The final half-hour of the presentation will be devoted to peer review, a widely accepted process by which journals assure the quality of published papers. This presentation will acquaint authors with the peer review process and help new reviewers understand what is expected of them and how the editor uses their reports. Journal staff members will be available throughout the week to talk with authors and referees regarding journal content and processes.

[542] WRITING A MANUSCRIPT FOR AEROSPACE MEDICINE AND HUMAN PERFORMANCE

F. Bonato
Montclair State University, Montclair, NJ

PROBLEM STATEMENT: When writing a manuscript for AMHP a decision needs to be made about article type. Once an article type is identified, knowing the type of information that goes in each category is important. **TOPIC:** The different AMHP article types will be discussed. A step by step-by-step description about how a manuscript is constructed will be provided. **APPLICATIONS:** Writing a manuscript clearly and concisely can lead to a smoother editorial processes and an increased chance at successful publication. Choosing the right submission category for a manuscript is also important. **RESOURCES:** 1. https://www.editorialmanager.com/AMHP/default.aspx. 2. https://www.asma.org/asma/media/asma/pdf-journal/Editorial%20Mgr/EM-AUTHOR-INSTRUCTIONS-Nov-2014.pdf.
Learning Objectives:
1. Understand the difference and components of the various types of articles *Aerospace Medicine and Human Performance* publishes.
2. Learn the basics of putting together a manuscript for submission to *Aerospace Medicine and Human Performance*.

[543] GETTING YOUR MANUSCRIPT INTO PRINT

P. Day
Aerospace Medical Association, Alexandria, VA

PROBLEM STATEMENT: In order to publish the highest quality papers in our journal, a manuscript goes through many steps. After the manuscript has been accepted for publication there are still many hurdles to jump to get it into print. As publishers, we have certain requirements to fulfill. **TOPIC:** The steps a manuscripts goes through on its way to publication will be discussed, including tooling for style and reference checking, copy editing, more reference checking, composition, corrections, and finally printing, posting, and mailing. **APPLICATIONS:** Emphasis will be on References and Figures as these two areas are where most of the problems occur. By adhering to the guidelines as published in the information for authors, your manuscript will be published faster. **RESOURCES:** https://www.editorialmanager.com/AMHP/default.aspx; https://www.asma.org/asma/media/asma/pdf-journal/Editorial%20Mgr/EM-AUTHOR-INSTRUCTIONS-Nov-2014.pdf. For reference formats see: https://www.nlm.nih.gov/pubs/formats/recommendedformats.html; https://www.nlm.nih.gov/bsd/uniform_requirements.html. For help with figures see: https://www.editorialmanager.com/AMHP/default.aspx; http://b.nanes.org/figures/; https://www.youtube.com/watch?v=S3zYTJ9iP6o.
Learning Objectives:
1. The audience will learn some of the pitfalls in amnuscript submission, such as references out of order or uncited.

[544] PEER REVIEW OF MANUSCRIPTS FOR AMHP

E. Boudreau
Department of Medical Informatics and Clinical Epidemiology, Oregon Health and Science University, Portland, OR

PROBLEM STATEMENT: Many people are unfamiliar with the process of manuscript peer-review. Because of this they may be reluctant to volunteer to be a peer reviewer, even if they are a subject expert. It is also important for authors to understand how this process works when submitting a manuscript for publication, so that they understand the review criteria. **TOPIC:** This tutorial will cover (a) the individual steps in the process of peer review from manuscript submission to author notification, (b) the typical criteria used for evaluation of manuscripts, and (c) the strengths and weaknesses of the peer review process. **APPLICATIONS:** The peer review process is a critical component of manuscript publication. Therefore, it is important that both authors and potential reviewers understand the steps involved in this process, and the potential advantages and pitfalls. **RESOURCES:** https://www.editorialmanager.com/AMHP/default.aspx (click on "reviewers" at the bottom of the page)
Learning Objectives:
1. At the completion of this activity, participants will under the manuscript peer review process, and be able to identify the advantages and disadvantages of this system.

[545] WHAT YOU NEED TO KNOW ABOUT SUBMITTING A MANUSCRIPT

D. Sventek
Aerospace Medical Association, Palmyra, VA

PROBLEM STATEMENT: In order for our authors to accurately submit a manuscript to *Aerospace Medicine and Human Performance*, it is critical to ensure instructions and directions are easily understood and the submission process is smooth with little effort. **TOPIC:** Submitting a manuscript to a peer-reviewed journal is a process with many steps, from submission to review, edit to re-review. Along the way, this process can become unwieldly. Even knowing the requirements of the type of manuscript can also be confusing. Following a bullet-point checklist will dissipate the confusion and allow for an easier and smoother process. **APPLICATIONS:** The need for comprehension should be considered during the planning stages of instructions to authors to ensure authors understand the category of submission, word requirements, reference requirements, and format. A bulletized checklist has been created specifically to aid authors in writing their document and submitting it on-line. This segment of the panel will focus on the ease of logging onto the Editorial Management website and all steps an author will need to follow to upload his or her manuscript. The sections that will give someone the most trouble, if not prepared, will be highlighted. Once an author understands the "upload" system, the process will be relatively simple.
Learning Objectives:
1. The author will learn how to log onto the Editorial Management system. He will find an intuitive system once a simple checklist is followed.

2. The author will learn how to decide what type of manuscript he will be submitting with word cound, reference count and formatting guidelines.
3. The author will learn how to maneuver the editorial management system to find the status of the manuscript, revise the manuscript and upload the revised manuscript.

Thursday, May 04 ***3:30 PM***
Governor's Square 11

S-101: SLIDE: MUSCULOSKELETAL INJURY, PAIN AND GAIN

Co-Chair: Takashi Nagai
Pittsburgh, PA

Co-Chair: Timothy Welsh
Bethesda, MD

[546] HEAD-SUPPORTED MASS EXPERT PANEL WORKING GROUP (HSM EPWG) PROGRAM OVERVIEW

B. Shivers, A. Madison, J. McEntire and C. Chancey
[1]*Injury Biomechanics Division, U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL*

MOTIVATION: In 2016, the U.S. Army Aeromedical Research Laboratory (USAARL) hosted the first Head-Supported Mass Expert Panel Working Group (HSM EPWG) at Fort Detrick, MD, in order to convene subject matter experts from all branches of service, academia, industry, and HSM end users. The goal of the HSM EPWG was to address on-going challenges, issues, and concerns related to research of acute and chronic injuries from HSM (helmet and helmet-mounted systems) in order to identify potential solutions, new approaches, and best practices for current work and future collaborations. **OVERVIEW:** Ongoing HSM research efforts and overviews of current and proposed operating environment-specific HSM systems were briefed. The multi-national group then collectively discussed and agreed upon priority research gaps and areas of collaboration to address the issues identified. Mission effectiveness was the highest-priority weighting factor, i.e., guidelines, criteria, and standards should be established such that HSM mass and mass offset do not impede or inhibit the Warfighter to perform required tactics, techniques, and procedures (TTPs). Development and adoption of uniform measurement techniques, reporting metrics, and test assessment methodologies were identified as priority research focuses moving forward. This uniformity is critical to consistent definition and measurement of HSM mass, center of mass (COM) offset, moment of inertia, pain levels, operational exposure limits, injury thresholds, and other significant components related to HSM research. Lack of HSM standards and injury risk curves specific to the ground operating environment is a critical gap across all branches of service. Systematic epidemiology studies documenting injury patterns, locations and occurrences, as well as understanding the mechanisms of injury were identified as a top near-term research priority. **SIGNIFICANCE:** While HSM-related research efforts aimed at mitigating risk and reducing injury are ongoing in individual branches of service, there is a clear need to define common objectives and areas of focus in order to maximize the payoff of these current and future research efforts. The first HSM EPWG established the baseline of near-term research priorities and collaboration opportunities. Follow-on meetings will reassess long-term research objectives in order to maximize research synchronicity.

Learning Objectives:
1. At the end of this presentation, attendees will understand the priority issues, concerns, and research gaps specific to head-supported mass-related acute and chronic injuries.

[547] RISK FACTORS FOR CERVICAL PAIN IN F-15C PILOTS

E. Chumbley[1], A. Stolfi[2] and J.C. McEachen[1]
[1]*Aerospace Medicine, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH;* [2]*Wright State University, Dayton, OH*

INTRODUCTION: Up to 97% of fighter pilots report cervical pain during their careers. The etiology likely relates to +Gz exposure, physical positioning with maneuvers, and varying load associated with headgear. We evaluated whether selected risk factors predicted cervical pain in this population. **METHODS**: An Institutional Review Board-approved, Health Insurance Portability and Accountability Act-compliant, observational study was undertaken with 21 male F-15C pilots. We recorded pilot age, total high-G hours, and previous neck problems, and measured cervical range of motion. For twelve weeks, pilots logged pre- and post-flight pain, whether joint helmet mounted cueing system (JHMCS) was employed, maximum +Gz experienced, and sortie duration. Pain with and without JHMCS was compared using two-way repeated measures ANOVA and correlations tested with Pearson correlations. **RESULTS**: Mean flight-related pain significantly increased by 0.729 on NRS with JHMCS and 0.517 without (P=0.005). Loss of neck extension coupled with JHMCS use correlated with increased pain (r=0.489, P=0.029). Higher number of previously reported neck problems correlated with pain when using JHMCS (r=0.474, P=0.040). Age of pilot, maximum +Gz per sortie, total high Gz hours flown, and hours per sortie did not correlate. **DISCUSSION**: To our knowledge, this is the first prospective observational study of risk factors for fighter pilots' cervical pain. We found a significant worsening of mission-related pain when using JHMCS. We confirmed flexed posture and history of prior neck problems as risk factors. This information will guide countermeasure development for high-G pilots. Further study should clarify if poor extension or an underlying etiology worsens pain.

Learning Objectives:
1. The learner will be understand risk factors for neck pain in fighter pilots which have been proposed in the literature and compare them to those validated by this study.

[548] DETECTING THE ORIGIN OF NECK PAIN CAUSED BY MUSCULAR DYSFUNCTION BY SURFACE ELECTROMYOGRAM AND WAVELET ANALYSIS - A CASE STUDY

S.H. Rochelt, J. Schnaidt and D. Bron
Swiss Air Force, Aeromedical Center, Duebendorf, Switzerland

BACKGROUND/LITERATURE REVIEW: Neck pain is a medical problem in modern military aviation. As a result the Swiss Aeromedical Center (AMC) has expanded a test and training procedure that specifically evaluates the spinal cord. This case study is a follow-up to previous Electromyogram (EMG) studies at the AMC. The purpose was to evaluate the origin and development of neck pain with the aid of a surface Electromyogram and a novel approach using wavelet analysis. **CASE PRESENTATION:** Three military pilots (44, 47, 52 years old respectively) performed standardized movement tests. Simultaneously, an EMG recorded the muscle activity. The experimental setup consisted of a baseline and a re-test follow-up within a three year period. The key outcome was that pilots A and B had acute neck discomfort. Pilot C, however, was free of pain following a successfully treated disc hernia. Secondary outcomes after the re-test included the sensation of pain of pilot A had shifted from the right to the left side, and pilots B and C were pain free. The EMG signal was processed with wavelet analysis. The different patterns were compared intra-individually for the two different dates. In case of pilot A, the wavelet pattern showed a distinctive shift from the right to the left side, correlating with the subject`s pain location. The wavelet analysis of pilot B showed a higher asymmetry of the muscle activity by right/left comparison in the baseline test. Conversely, the subject suffered from left-sided cervical pain. Following the re-test, the wavelet analysis showed no visible difference in muscle activity when the subject was pain-free. Pilot C showed no signs of acute pain for either test. The EMG pattern also showed no visible differences. **OPERATIONAL/CLINICAL RELEVANCE:** The different courses of pain of all three subjects were visible in the wavelet analysis. Since muscle activity clearly correlated with the intensity of pain in all three cases, a statement could be made about the origin of pain. A highly activated muscle is becoming fatigued, possibly resulting in inflammation. Tentatively, conclusions about the origin of pain by means of an EMG and wavelet analysis are possible. Prospectively, this tool could be integrated in the existing prevention program.

Learning Objectives:
1. Wavelet analysis is a good method to make muscle activity visible

[549] EXERCISE REGIMEN FOR MITIGATION OF ACUTE AND CHRONIC PAIN IN MILITARY AIRCREW

V. Ramachandran[1], J.A. Jones[1], R.A. Scheuring[4], R. Ramakrishnan[1], R.D. Filler[6], C.M. Perry[3], B.S. Shender[2] and D. Baskin[7]
[1]Center for Space Medicine, Baylor College of Medicine, Houston, TX; [2]Human Systems, NAVAIR, Patuxent River, MD; [3]Aerospace Medicine, U.S. Navy, Jacksonville, FL; [4]Space Medicine, NASA Johnson Space Center, Houston, TX; [6]Marine Aircraft Group 39, Marine Corps Base Camp Pendleton, Camp Pendleton, CA; [7]Department of Neurosurgery, Methodist Houston Hospital, Houston, TX

INTRODUCTION: Neck pain is the fourth leading cause of years lost to disability worldwide with a lifetime prevalence of 49%. Due to abrupt g-loading, helmet/vibratory loads and fatigue, military pilots are prone to cervical injury, leading to yearly neck pain prevalence of 56%. Similarly, astronauts are at risk for cervical pathologies such as herniated nuclei pulposi and neck pain during extravehicular activity. Pilots with chronic neck pain have reduced range of motion (ROM) as well as weakness and fatigue of segmental neck muscles. Stretching and strengthening exercises can reduce neck pain and improve muscle function. Portable exercise devices accommodate deployed personnel and facilitate self-guided exercise. The authors previously reported a pilot study of short-term exercise countermeasures in F/A-18 pilots. This ongoing, fleet-wide study investigates the ability of a directed exercise program using the NeckXTM, a lightweight and portable device, to: (1) reduce neck pain frequency and magnitude and (2) increase ROM, strength, and endurance of the cervical musculature in USN, USA, and USAF aviators. **METHODS:** Following IRB approval, 6 subjects (5 males, 1 female) underwent a 12-week exercise program using the NeckXTM cervical stretching and exercise device 3X/week. Mean baseline and post-program measurements of cervical strength (resistance), endurance (repetitions), and ROM (goniometer) were obtained. Subjects completed weekly logs to assess pain frequency and magnitude (0-10 scale) and document contributing factors. **RESULTS:** Mean strength increased: flexion (+104%), extension (+57%), lateral bend (+50%), and rotation (+47%). Mean endurance increased: flexion (+142%), extension (+157%), lateral bend (+170), and rotation (+217%). Mean flexibility increased: flexion (+17%), extension (+36%) lateral bend (+23%), and rotation (+63%). Subjects reported reduced severity and frequency of neck pain in weekly logs. **DISCUSSION:** This collaborative study between the Department of Defense, academia, and NASA has thus far demonstrated that a directed cervical exercise regimen involving the NeckXTM can improve strength, endurance, and ROM in a subset of military pilots. This may prevent medical disqualification incidents while increasing pilot performance and mission success. Current objectives include increasing subjects from more fleets and enrolling ISS crew in future studies to possibly counteract neck pathologies presenting before, during, and after spaceflight.

Learning Objectives:

1. Identify the human and occupational factors contributing to cervical neck pain in military aviators and astronauts.
2. Explain the benefits of neck exercise programs in combatting neck pain.
3. Explain briefly the past and present state of research done in the area of cervical neck pain in military aviators.

[550] INCIDENTAL FINDING OF SYRINGOMYELIA IN A SYMPTOMATIC MILITARY HELICOPTER PILOT: A CASE REPORT

A. Schiemer
Royal Australian Navy, Gerringong, Australia

PROBLEM STATEMENT: This case report describes a military helicopter pilot who experienced intermittent upper limb paraesthesia and was found to have a central spinal canal syrinx. **BACKGROUND:** A syringomyelia is a cyst that has formed within the spinal cord. They can be progressive and compress nerve fibres, resulting in a variety of symptoms including limb weakness and back pain. With the advancement of Magnetic Resonance Imaging (MRI) techniques, the incidental finding of syringomyelia has provided a challenge for clinicians, due to the wide variety of possible symptoms, and limitations in viable imaging modalities. In military aviation, neurological findings such as limb paraesthesia in pilots raise questions often involving extensive investigation that can lead to risky and invasive management. Conversely, the potential for chronic progression of a spinal syrinx and subsequent neurological deterioration, however rare, makes early identification critical. Ultimately, the discovery of such a lesion may have permanent implications on operational capabilities and individual flying status. **CASE PRESENTATION:** The subject pilot was a 25-yr old Australian Navy Seahawk helicopter pilot. He presented to medical with several recent episodes of right arm paraesthesia and sharp pains between the scapulae, with at least one occurrence waking him at night. Upon undergoing spinal MRI, he was found to have dilatation of the central canal in a syrinx-like pattern in the lower cervical region. Specialist neurology follow-up at a complex case meeting agreed that the finding was persistent and unlikely to be responsible for his symptoms. No surgical input was recommended at the time. His symptoms were attributed to mild cervical spondylosis which resolved with ongoing physiotherapy, and he was subsequently returned to flying status. **OPERATIONAL/CLINICAL RELEVANCE:** The case highlights several issues involved with the incidental finding of a syringomyelia. Surgical intervention has been known to worsen symptoms. Conversely, studies have identified minimal radiological progression in cases of idiopathic syringomyelia, with even fewer individuals displaying neurological deterioration. For military aircrew, potentially unnecessary neurosurgical intervention, particularly when more conservative options are available, poses significant risks to a flying career and overall operational capability.

Learning Objectives:

1. Describe the potential clinical presentation of a patient with syringomyelia.
2. Demonstrate an understanding of the options available in the monitoring and management of an incidental syringomyelia.

[551] SPECIAL OPERATIONS TRAINING ON TESTOSTERONE, LEAN MASS, STRENGTH AND POTENTIAL FOR THERAPEUTIC TESTOSTERONE REPLACEMENT: A REVIEW OF THE LITERATURE

J. Ordway[3,2], R. O'Hara[2] and J. Linderman[1]
[1]Health and Sport Science, University of Dayton, Dayton, OH; [2]Aeromedical Research, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; [3]VESA Health & Technology, San Antonio, TX

INTRODUCTION: Special Operations Forces (SOF) are routinely exposed to physically demanding missions that result in significant changes in body composition, work capacity, and endocrine function. Negative energy balance and sleep deprivation, which are independently known to decrease levels of testosterone, are the primary contributors to these changes. The use of exogenous testosterone has been shown to increase lean body mass (LBM) and muscle function in healthy males and reverse muscle wasting in diseased populations. Therefore, the primary purpose of this review is to summarize and contrast literature on both SOF and non-military personnel on the relationships between a negative energy balance, sleep deprivation, and decreased testosterone. A secondary purpose is to summarize the effects of exogenous testosterone therapy in healthy males as well as in reversing the effects of muscle wasting diseases. **METHODS:** A search of the literature from 1975-2015 utilizing search engines (i.e., PubMed) found 45 out of 70 relevant sources that directly addressed the primary or secondary purposes of this literature review. Data from these publications were summarized into tables providing mean observations. **RESULTS:** SOF training results in mean decreases in testosterone (-63%), LBM (-4.6%), and strength (-11.7%), which appear to be associated with an energy deficit (-3,351 kcal/d) and sleep deprivation (3 h/d). Exogenous testosterone therapy increases LBM (6.2%) and strength (7.9-14.8%) and reverses cachexia (2.0%) and decreased strength (12.7%) in those suffering from diseases such as chronic obstructive pulmonary disease and human immunodeficiency virus. **DISCUSSION:** The seeming inevitability of a large negative energy balance coupled with reduced sleep during SOF training indicates that investigations incorporating negative energy balance, reduced sleep, and testosterone therapy are warranted in both experimental animal models and human subjects. The use of testosterone supplementation in SOF may attenuate changes in body composition and muscle function during SOF training or sustained operations.

Learning Objectives:

1. **Learning Objective:** The audience will learn about benefits and detriments of testosterone supplementation to enhance or maintain mission performance.