Wednesday, 05/20/2020 ***4:00 PM***
Centennial Ballroom II/III/IV

[S-67]: PANEL: THE RAM BOWL

Sponsored by American Society of Aerospace Medicine Specialists

Chair: Al Parmet

Co-Chairs: Rebecca Blue, Jan Stepanek, Robert Johnson

[348] THE 12TH ANNUAL RAM BOWL

Allen Parmet[1], Rebecca Blue[2], Jan Stepanek[2], Robert Johnson[3], Roy Allen Hoffman[4], Mary Cimrmancic[5], Walter III Dalitsch[6], Rahul Suresh[3]
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(Education - Tutorial Proposal)

The 12th Annual RAM Bowl features teams from the Air Force, Navy/Army, Mayo Clinic, University of Texas and an International team competing for the Louis H. Bauer Trophy. Aerospace Medicine Residents are required to demonstrate multiple competencies to satisfy the requirements of ACGME and ABPM and serve as specialists in the field. Multiple tools are available for developing appropriate didactic knowledge in aerospace medicine, public health, epidemiology, biostatistics and health care management. Teams complete in a college bowl format that tests aerospace medicine competencies, recall speed, teamwork and individual knowledge. Topics include the specialty aerospace medicine competencies including the flight environment (atmosphere, radiation, vibration, acceleration, and microgravity), clinical aerospace medicine, aircraft and space vehicle systems/operations, accident investigation, historical events, aerospace physiology, human factors, ergonomics, medical standards, federal aviation regulations, passenger transport, restraint and escape, cockpit resource management and AeroMedical transportation. Questions are divided into toss-up questions and bonus questions. Multiple rounds of competition will lead to the selection of this year's victor and awarding of the Louis H. Bauer Trophy, sponsored by the American Society of Aerospace Medicine Specialists.

Learning Objectives

1. The contest will enable participants to prepare for ABPM examinations in Aerospace Medicine.
2. Attendees will receive an intense review of Aerospace and Preventive Medicine.
3. Conference attendees will gain insight into life, the universe and everything.

THURSDAY, MAY 21, 2020

Thursday, 05/21/2020 ***8:15 AM***

55TH ANNUAL HARRY G. ARMSTRONG LECTURE/PANEL

Thomas Dimitroff

"SELECTION AND TRAINING IN PROFESSIONAL SPORTS"

Thursday, 05/21/2020 ***9:30 AM***
Exhibit Hall

[S-68]: POSTER: PHYSIOLOGY

Chair: Peter Hodkinson

Co-Chair: Nathan Almond

[349] NEAR-INFRARED SPECTROSCOPY DURING HYPOBARIC HYPOXIA TRAINING IN A HIGH ALTITUDE CHAMBER

Andreas Werner[1]
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(Original Research)

INTRODUCTION: Flying staff is endangered by altitude-induced oxygen (O2) reduction. Hypoxia is an O2 lack at the cellular level which leads to disturbances of the functional and structural metabolism, and finally necrosis. Peripheral O2-saturation (SpO2) monitoring is standard during the hypobaric hypoxia training (hht) in our high altitude chamber. Physiologically, hypoxia induces a centralization; therefore, we postulated that this monitoring could be insufficient. Near-infrared spectroscopy (NIRS) is an entirely new technique measuring central oxygenation (rSO2) relatively. Aim of the study was the comparison of peripheral to central oxygenation. **METHODS:** 108 voluntary training participants (written inform consent, 99 ♂; 34.9 ±7.5 ys; 180.5 ±6.9 cm; 81.2 ±9.6 kg; 34.9 ±2.1 kg/m ^{2}; 99 righthander, 21 smokers) were included in the study. The profile of the hht was: plateau at 25kft (acute) and mild hypoxia at 15kft. The standard monitoring was 1-ch-ECG, Hf, and SpO2 (Masimo®, MS5). The regional O2 measurement (frontal brain tissue) was obtained bihemispheric with NIRS (INVOS™, 5100C). The trainees were asked to report their hypoxia symptoms. After data synchronization, the characteristics were analyzed. **RESULTS:** The values for SpO2 and rSO2 were significantly different (p<.001) and not correlated (CCC .002). Percental desaturation of rSO2 and SpO2 were significantly different (p<.001) and weakly correlated (CCC .488). The bias of both methods is high and the limits of agreement with >10% unacceptable. There were found no differences in left and right NIRS (pns, CCC .838). The duration for reoxygenation for rSO2 and SpO2 were significantly different (p <.001; rSO2 recovers delayed (25s vs 58s [25kft], 40s vs 92s [15kft]). rSO2 is less interference-prone than SpO2 (95 vs 0 events). **DISCUSSION:** The NIRS oximetry is a valid method measuring central oxygen saturation. A bihemisphärische measurement seems to be unnecessary. It detects the regional hypoxia reliably, and hypoxia symptoms correlate significantly better with the rSO2 curves. NIRS is a valuable supplement to monitor blood saturation. Pulse oximetry during hypoxia demonstration was delayed and did not reflect the symptoms correctly concerning the time axis. The delay in reoxygenation found in rSO2 could maybe explain the somnolent behavior. Further investigations will show if NIRS could be used as the new monitoring. Conceivable, this could be to monitor trafficking aircrews and increase safety.

Learning Objectives

1. The near-infrared spectroscopy (NIRS) is a appropriate method to monitor oxygen saturation in the blood during hypobaric hypoxia training.
2. The NIRS could detect earlier the deoxygenation and therefore increase safety in the training.

[350] RELATIONSHIP BETWEEN BEHAVIORAL CHANGE AND HIGH GRAVITY EXPOSURE BY AN ANIMAL MODEL

Min-Yu Tu[1], Gary Ro-Lin Chang[2], Chuan-Mu Chen[2], Chung-Yu Lai[1], Chia-Sheng Chen[1]
[1]Kaohsiung Armed Forces General Hospital Gangshan Branch, Kaohsiung City, Taiwan; [2]National Chung Hsing University, Taichung City, Taiwan

(Original Research)

INTRODUCTION: High gravity (G) training is a strenuous exercise and stress for fighter pilots. Previous studies found that high G training can lead to several physiological and psychological effects, such as acute fatigue, residual motion sickness, and depression. However, there are difficulties to quantify those effects of behavioral changes on human pilots. **OBJECTIVES:** The aim of this study was designed to establish a reliable Sprague Dawley (SD) rat model that reflects the behavioral changes after high G exposure. **METHODS:** Eight adult male SD rats were used in this experiment. All rats were housed in the environment of 12/12-hour light and dark cycle with a temperature of 23±1°C and a humidity of 50±10%. Rats were free to access food and water. On the day before the experiment, the rats were firstly applied to high plus maze and open field tests. High G environment was performed by 8G/30 seconds for two rounds by using a human centrifuge. After centrifugation, rats

were subjected to high plus maze and open field tests within 30 minutes. The behavioral data obtained after centrifugation was compared with that before the experiment. All statistical analysis was performed by two-tailed paired t test using SPSS 22.0 software. **RESULTS AND DISCUSSION:** After high G centrifugation, results of high plus maze test showed that rats had significant reduction of the overall moving distance (before vs. after: 10,782 ± 1,982 vs. 4,033 ± 3,852 mm; $P<0.01$) and reduction of the moving distance in the open arms (before vs. after: 2,526 ± 1,419 vs. 303 ± 623 mm; $P<0.05$; however, the duration time in the closed arms was increased significantly (before vs. after: 166 ± 23 vs. 278 ± 31 sec; $P<0.001$). Corresponding to open field test, the same finding revealed that total moving distance (before vs. after: 7,602 ± 3,778 vs. 2,367 ± 1,871 mm; $P<0.05$) was also decreased significantly in rats after high G centrifugation. In this study, results suggested that we successfully established a rat model for high gravity-induced behavior fatigue and impaired cognitive ability. The future work will extend to investigate the recovery time of SD rats in this extreme environment and to develop proper methods to alleviate the stress after high G exposure.

Learning Objective

1. To understand behavioral changes after high G exposure by rat model.

[351] EFFECT OF POSITIVE ACCELERATION ALONG Z AXIS (+GZ) ON ATTENTION

Nanda Kishore[1]
[1]*Institute of Aerospace Medicine, Bangalore, India*

(Original Research)

INTRODUCTION: Positive acceleration along G axis (+Gz) being one of the major and commonest aviation stressor for the aircrew, especially in fighter jets. Aircrew need a proper level of mental and physical performance. One such entity which measures the performance is the attention. +Gz at some level leads to compromised cerebral blood flow, which could affect attention i.e. the performance. **METHODS:** Subjects were fighter pilots who came to Institute of Aerospace Medicine (IAM) for Operational Training in Aerospace Medicine (OPTRAM) course. Total of 50 subjects were considered for the study. High Performance Human Centrifuge (HPHC) at IAM, Bangalore was used, to expose the subjects to +Gz. Psychological Experimental Building Language (PEBL) software was used to measure attention over a laptop. **RESULTS:** Subjects were tested by PEBL before and after the exposure to +6Gz for 30 sec without AGSM in an open loop profile (Machine controlled). Post exposure the attention in most of the cases was decreased, compared to pre exposure attention indicating decreased performance. **DISCUSSION:** Attention being an essential cognitive function in situational awareness and effective performance. Post exposure to high G profile, secondary to compromised cerebral blood supply immediately post run. The performance was relatively deteriorated in terms of prolonged reaction time/ increased number of mistakes/ decreased number of tasks attempted per minute.

Learning Objectives

1. To evaluate the performance of a fighter pilot in combat maneuvers, who exposes to aviation stressors like +Gz.
2. Determine the individual capability.
3. Relevance on importance of anti g straining maneuver, anti G suit.

[352] EFFECT OF HIGH INSPIRED OXYGEN CONCENTRATION ON THE BLOOD PRESSURE RESPONSE TO ANTI-G TROUSER INFLATION UNDER SUSTAINED +GZ ACCELERATION

Henry Tank[1], Alec Stevenson[1], Sonny Gates[2], Rachel Firth[1], Jeremy Radcliffe[1], Ross Pollock[3]
[1]*QinetiQ, Farnborough, United Kingdom;* [2]*QinetiQ, Portsmouth, United Kingdom;* [3]*King's College London, London, United Kingdom*

(Original Research)

INTRODUCTION: Pilots of high performance aircraft breathe an enriched oxygen gas mix to maintain a sea-level equivalent oxygenation, or better, at high cabin altitudes. High arterial oxygen tensions can suppress chemoreceptor activity which may influence the cardiovascular response to +Gz but this has yet to be investigated. **METHODS:** As part of a larger study investigating the development of acceleration atelectasis, beat-to-beat non-invasive arterial blood pressure (ABP), heart rate (HR), end-tidal partial pressure of oxygen ($PetO_2$), peripheral arterial oxygen saturation (SpO_2) and transcutaneous oxygen tension ($tcPO_2$) were recorded in 14 subjects who undertook two 90 second exposures at +5 Gz on a centrifuge, breathing air (normoxia) or 94% oxygen (hyperoxia). Subjects wore full coverage anti-G trousers (FCAGT) and were instructed to remain relaxed throughout, only tensing their muscles if required to prevent visual loss. **RESULTS:** Hyperoxia prevented a decrease in SpO_2 under +Gz, which was otherwise reduced to ~85% in normoxia, while a reduction in $tcPO_2$ was observed in both conditions. Heart-level ABP was increased under +Gz, with greater rises seen with longer durations of exposure, but appearing to plateau after ~75 seconds. At +5 Gz with FCAGT inflation, systolic blood pressure was significantly lower ($P < 0.01$) in hyperoxia compared to normoxia, but diastolic pressure remained unaffected. Thus, hyperoxia attenuated the rise in pulse pressure ($P < 0.003$). Hyperoxia had no effect on blood pressure at rest at +1 Gz, though heart rate was slightly lowered ($P < 0.05$). **CONCLUSION:** These data suggest that chemoreceptors play a role in the pressor response to +Gz acceleration. Altered cardiovascular performance in aircraft using high oxygen concentrations as the breathing gas may result in degraded G protection. Further studies are required to determine whether a similar effect occurs with lower oxygen concentrations representative of oxygen system output at low cabin altitudes.

Learning Objective

1. The audience will learn about the effect of high inspired oxygen concentration on the blood pressure response to anti-G trouser inflation under sustained +Gz acceleration.

[353] ANALYSIS OF IN-FLIGHT G-INDUCED LOSS OF CONSCIOUSNESS EVENTS FROM CASE SERIES REVIEW

Hsin-Hui Chen[1], Jiou-Ru Ouyang[2], Kwo-Tsao Chiang[3], Chung-Yu Lai[3], Hsin Chu[4]
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(Original Research)

INTRODUCTION: G-induced loss of consciousness (GLOC) is an emergent situation which may cause fatal accidents especially in pilots of high performance fighters. Anti-G straining maneuver (AGSM) is the most crucial technique that can increase pilots' G tolerance. In Taiwan, pilots should be qualified by advanced high G training in human centrifuge before they can be transferred to high performance aircrafts. However, there are still GLOC events in flight training in high performance aircrafts. **AIM:** To investigate the potential factors causing in-flight GLOC. **METHODS:** This was a retrospective case-series report, collected between January 2016 and October 2019. Five young fighter pilots who completed introductory F-5 fighter training and assigned to F-16 agile aircraft, suffered in-flight GLOC during basic F-16 flight training. They were interviewed and their AGSM performances evaluated by flight surgeon. Possible GLOC contributing factors were analyzed. **RESULTS AND CONCLUSIONS:** There were five GLOC events in controlled period, average age of the pilots was 26 years old. All five GLOC events (four in dual-seat configuration aircraft) developed while pilots were practicing basic fighter maneuvers. Three factors contributed to these GLOC events. The first factor is inadequately performed AGSM. Three subjects (60%) failed to anticipate G-onset, causing delayed execution of AGSM. In addition, one of them didn't hold the breathing and make an air exchange during the period of rapid G load. Secondly, poor G tolerance possibly due to physical characteristics was another variable. Relaxed G tolerance among two of them (40%) were only between 4.0G to 4.5G. Effectiveness of AGSM was about 3.5G in gradual-onset-rate profile. These pilots reported visual symptoms during the plateau phase of high G training (9G for 15 seconds) in human centrifuge. Finally, one pilot (20%) attributed his poor AGSM performance to fatigue due to multiple sorties prior to GLOC. All five pilots practiced AGSM under the guidance of aviation physiologist and re-qualified human centrifuge high G training profile. They returned to flight training uneventfully. In conclusion, aircrew must be able to perform AGSM efficiently and timely in order to prevent in-flight GLOC. Good physical

fitness can optimize pilots' G tolerance while self-imposed stress will comprise it.

Learning Objective

1. To understand the possible GLOC contributing factors in young fighter pilots.

[354] TRIAL TO ESTABLISH FORMULA TO PREDICT G-INDUCED LOSS OF CONSCIOUSNESS (G-LOC)

Masataka Mine[1], Nobuhiro Ohrui[1], Koichiro Kuramoto[1], Koichi Kurihara[1], Masanori Fujita[2], Naruo Kuwada[1]
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(Original Research)

INTRODUCTION: Gravity-induced loss of consciousness (G-LOC) is a major threat to fighter pilots and may result in fatal accidents. High +Gz (head-to-foot direction) acceleration force induces cerebral blood loss and results in loss of peripheral vision, loss of central vision (black out), and G-LOC. In Japan Air Self-Defense Force, Aeromedical Laboratory (JASDF AML), We measured trainee's cerebral oxyhemoglobin (oxyHb) value using near infrared spectroscopy (NIRS) (NIRO-150G, Hamamatsu Photonics K.K., Hamamatsu, Shizuoka, Japan) during human centrifuge training. In the past, we tried to establish a formula to predict G-LOC using oxyHb value, height, weight, and body mass index (BMI). The results at that time, G-LOC was significantly associated with BMI and Rate of change of Maximum to Minimum value of oxyHb by Logistic regression analysis. The formula to predict G-LOC is following: Log (P/1−P) = −0.2951 X (BMI) −0.6919 X (Rate of change) +2.9701. P represents percent probability of G-LOC (decision level: 0.15, sensitivity: 67.6%, specificity: 81.4%, accuracy: 79.5%). This time, we examined the accuracy of this prediction formula. **METHODS:** The subjects were trainees who underwent human centrifuge training of JASDF AML Fighter Training Basic course students from 2017 to 2018, who were able to confirm BMI and NIRS data. The trainees' age was 24.1 ±1.7 (S.D.) (range, 22~30) years old, and BMI was 22.5±1.8 (19.15~27.76). The training profiles evaluated were following: 4G–15sec, 5G–10sec, 6G–8sec, and 7G–8sec, with anti-G straining maneuver, but without G-suits (60 sec interval and onset rate of 1G per sec). *RESULTS:* Among 59 trainees, 17 (28.8 %) had G-LOC and 42 (71.2 %) did not have G-LOC. Regarding the accuracy of the formula to predict G-LOC, the sensitivity was 59.5 % and the specificity was 76.2 %, which was almost the same as when the prediction formula was created. **DISCUSSION:** We established the formula to predict G-LOC with the sensitivity was 56.2 % and the specificity was 76.7 %.BMI and changing of cerebral oxyHb were main factors to predict G-LOC. We want to contribute to reduce accidents due to G-LOC using our formula to predict G-LOC for actual aviation environments in the future.

Learning Objectives

1. The participant will be able to understand what is G-LOC prediction formula.
2. The participant will be able to understand Change of cerebral oxyHb and BMI are the factors that make up the G-LOC prediction formula.

[355] EFFECTS OF SHORT TERM HYPOBARIC AND NORMOBARIC HYPOXIC PRECONDITIONING ON ACUTE HYPOXIA EXPOSURE IN MICE

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(Original Research)

INTRODUCTION: Hypoxic preconditioning (HPC) has been shown to be protective against injuries induced by hypoxia exposure and effective in improving tolerance or performance at high altitude. Previous studies have adopted different methods to achieve HPC, including hypobaric and normobaric HPC. However, whether hypobaric or normobaric HPC exerts similar preconditioning effects is still controversial. The purpose of this study is to compare effects of these two different HPC protocols on acute hypoxia tolerance in mice. **METHODS:** Male Kunming (KM) mice were randomly divided into the following 7 groups (n=10 in each group): hypobaric HPC in a hypobaric chamber (405 mmHg, 5 000 m of altitude, 1 h/d (H1) or 2 h/d (H2) or 4 h/d (H4) for 7 d; normobaric HPC in a normobaric chamber (10.6 % nitrogen oxygen gas mixture), 1 h/d (N1) or 2 h/d (N2) or 4 h/d (N4) for 7 d; the control group (CON). After HPC period, survival time of the mice (9 600 m altitude) from different groups was recorded upon exposure to acute hypoxia. The blood was collected after the mice in each group was sacrificed immediately. The hemoglobin concentration was examined by Radiometer ABL90 Flex. **RESULTS:** After HPC training, survival time of H2, N2, H4 and N4 group was significantly (P<0.01) prolonged when exposed to 5 % nitrogen oxygen gas mixture. There was no significant difference neither in H1 nor N1 group compared to CON. The hemoglobin concentration was also significantly (P<0.01) increased in response to 7 days HPC training (H1, N1, H2, N2, H4 and N4) compared to CON. Related to hypobaric /normobaric HPC protocols, the differences of survival time and hemoglobin concentration were significantly (P<0.01) increased in N2 and N4 group compared to H2 and H4, respectively, but no significant difference was found between H1 and N1 group. **DISCUSSION:** HPC prolongs the survival time of KM mice when exposed to acute hypoxia and increases hemoglobin concentration in order to carry more oxygen. NHPC might results in better protective effects than HHPC against acute hypoxia exposure.

Learning Objectives

1. To compare physiological effects on hypobaric and normobaric hypoxic preconditioning.
2. Attendees will identify factors associated with aforementioned differential effects.

[356] HYPOXIA AWARENESS TRAINING: PILOTS' EXPERIENCE OF HYPOXIA PARTICIPATING IN FIVE AVIATION PHYSIOLOGY COURSES OVER A TIME PERIOD OF 16 YEARS

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(Original Research)

INTRODUCTION: The German Air Force Centre of Aerospace Medicine provides Hypoxia Awareness Training for flight personnel in a hypobaric chamber at intervals of four years. Refresher training in aviation medicine is required throughout the careers of the flight personnel. This raises the question whether these personal hypoxia experiences have changed over time. **METHODS:** 70 male military aircrews attended five aviation medicine training courses every four years between 2002 (age 33 4 yrs.) and 2019. Each pilot underwent 5 exposures to reduced pressure in a hypobaric chamber to a simulated altitude of 25,000 feet to experience change of pressure and hypoxia (hypoxia recognition training). Heart frequency, oxygen saturation, hypoxia recognition time (HRT) and hypoxia symptoms were recorded. After a modification of the hypobaric chamber a remote controlled oxygen -separation was introduced in 2003. **RESULTS:** There was a significant difference regarding the hypoxia recognition time in the first and the following courses. In the first course the students disconnect themselves from 100% oxygen and the HRT was 72 sec. After the modification in 2003 the students were disconnected unperceived by the instructor from outside the chamber. The HRT under this condition were at least 99 sec (99 sec – 104 sec). The oxygen saturation when feeling the first hypoxia symptom averaged to 87 %. The students reconnect to 100 % oxygen at an average oxygen saturation of 70 %. The most frequent 1st symptom was sensation of heat (44 %) followed by dizziness (18%). Only 8 pilots (11%) had the same first symptom during all five courses. 13 (19%) aircrews didn't experience any hypoxia symptoms at least one time during the aeromedical training courses and 2 aircrews didn't feel any symptoms during three hypoxia demonstrations. **DISCUSSION:** The difference regarding the HRT between the first and the other courses could be an effect of the different disconnection methods from 100 % oxygen. In the first course the disconnection from oxygen was conducted by the students but not in the following courses. So this could be the explanation why they felt the hypoxia symptoms 27 sec earlier. The recognition of hypoxia symptoms is not very reliable and therefore it makes sense to train it during a pilot's career. Medical monitoring is helpful for the safety crew to realize health problems of trainees in time and enables students to compare subjective feelings with objective data.

Learning Objective

1. Understand the benefit of hypoxia training.

[357] INVESTIGATION OF NORMOBARIC HYPOXIA TRAINING IN JAPAN AIR SELF-DEFENSE FORCE

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(Original Research)

INTRODUCTION: Japan Air Self-Defense Force (JASDF) has been providing hypoxia recognition and emergency procedure training by using a hypobaric chamber. Recently, the Reduced Oxygen Breathing Device (ROBD) was developed for mask-on hypoxia training under normobaric conditions. Some reports suggest that the ROBD training is more realistic than the hypobaric chamber training. JASDF is going to introduce the ROBD for the refresh training. The aim of this study was to obtain the information for training program development by comparing three types of simulations. **METHODS:** Participants were 9 healthy subjects (all male, age 37.8±11.9) who agreed to our research protocol. We prepared three simulations: firstly decreasing the oxygen rate gradually (like mask leak), secondly decreasing the oxygen rate suddenly (like disconnect of O_2 hose), finally decreasing the oxygen rate in 3 stages. All simulations were experienced by all subjects and they had already known what simulation they did beforehand. We measured brain blood flow (NIRS), Oxygen saturation (SPO_2) and heart rate (HR). The cognitive response was also measured by the Trail Making Test type B (TMT-B) for index of effectiveness of simulations. **RESULTS:** As altitude elevates, the NIRS suggests that the total-hemoglobin and deoxy-hemoglobin increased and oxy-hemoglobin decreased in all three hypoxia situations. Significant differences were found in the SPO_2 and the HR between sea level and 24,000 ft respectively. The achievement time of the TMT-B at 24,000 ft was significantly longer than at sea level in all three situations. **DISCUSSION:** All three simulations could impair subjects cognitive function effectively at 24,000 ft. On the other hand, we could not identify any differences under 24,000 ft clearly. This result suggests that 24,000 ft equivalent altitude air breathing induces hypoxia in gradual and sudden simulations. So we could prepare different types of simulations equivalent altitude of 24,000 ft for aviators. In this study we had already told what simulations the subjects did beforehand. Cause of that we need to compare open trial effectiveness with blind test.

Learning Objective

1. The participant will be able to understand cognitive function in normobaric hypoxia and compensatory action of normobaric hypoxia.

[358] AQUA LUNG© PORTABLE HELICOPTER OXYGEN DELIVERY SYSTEM (PHODS) IN THE ALTITUDE CHAMBER: CEREBRAL BLOOD OXYGEN SATURATIONS

Aaron McAtee[1], Leonard Temme[1], Robert Eschelman[1], Bobby Bowers[1], Amanda Hayes[1], Chad Adaway[1], Paul StOnge[1], Dennis Ard[2], Steven Murty[2], Claire Goldie[1]
[1]U. S. Army Aeromedical Research Laboratory, Fort Rucker, AL, USA; [2]School of Army Aviation Medicine, Fort Rucker, AL, USA

(Original Research)

INTRODUCTION: The Portable Helicopter Oxygen Delivery System (PHODS) provides supplemental oxygen (O2) to Army personnel in unpressurized aircraft up to 18K feet (ft.) above mean sea level (MSL). PHODS attaches to the user's survival vest and helmet to deliver a predetermined bolus of nearly 100% O2 via a flexible nasal cannula or face mask. Initial PHODS testing used conventional pulse oximetry to monitor peripheral blood O2 saturation (SpO2). The present test assesses PHODS using regional cerebral blood O2 saturation (rSO2). **METHODS:** The U.S. Army School of Aviation Medicine altitude chamber enabled PHODS evaluation at ground level, 14K, and 17.8K ft. above MSL. At each altitude, twenty-one Army aircrew volunteers used PHODS as prescribed in the user manual to assess its performance during 10 minutes (min) of reaction time (RT) measures, 5 min of scripted speech (SS) to challenge the PHODS nasal cannula, and 2 min of self-paced squats as a surrogate physical workload (WL). A commercial, off-the-shelf, near infrared transcranial spectroscopic (NIRS) device monitored rSO2 in parallel with standard SpO2. **RESULTS:** Of the 21 datasets, two were removed; one due to equipment failure and one due to noise. The analysis calculated the slope of the rSO2 and SpO2 over the duration of each task at each altitude. Thus, the figure of merit was the slope for the 5 min of SS, the 10 min of RT, and the 2 min of WL at each altitude. A 2-factor analyses of variance compared slopes. The rSO2 slope was significantly affected by task, $F(2, 155) = 67.88$, $p<0.05$ and by altitude, $F(2, 155) = 3.93$, $p<0.05$. Specifically, rSO2 slope was essentially flat over the SS and RT for the three altitudes; but was significantly affected by altitude during WL, $F(2, 37) = 13.77$, $p\leq0.05$. Notably, SpO2 slope was flat over all tasks. **DISCUSSION:** While PHODS maintained rSO2 over the duration of the SS and RT for the 14K and at 17.8K ft. altitude, it progressively decreased during WL whereas SpO2 was unaffected. This is a statistical finding–its operational importance remains to be determined, but clearly, SpO2 did not predict rSO2.

Learning Objective

1. Understand the test and evaluation of the Portable Helicopter Oxygen Delivery System (PHODS) in the altitude chamber using conventional pulse oximetry to monitor peripheral blood O2 saturation (SpO2) and near infrared transcranial spectroscopic (NIRS) measures of regional cerebral blood O2 saturation (rSO2).

[359] EFFECTS OF RAPID HYPOBARIC PRESSURE FLUCTUATIONS ON A RODENT MODEL

Andrew Keebaugh[1], Shawn McInturf[2], Brian Sharits[1], Sanjeev Mathur[3], Amber Braddock[3], Arden James[3], Karen Mumy[2]
[1]Oak Ridge Institute for Science and Education, Oak Ridge, TN, USA; [2]Naval Medical Research Unit Dayton, Wright-Patterson AFB, OH, USA; [3]Henry M. Jackson Foundation for the Advancement of Military Medicine, Bethesda, MD, USA

(Original Research)

INTRODUCTION: Episodic, repeated cockpit pressure fluctuations can occur in aircraft due to complications with the system designed to control and maintain cockpit pressurization. It is possible that these decompression/compression cycles could place aircrew at risk for a range of physiologic or cognitive performance deficits, but it is unclear if these fluctuations are severe enough to elicit these effects. **METHODS:** This study investigated the effect of hypobaric pressure fluctuations on the formation of vascular gas emboli and biomarkers of decompression injury, behavioral changes during and post-exposure, and indicators of respiratory trauma in male Sprague Dawley rats. This study protocol was reviewed and approved by the Wright Patterson AFB Institutional Animal Care and Use Committee in compliance with all applicable federal regulations governing the protections of animals and research. **RESULTS:** Ultrasound imaging during exposure revealed no vascular gas emboli in the pulmonary artery of rats exposed to fluctuation profiles of up to 1.2 psi/sec during a 25 minute period (initial altitude of 8,000 feet). Additionally, rats exposed to fluctuation profiles of up to 0.8 psi/sec during a 25 minute period (initial altitude of 8,000 feet) displayed no signs of behavioral abnormalities following exposure including altered gait, increased pain or anxiety, or decreased activity. An unexplained decrease in activity was observed in rats during exposure to 0.8 psi/sec fluctuations, but not at lower fluctuation rates. There were no fluctuation-associated changes in respiration during exposure and no indication of decompression-related pulmonary or vascular changes in tissue samples. **DISCUSSION:** No overt physiological changes or definitive behavioral abnormalities were found in rats acutely exposed to hypobaric pressure fluctuations. This work is a first step in establishing an understanding of safe exposure levels as a function of fluctuation rate that can be used to protect aircrew health and performance.

Learning Objective

1. The audience will learn about research using a rodent model to provide an initial understanding of the physiological consequences of episodic hypobaric pressure fluctuations that can occur in aircraft.

[360] HYPOBARIC CHAMBER TRAINING: BIOMARKERS OF HYPOXIA IN MILITARY PILOTS

Paola Verde[1], Anita Greco[2]
[1]Italian Air Force, Pratica di Mare AFB, Italy; [2]ISS, Rome, Italy

(Original Research)

INTRODUCTION: hypobaric chamber camera experience is important for aviation training as it enables pilots to learn and recognize

personal hypoxia symptoms. Physiological responses and cognitive impairment have been extensively studied to avoid inflight hypoxia incident, biochemical effects of hypobaric-hypoxic environment in pilots have not equally investigated. Blood biomarkers of oxidative stress have been studied after hypobaric chamber training of healthy young military pilots. **METHOD:** Two group of pilots matched for age (22 y - 21/25 bmi (24 - 21/27)) and life style were exposed at 35,000 ft and 25,000 respectively and plasma total anti oxidant capacity, F2-isoprostane, 3-nitrotirosine and thromboxane B2 were measured, together with plasmatic zincum. Biomarkers analysis were carried out at baseline and after exposure to hypoxia at 25,000 and 35,000 respectively. **RESULTS:** After hypobaric chamber training, no changes in mean levels of all the proposed plasma biomarkers were observed, nevertheless we found a consistent decrease of Zinc levels (28.3%, p<0,0001). Individual Zinc plasma decrease was correlated with basal Isoprostane levels (r=-0.65, p<0.0001). Individual variation in Isoprostane levels were negatively correlated with blood oxygen saturation of hemoglobin at 18.000ft (r=-0.41, p=0.0228), to which both groups were exposed during training. **DISCUSSION:** Our findings support the evidence that hypobaric chamber training induces an increase in Isoprostane only in subjects who experienced low blood oxygen saturation of hemoglobin, suggesting that hypoxia, oxidative stress and vascular response are correlated phenomena. Hypoxia also caused a significant decrease in Zinc plasma levels, which may be due to a cellular uptake in order to restore the redox equilibrium operated by enzymes with Zinc ion on the active site, i.e. Carbonic Anhydrase and Superoxide Dismutase. On this basis, we suggest that the effects of hypobaric hypoxia could be counteracted by an efficient antioxidant Zinc-dependent mechanisms.

Learning Objectives

1. The participant will be able to better understand the effects of hypobaric chamber training on cellular redox metabolism.
2. The participant could understand how quantify the stress experienced in hypobaric chamber through the ex vivo measurement in plasma of particular biomarker.

[361] IS IN-FLIGHT HYPOXIA STILL A PROBLEM FOR AVIATORS, AND WHAT CAN WE DO ABOUT IT?

Rowena Christiansen[1], Shane Campbell[2]
[1]University of Melbourne, Melbourne, Australia; [2]Australian Health Practitioner Regulation Agency, Melbourne, Australia

(Original Research)

INTRODUCTION: In order to investigate the three questions posed of what effects hypoxia has on pilots, why it is a threat even today, and what can be done to protect against it, a twelve-year retrospective literature review was carried out in the annals of the two journals of the Aerospace Medical Association: "Aviation, Space and Environmental Medicine" (January 2007 to December 2014), and "Aerospace Medicine and Human Performance" (January 2015 to September 2019). **METHODS:** The following search terms were used for a 'first pass' visual scan of the journals: "hypoxia", "hypoxic", "hypoxemia", "oxygenation", and "anoxia". This was followed by a cross-check with the yearly index published in the December journal of each year. All relevant articles were entered into EndNote as well as into a spreadsheet which identified them as falling into one (or more) of the following categories: "Hypoxia effects", "Still an issue?", "Countermeasures", "Hypoxemia and 'fitness to fly' studies", "Altitude medicine", "Equipment and technical aspects", and "Microgravity exposure". The spreadsheet and the EndNote list of citations are appended to this submission. **RESULTS:** A total of 125 articles was identified. 60 articles related to the effects of hypoxia, with six of these also dealing with hypoxia awareness training. Seven articles illustrated the ever-present hazard of hypoxia and the importance of physiological training. 30 articles addressed a variety of countermeasures. The remainder of the articles have been excluded from the discussion as these were not directly relevant to addressing the three subject questions. This included sixteen articles dealing with hypoxemia and 'fitness to fly', (save for two of these overlapping with hypoxia effects (regarding pulmonary hypertension)), eleven articles categorized under 'altitude medicine', eight articles dealing with equipment or operational aspects, and two articles considering adjuvant microgravity exposure. There were nine overlapping articles in total. **DISCUSSION:** The research contained in all of these articles serves to advance knowledge about the effects of hypoxia, and the utility of various countermeasures. In addition to the 'tried and true' approach of hypoxia awareness training, there are various emerging technologies and further areas for research. Individual physiological variability, as well as external extenuating factors, will continue to play a role in unexpected occurrences of hypoxic symptoms.

Learning Objectives

1. Readers will learn about the variety of physiological effects that hypoxia has on aviators.
2. Readers will gain an appreciation of why hypoxia continues to remain an issue for aviators.
3. Readers will gain insight into a range of countermeasures against hypoxia, including hypoxia awareness training.

[362] EFFECTIVENESS OF CHEST COMPRESSIONS UNDER MILD HYPOXIA: SHOULD RESCUERS BREATHE SUPPLEMENTAL OXYGEN ON COMMERCIAL FLIGHTS

Katherine Reis[1], Keith Ruskin[1], Anna Clebone[1]
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(Original Research)

INTRODUCTION: Chest compressions are a critical, lifesaving component of cardiopulmonary resuscitation (CPR). The pressure altitude inside most transport-category airplanes is 6,000-8,000 feet (1829 – 2438 m) and we hypothesize that the ability of a rescuer to provide chest compressions during commercial airline flight may be compromised due to mild hypoxia. In this abstract we report preliminary results from an ongoing study. **METHODS:** In this blinded within-subjects crossover study, participants performed up to 14 two-minute rounds of chest compressions in two simulated conditions: normal-altitude conditions (FiO2 0.21) or high-altitude (8,000 feet) conditions (FiO2 0.15) using a reduced oxygen breathing device (Hypoxico, New York, NY). A convenience sample of 7 participants (age 20.4±0.98, 6 female) who were CPR certified was used. Subjects were randomized to perform CPR while breathing a gas mixture through a face mask that contained either FiO2 0.21 or 0.15 each session. Chest compression quality was measured using Laerdal's Quality CPR instructor mobile application. Participants were stopped if the American Heart Association's guideline threshold of a 5-6 centimeter depth or a 100-120 compressions/minute rate for <66% of blocks was not met. The primary outcome was the number of successful rounds of CPR in each condition. A Wilcoxon Signed-Rank Test was used to determine the difference in CPR performance between the normoxic and hypoxic conditions. **RESULTS:** No subject completed more rounds in the hypoxic condition than in the normoxic condition. A significant effect of condition was reflected by a Wilcoxon Signed-Rank Test (p=0.028, W=15). **DISCUSSION:** Despite a small sample size, we found that hypoxia impaired CPR. This suggests that the quality of CPR is indeed impacted by FiO_2. These results suggest that the rescuer should be provided with supplemental oxygen when performing CPR during flight.

Learning Objectives

1. Participants will learn the effects of hypoxia on a rescuers ability to perform cardiopulmonary resuscitation.
2. Participants will understand the limitations of cardiopulmonary resuscitation that occur in the air transport environment.

[363] IDENTIFICATION OF FATIGUE RISK MANAGEMENT SYSTEMS RELEVANT TO ARMY ROTARY WING EXTENDED OPERATIONS

Jordayne Wilkins[1], Kathryn Feltman[1], Christina Delgado-Howard[1]
[1]U.S. Aeromedical Research Laboratory, Fort Rucker, AL, USA

(Original Research)

INTRODUCTION: Army rotary wing extended operation work cycles can last 14-16 hours and take place in harsh environments. Aviators often fly around-the-clock with little opportunity for sleep. Fatigue caused by operational demands and poor sleep is a common feature of aviators' duty days. Fatigue is compounded by the physiological limitations experienced by aviators during the window of circadian low—a period of maximum sleepiness and low performance capability during a 24-hour cycle. As a result, the need for a method of adding performance indicators into flight operations risk predication models was identified as a gap by the Army's rotary wing community. This presentation

describes findings from an expert panel that evaluated fatigue risk management systems (FRMS) with potential applicability to Army aviation. **METHODS:** A multi-step process was conducted; first, a systematic literature review identified relevant FRMS. Second, these were presented to an expert panel that included aviation operations experts and researchers from military, federal government, and industry. Third, interim recommendations were published in a USAARL Report (See Nwala et al., 2019). The final step of the process identified next steps for the development of tools to meet the fatigue management needs of Army aviators. **RESULTS:** Eight viable systems were found from the review. It was also found that no FRMS currently exist for rotary-wing operations. Of the eight FRMS identified, the panel found that two systems showed promise for this population: 2B-Alert (developed by the U.S. Army Medical Research and Development Command) and FAID Quantum developed by a private company. The panel also developed a set of near and long-term recommendations, which will be discussed in this presentation. **DISCUSSION:** The evidenced-based presentation of currently available FRMS to an expert panel of Army aviation stakeholders led to the identification of two FRMS with promise for rotary wing extended operations. The impact of the panel discussion extends beyond the identification of potential FRMS. By convening a multidisciplinary panel of experts, the conversation created a much-needed venue for exploring current operational needs related to fatigue and valuable insight on how others fields manage it. The panel also produced a set of recommendations that require future collaboration in order to evaluate current technology and/or develop future FRMS tailored to the Army's rotary wing needs.

Learning Objective

1. To garner knowledge on the available fatigue and scheduling management tools and how they apply to military aviation operations.

[364] EXCESSIVE DAYTIME SLEEPINESS (EDS) AND OBSTRUCTIVE SLEEP APNOEA (OSA) AMONG AIRCREW: A QUESTIONNAIRE SURVEY

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[1]No. 2 Aero Medical Training Center, Hyderabad, India; [2]Institute of Aerospace Medicine, Bengaluru, India

(Original Research)

INTRODUCTION: Obstructive Sleep Apnea (OSA) is a condition resulting in disrupted sleep and excessive daytime sleepiness/somnolence (EDS) with demonstrable deficits in cognitive and psychomotor performance. Indian studies have shown prevalence of 4.9-19.7 % in males and 2.1-7.4 % in females. Prevalence among military aviators is unknown. **MATERIAL AND METHODS:** EDS was determined by employing Epworth Sleepiness Scale (ESS) among the 54 male aircrew in an Air base. The risk for OSA was also determined among these individuals by using STOPBANG questionnaire. **RESULTS AND DISCUSSION:** It was found that none of the aircrew in the study group is found to have dangerously sleepy (DS). 11.11% of the studied population were found to have EDS which is less than the prevalence rate in India as per a study conducted by NIMHANS (National Institute of Mental Health And Neuroscience) on general population and the western world (prevalence rate of 16.7%) as found by Gislason et. al. OSA risk amongst the study population was (n=9/54) 16.16 %. The prevalence of OSA in India male (4.9 to 17.9%). Thus, percentage of aircrew showing the risk for OSA in this cross-sectional study, is comparable with the general population in India. However, no correlation was found between the risk factors of OSA with ESS. The reasons for EDS could be attributed to the factors like personal life style, sleeping habits, poor work-rest schedules etc. It is interesting to note that, none of the aircrew, who is positive for OSA risk is showing EDS/DS. This further confirms that OSA risk individuals may not have EDS/DS and this could be a reason why, OSA largely remains underdiagnosed and untreated in clinical practice.

Learning Objectives

1. Epworth Sleepiness Scale (ESS) and Stopbang Questionnaire can be effectively used in the field working environment to assess Excessive Daytime Sleepiness (EDS) and Obstructive Sleep Apnea (OSA) respectively.
2. EDS may not always be due to OSA. Further evaluation must be done in all cases of OSA.

[365] INVESTIGATION OF SLEEP QUALITY IN AIR FORCE CADETS DURING AVIATION PHYSIOLOGICAL TRAINING: COMPARE WITH CADETS IN 2015

Yi-Hsiang Hsin[1], Chung-Yu Lai[1], Min-Yu Tu[1]
[1]Aviation Physiology Research Laboratory, Kaohsiung Armed Force General Hospital Gangshan Branch, Kaohsiung City, Taiwan

(Original Research)

INTRODUCTION: There is extremely high level of pressure and challenge during in-flight training and may affect sleep quality. AF cadets will undertake aviation physiological training before flying. Previous studies were lack of investigation of Sleep quality in AF cadets. This investigation will also compare with data collected from cadets in 2015. MATERIAL AND **METHOD:** This was a cross-sectional study conducted in 2019. AF cadets from Air Force Academy are divided into four groups every year. 121 subjects were recruited from the first to third group. Compare with data collected from cadets in 2015. Pittsburgh Sleep Quality Index (PSQI) was applied to access sleep quality and contained seven aspects including Subjective sleep quality, Sleep latency, Sleep duration, Habitual sleep efficiency, Sleep disturbance, Use of sleeping medications and Daytime dysfunction. Scores of each aspect were between 0-3 and the global scores greater than 5 indicated bad sleep quality. SPSS 20.0 software was applied to analyze data. **RESULTS:** Global PSQI scores were 5.21 and 5.51 in AF cadets in 2019 and cadets in 2015 respectively(p =0.373). We make a internal comparation between three group cadets in 2019 found that Global PSQI scores were 5.90, 4.79 and 4.88 respectively(p =0.059). **DISCUSSION:** AF cadets in 2019 had better global PSQI scores than cadets in 2015. Internal comparison between three groups cadets in 2019 showed that the first group had worse global PSQI scores than other two groups. However the results were non-significant. General speaking, There was no significant difference sleep quality between AF cadets in 2019 and cadets in 2015 during aviation physiological training. The data could use as baseline. In the future, we will follow up to investigate the trend of AF cadet in 2019 sleep quality during flight training.

Learning Objective

1. The audience will learn about sleep quality of AF cadets during aviation physiological training in 2019 in Taiwan.

[366] CHRONONUTRITION: THE EFFECTS OF MEAL CONTENT AND TIMING ON SLEEP AND CIRCADIAN RHYTHMS

Dacia Boyce[1], Jeff Oury[2]
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(Education - Program / Process Review Proposal)

BACKGROUND: Aviators, flight surgeons, and support personnel frequently travel across several time zones for training and missions, or experience shifts in their sleep schedules while supporting missions. Although strategies for entrainment of the circadian rhythm with light are well established, less is known about how meals, in both content and timing, can affect the quality and duration of sleep, or the ability of food to entrain the circadian rhythm. There is little guidance for travelers and crewmembers for this aspect of fatigue management. **OVERVIEW:** The circadian rhythm is well known for its control over wakefulness, hormone secretion, and body temperature. Controlled by the suprachiasmatic nucleus (SCN) of the hypothalamus, light forms the primary input for entrainment of the circadian rhythm, but studies have shown correlation of different diets with sleep quality. A review of the literature was conducted with regards to both content and timing of meals and their effect on several sleep parameters, including sleep duration (SD), sleep latency (SL), sleep efficiency (SE), waking after sleep onset (WASO) and overall sleep quality (SQ). **RESULTS:** Intake of certain foods including high glycemic index meals, rice bran extract, tart cherry juice, and kiwifruit have been shown to positively affect parameters including SQ, SL, SD, WASO, and SE. Cross-sectional analyses of various populations have also shown correlation of higher intake of seafood, greater food variety, and adherence to the Mediterranean diet with improved SQ relative to others in their cohort. Micronutrients also have been shown to affect sleep, with iron, magnesium, and zinc showing positive effects on SD. Other micronutrients have conflicting associations reported in the literature. **DISCUSSION:** In small controlled trials, intake of specific foods or

micronutrients and adherence to the Mediterranean diet have been shown to improve multiple qualitative sleep parameters. Without caloric deficit, the timing of meals has not been shown to affect entrainment of the SCN. Most studies concerning diet and sleep quality are cross sectional or have a small sample size, making generalizability for travelers and use in operational settings difficult, although interventions for short-term improvement of sleep are promising. More work remains to be done, especially in athletes. Controlled trials with objective sleep data will shed more light on the overall effects of dietary changes on sleep quality.

Learning Objectives

1. Readers will better understand the relationships between diet and sleep, and how these interact to influence task performance.
2. Readers will be able to recognize sleep-promoting foods and micronutrients and the limits of these interventions for changing the circadian rhythm.
3. Readers will be able to think critically on their own dietary habits and how these might influence the quality of their sleep.

[367] DEVELOPMENT OF A SPECIAL CAGE FOR RATS TO STUDY THE EFFECTS OF SLEEP DEPRIVATION

Soo Hyun Joo[1], Ah-Yeoun Jung[1], Hyelim Park[1], Kyu-Sung Kim[1], Young Hyo Kim[1]
[1]Inha University School of Medicine, Inha Institute of Aerospace Medicine (IIAM), Incheon, Republic of Korea

(Original Research)

INTRODUCTION: Aviation workers and astronauts are prone to irregular sleeping patterns and the resulting lack of sleep. Therefore, it is crucial to understand the short- and long-term effects of sleep deprivation on each organ of the human body and to prepare countermeasures to overcome them. Therefore, in this study, we aimed to construct equipment that can expose experimental animals to sleep deprivation for several days, and study the immunological changes of them according to sleep deprivation. **METHODS:** In this study, we made a special cage for sleep deprivation test using 'Modified multi-platform model' by using water avoidance character of rats. For the control (healthy sleep) experiment, we applied a large platform model (wider diameter platform designed to allow rats to sleep on) in the same cage. The cage roof was designed to prevent rats from escaping while allowing them to receive food and water within the cage. The height of the platform was lowered to prevent the rats from drowning during the experiment. Besides, for hygienic operations, the motor system that can automatically supply and drain water was introduced. **RESULTS:** Fourteen-week-old male Wistar Rats were exposed to 72 hours of sleep deprivation. Sleep deprivation (SD) group showed significantly more weight loss and more infiltration of inflammatory cells such as eosinophils and neutrophils in bronchoalveolar lavage fluid compared to the healthy sleep (HS) group. Also, peribronchiolar inflammatory infiltration tended to increase in histopathologic examination of lung tissue. Serum IL-1 and corticosterone levels were not significantly different between SD and HS groups. **DISCUSSION:** Through this study, we successfully developed a cage for sleep deprivation research, and conducted primary research on the immunological effects of sleep deprivation.

Learning Objective

1. The participant will be able to understand methods for exposing experimental animals to sleep deprivation conditions.

[368] INCIDENCE AND TIME-COURSE OF SIMULATOR SICKNESS AMONG MILITARY PILOTS

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(Original Research)

INTRODUCTION: Simulator sickness (SS) is commonly defined as any form of discomfort resulting from the use of a simulator. With advancements in flight simulation technology, it is plausible that the higher fidelity of newer-generation simulators may reduce sensory mismatch, with a concomitant decrease in the incidence of SS. This study sought to determine the incidence, severity and time-course of SS among Republic of Singapore Air Force (RSAF) pilots post-flight simulator training. **METHODS:** A survey was conducted on RSAF pilots undergoing flight simulator training over 3-mo. Each subject completed a questionnaire immediately after ("OH"), and at the 3-h ("3H") and 6-h ("6H") marks. The questionnaire included the 16-item Simulator Sickness Questionnaire (SSQ), as well as a 6-point Likert scale for subjects to rate their confidence in operating an aircraft at the point of survey administration. **RESULTS:** 258 Asian pilots with a median age of 31.5 yr (range, 21 - 55 yr) and mean age of 32.6 ± 6.56 yr participated in the study. The prevalence of SS was 48.1% at 0H, 30.8% at 3H and 16.4% at 6H. Based on a threshold of SSQ score >10, the prevalence of operationally significant SS was 33.3% at 0H, 13.2% at 3H and 8.1% at 6H. The mean within-subject reduction in SSQ score from 0H to 3H was 8.4, and from 3H to 6H was 1.6. The most frequent SS symptoms reported were fatigue (38.1%), eye strain (29.0%) and "fullness of head" (19.9%). There was no significant difference in mean SSQ scores between helicopter and fixed wing aircraft pilots. Older, more experienced pilots had greater scores at 0H, but this association did not persist to the 3H and 6H marks. An inverse correlation was found between SSQ score and self-reported confidence in operating an aircraft. **DISCUSSION:** As far as we are aware, this study is the first to chart the prevalence of operationally significant SS (i.e., SSQ score > 10) among Asian pilots over serial time points. Although some subjects still reported SS symptoms after 3 - 6h, our finding that those with higher SSQ scores reported being less confident at operating an aircraft provides a level of assurance that most pilots with SS will be able to judge their fitness-to-fly based on subjective physiological cues. Finally, sensitivity analysis performed to address likely response bias suggests that the true prevalence of SS symptoms is closer to 23.8% at 3H (operationally significant SS, 10.2%) and 16.4% at 6H (operationally significant SS, 8.1%).

Learning Objective

1. To gain an appreciation of the incidence, severity and time-course of simulator sickness among military pilots post-flight simulator training.

[369] IMPACT OF GENETIC VARIABILITY ON PREDICTED HIGH-PERFORMANCE AIRCRAFT PILOT EXPOSURES

Tammie Covington[1], Darrin Ott[2], Heather Pangburn[2], Joseph Jarvis[2], Jeffery Gearhart[1]
[1]HJF on contract to the 711th Human Performance Wing, Wright-Patterson AFB, OH, USA; [2]711th Human Performance Wing, Wright-Patterson AFB, OH, USA

(Original Research)

INTRODUCTION: Previous work used high-performance aircraft pilot exhaled breath samples with physiologically-based pharmacokinetic (PBPK) modeling to predict in-flight concentration ranges for some possible inhalation exposures. These predictions were point estimates for an "average" pilot. Conducting Monte Carlo analyses accounted for inter-individual variation, but still did not account for more complex differences in metabolism and clearance that could affect the pharmacokinetics of potential exposure chemicals and, thus, the potential risk due to these exposures. **METHODS:** The work presented here utilizes the PBPK model previously used to predict in-flight concentration ranges for pilots. Available data on known genetic polymorphisms for metabolism of volatile organic chemicals, such as frequency of the polymorphism and impact of the polymorphism on metabolism, were compiled from the literature and were analyzed as to their usefulness for predicting differences in potential exposure. Pertinent information was then incorporated into parameter distributions for use with the PBPK model in a Monte Carlo analysis. These analyses included distributions for only the metabolism parameters and for all parameters to explore the impact of genetic polymorphism in conjunction with individual variability. Where data were available for polymorphisms in metabolism of both the parent and the metabolite, distributions for both were included in the Monte Carlo analysis to assess not only the effect upon parent chemical predictions, but also the effect upon metabolite pharmacokinetics. **RESULTS:** Predicted area-under-the-curve (AUC) for venous blood concentrations as well as distributions for exposure reconstructions were compared to the previously determined point estimates to demonstrate the resulting impact of accounting for the genetic polymorphisms. Differences in both predicted AUCs and exposure distributions were noted. In particular, AUC predictions fell both above and below the AUC point estimate for simulated isopropanol exposure. **DISCUSSION:** This

work demonstrates the importance of understanding the impact of genetics when assessing risk to protect a "population" as opposed to an "average" individual. The work presented here is part of an ongoing effort aimed at developing a capability to best assess true pilot physiology in a "virtual" context so that aircraft cabin exposure guidelines may be produced to ensure limited probability of contaminated cabin spaces.
Learning Objective
1. Understand how genetic polymorphisms can impact the pharmacokinetics and subsequent risk for exposure to a given chemical.

Thursday, 05/21/2020 ***10:00 AM***
Centennial I

[S-69]: PANEL: AEROMEDICAL RISK ANALYSIS PRACTICE UPDATES

Sponsored by The American Society of Aerospace Medicine Specialists

Chair: Daniel VanSyoc

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

[370] CENTRAL SEROUS RETINOPATHY: MATCHING THERAPY WITH PATHOPHYSIOLOGY

Jonathan Ellis[1]
[1]*Aeromedical Consultation Service, Wright-Patterson AFB, OH, USA*

(Education - Tutorial Proposal)

TOPIC: Central Serous Retinopathy: Matching Therapy with Pathophysiology. Central serous retinopathy is one of the more common diagnoses seen by ophthalmology at the ACS. Recent studies have elucidated the underlying causal pathophysiology of CSR, which now allows for targeted therapy. The new recommended treatment paradigm will be discussed to optimize visual outcomes and reduce DNIF time for aviators. **APPLICATION: Treatment of Central Serous Retinopathy in Aircrew for both Military and Civilian populations. RESOURCES:** Bousquet E, et al. Mineralocorticoid Receptor Antagonism in the Treatment of Chronic Central Serous Chorioretinopathy: A Pilot Study. Retina 2013; 33:2096-2102. Bousquet E, et al. Predictive Factors of Response in Mineralocorticoid Receptor Antagonists in Nonresolving Central Serous Chorioretinopathy. Am J Ophthalmol 2019; 198:80-87. Gruszka A. Potential involvement of mineralocorticoid receptor activation in the pathogenesis of central serous chorioretinopathy: case report. Europ Rev Med Pharmacological Sci, 2013; 17: 1369-73. Nicholson B, Noble J, Forooghian F, and Meyerle C. Central Serous Chorioretinopathy: Update on Pathophysiology and Treatment. Surv Ophthalmol, 2013; 58(2): 103-126. Green RP, Carlson DW, Dieckert JP, and Tredici TJ. Central Serous Chorioretinopathy in US Air Force Aviators: A review. Aviat Space Environ Med, 1988; 59(12): 1170-75.
Learning Objectives
1. The audience will learn about the pathophysiology of central serous retinopathy (CSR) and the most common cause in active duty aged aircrew.
2. The audience will learn about current available therapies for central serous retinopathy.
3. The audience will learn about systematically choosing therapy to target the now understood pathophysiology of CSR.

[371] TRAUMA- AND STRESSOR-RELATED DISORDERS IN USAF AVIATORS - PART 1, ADJUSTMENT DISORDERS

Terry Correll[1]
[1]*U.S. AIR FORCE SCHOOL OF AEROSPACE MEDICINE, Wright-Patterson AFB, OH, USA*

(Education - Tutorial Proposal)

INTRODUCTION: Trauma- and stressor-related disorders include adjustment disorders, acute stress disorder, and posttraumatic disorder. These disorders are disqualifying for all classes of flying in the U.S. Air Force. Therefore, they have a significant impact on individual and mission readiness. **TOPIC:** Part 1 of this presentation will focus on adjustment disorders. Extended "down" times are common in aviators with adjustment disorders. It is very common for aviators with adjustment disorders to be prescribed a long-term antidepressant, receive no psychotherapy, and even not to be evaluated and treated by mental health. This presentation discusses the treatments for adjustment disorders along with their potential waiverability following treatment and stabilization of the aviator. When managed well, many adjustment disorders never require DNIF periods, and even when they do, their length can be minimized. **APPLICATION:** Excellent evaluation and management (including potentially healthy lifestyle interventions, psychotherapy, and medication) can not only minimize and even avoid DNIF periods, but can enhance resilience to avoid recurrence of similar adjustment disorder episodes. This presentation will simplify the flight surgeon's job by elucidating these concepts and describe effective management strategies for trauma- and stressor-related disorders. **RESOURCES:** 1. Van Syoc DL, McDonald KD, Correll TL. Adjustment Disorders (May 14). In: Air Force waiver guide. Wright-Patterson AFB (OH): U.S. Air Force School of Aerospace Medicine; 2019:11-17. 2. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*, 5th edition. Arlington (VA): American Psychiatric Association; 2013:265-290.
Learning Objective
1. Excellent evaluation and management (including potentially healthy lifestyle interventions, psychotherapy, and medication) can not only minimize and even avoid DNIF periods, but can enhance resilience to avoid recurrence of similar adjustment disorder episodes. This presentation will simplify the flight surgeon's job by describing effective management strategies for adjustment disorders.

[372] TRAUMA- AND STRESSOR-RELATED DISORDERS IN USAF AVIATORS - PART 2, POSTTRAUMATIC STRESS DISORDER

Ryan Peirson[1]
[1]*U.S. AIR FORCE SCHOOL OF AEROSPACE MEDICINE, Wright-Patterson AFB, OH, USA*

(Education - Tutorial Proposal)

INTRODUCTION: Trauma- and stressor-related disorders include adjustment disorders, acute stress disorder, and posttraumatic disorder (PTSD). These disorders are disqualifying for all classes of flying in the U.S. Air Force. Therefore, they have a significant impact on individual and mission readiness. **TOPIC:** Part 2 of this presentation will focus on posttraumatic stress disorder. The diagnosis of PTSD, especially in the combat environment, is fraught with difficulty. Flight surgeons and mental health providers need to consider the length, severity, and functional impact of PTSD symptoms along with the situationally-induced nature and accompanying stressors that triggered the condition. This presentation discusses the treatments for PTSD along with its waiver potential following treatment and stabilization of the aviator. When managed well, PTSD may not require waiver. **APPLICATION:** PTSD is a prevalent condition among military members and is potentially waiver-eligible in USAF aircrew. Residual symptoms after treatment may remain and not impair the member from performing assigned duties. Excellent evaluation and management (including potentially healthy lifestyle interventions, psychotherapy, and medication) can minimize DNIF periods, and can enhance resilience to avoid recurrence. This presentation will highlight these concepts and describe effective management strategies for trauma- and stressor-related disorders. This is primarily applicable to USAF flight surgeons, but it also has utility for other military services and civilian flight medicine. **RESOURCES:** 1. Wood J, Heaton J, and Van Syoc D. Post-Traumatic Stress Disorder (PTSD) (June 2017). In: Air Force waiver guide. Wright-Patterson AFB (OH): U.S. Air Force School of Aerospace Medicine; 2019. 2. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*, 5th edition. Arlington (VA): American Psychiatric Association; 2013:265-290.
Learning Objective
1. The participant will understand how posttraumatic stress disorder is considered a medically disqualifying diagnosis by the USAF.

[373] ASAMS AEROMEDICAL RISK ANALYSIS - AUTOSOMAL DOMINANT POLYCYSTIC KIDNEY DISEASE

Charles Mathers[1]
[1]FAA, League City, TX, USA

(Education - Tutorial Proposal)

INTRODUCTION: Autosomal dominant polycystic kidney disease (ADPKD) is an inherited condition which can lead to a decline in kidney function and hypertension. Aeromedically significant presenting symptoms can include hypertension, hematuria, proteinuria, renal insufficiency, flank pain due to renal hemorrhage, nephrolithiasis, or urinary tract infection. ADPKD can also present with significant extra-renal manifestations, such as cerebral aneurysm, hepatic and pancreatic cysts, cardiac valve disease, colonic diverticula, and abdominal wall and inguinal hernia. **TOPIC:** This presentation will provide an overview of ADPKD and discuss its aeromedical significance, with a specific focus on screening for the presence of cerebral aneurysm. **APPLICATION:** Aeromedical practitioners will gain insight regarding the potential aeromedical risks associated with ADPKD.

Learning Objective

1. Understand the prevalence of cerebral aneurysm in pilots with autosomal dominant polycystic kidney disease.

[374] PAST, PRESENT, AND FUTURE OF REFRACTIVE SURGERY IN THE US AIR FORCE

Michael Parsons[1]
[1]HPW/U.S. AIR FORCE SCHOOL OF AEROSPACE MEDICINE, Fairborn, OH, USA

(Education - Tutorial Proposal)

TOPIC: The USAF Refractive Surgery program was established to improve Readiness for all USAF Warfighters. Concurrently, it was tailored to meet the unique needs of USAF aircrew in order to ensure that these elite airmen were getting the latest technology, but in a manner that had been demonstrated to be safe and effective for each member. This presentation will discuss the history of the development of the program, unique challenges to having refractive surgery patients in this environment, standards to mitigate risk of visual degradation or deterioration postoperatively, and finally, opportunities/limitations for refractive surgery in aircrew in the future. **Learning Questions:** 1. What is the purpose of a centrally monitored program for refractive surgery candidates in the aerospace environment? 2. What are some of the unique challenges and concerns of refractive surgery specific to aircrew as compared to ground-based airmen.

Learning Objectives

1. What is the purpose of a centrally monitored program for refractive surgery candidates in the aerospace environment?
2. What are some of the unique challenges and concerns of refractive surgery specific to aircrew as compared to ground-based airmen.
3. To best understand the role of the USAF Refractive Surgery program in order to maximize the pool of medically qualified aircrew able to meet mission demands.

Thursday, 05/21/2020 ***10:00 AM***
Centennial II

[S-70]: PANEL: NAVAL AVIATION SURVIVAL TRAINING - IDENTIFYING AND IMPLEMENTING ENHANCEMENTS FOR INCREASING HUMAN PERFORMANCE

Chair: Beth Atkinson

Co-Chair: Timothy Welsh

PANEL OVERVIEW: The panel will include presentations that provide an overview of challenges and advances underway for aviation survival training. Navy instruction (Department of the Navy, 2016, CNAF M-3710.7) outlines a variety of training requirements that are addressed during aviation survival training. The first presentation in this panel will describe the results of a qualitative analysis of student critiques to provide an overview student perceptions of current aviation survival training, and offer recommendations for areas of improvement. The next two presentations will provide an overview of enhancements underway related to mask off and mask on hypoxia training. For mask off hypoxia training, presenters will provide an overview of a preliminary analysis of a software designed to provide students with relevant tasking to complete while experiencing the effects of hypoxia to highlight symptoms experienced. The next presentation, focused on mask on hypoxia training will provide an overview of differences identified between available training solutions from the perspective of both students and instructors. The fourth presentation will provide the preliminary results of a spatial disorientation curriculum analysis focused on identifying available technologies to provide recommendations for how to modernize training in a way that provides aviators with an opportunity increase training effectiveness. The fifth and final presentation will provide an overview of parachute training including a review of training objectives and results of a market research analysis, as well as outline an upcoming training effectiveness evaluation of existing training solutions. The views of the author expressed herein are do not necessarily represent those of the U.S. Navy or Department of Defense (DoD). Presentation of this material does not constitute or imply its endorsement, recommendation, or favoring by the DoD. NAWCTSD Public Release 19-ORL085 Distribution Statement A – Approved for public release; distribution is unlimited.

[375] NORMOBARIC HYPOXIA TRAINER DISTRACTOR TASKING REDESIGN

Mitchell Tindall[1], Aaron Bishop[2], Melissa Burke[2], Beth Atkinson[1]
[1]Naval Air Warfare Center Training Systems Division, Orlando, FL, USA; [2]U.S. Navy, Jacksonville, FL, USA

(Original Research)

INTRODUCTION: The Normobaric Hypoxia Training (NHT) chamber was designed to provide a hypoxia training solution for mask-off aircrew. Previous training solutions were inappropriate. The Low Pressure Chamber due to serious safety risks and maintenance challenges, and the Reduced Oxygen Breathing Device (ROBD) which provided negative training since hypoxia was experienced in a mask-on environment which is the exact hypoxia treatment protocol for mask-off aircrew. For distractor tasking while in the NHT chamber, software was designed to provide students with tasking to complete while experiencing the effects of hypoxia. Ideally to illustrate cognitive deficiencies and physiological symptoms. **METHODS:** In order to better understand the needs of trainees and their current experiences with the system, both observations and a survey were utilized. Current Aviation Survival Training Center (ASTC) instructors observed training sessions in order to generate a list of potential issues and solutions with the tablet currently used by students in the NHT chamber to provide distractor tasking. From these observations, a survey was made and distributed to students which inquired about their use of the system – including questions about usability, engagement, functionality, and applicability of tasking to relevant job duties. **RESULTS:** Results of the survey indicated that though the tablet was easy to use and functional (e.g., no lag), there were major issues with the tasks themselves. Namely, students indicated that the instructions for the tasks were very unclear or not presented, the tasks were unengaging, and the tasks did not address Knowledge, Skills, and Abilities (KSAs) relevant to their actual job duties. In addition, qualitative results noted that the tasks got very repetitive and the instructions were confusing or unclear for some of the tasks. **DISCUSSION:** Tasking of students while in the NHT chamber is important, as proper tasking will allow student to best understand how hypoxia could affect them while performing their job duties. In addition, engaging and appropriate tasking will provide a higher fidelity experience that allows students to experience the insidious nature of slow onset hypoxia that mask-off aircrew are most likely to experience. From the results of the current research, the distractor tasking software will undergo a redesign in order to provide better tasking.

Learning Objective

1. Better understand the current strengths and limitations of existing supplemental training technologies for mask on hypoxia training.

[376] PARACHUTE DESCENT TRAINING: ANALYSIS OF LEGACY AND ADVANCED SYSTEMS

Beth Atkinson[1], Lee Sciarini[2], Steve Kass[3], Brian Stensrud[4], Jon Champine[5], Matthew Pierce[1], Valerie Morganson[3]
[1]Naval Air Warfare Center Training Systems Division, Orlando, FL, USA; [2]Naval Survival Training Institute, Pensacola, FL, USA; [3]University of West Florida, Pensacola, FL, USA; [4]SoarTechnology, Orlando, FL, USA; [5]Aviation Survival Training Center, Miramar, CA, USA

(Original Research)

INTRODUCTION: Parachute Descent Procedure (PDP) training is a quadrennial requirement for Naval aviators to complete as part of the Naval Aviation Survival Training Program (NASTP). During PDP training, aviators are taught how to safely eject from the aircraft, and deploy their chute and related equipment during descent (e.g., seat kit), as well as how to recover from common parachute malfunctions. However, trainee and instructor feedback regarding current training practices indicate potential areas for improvement to training. **METHODS:** Current efforts are focused on understanding the current system and its limitations, performing market research to better understand the parachute training technologies available, and conducting a training effectiveness evaluation, to make sure the new PDP trainer is training the proper Knowledge, Skills, and Abilities (KSAs). To this end, a Cognitive Task Analysis (CTA) is being performed to analyze the underlying mental processes utilized in order to perform successful PDP training. **RESULTS:** Preliminary analyses of the CTA has indicated that there are several KSAs associated with PDP training, including but not limited to: decision-making, situational awareness, and knowledge of procedures. In addition, market research has indicated that a bevy of technologies are available, though most are incredibly high fidelity, and high cost. **DISCUSSION:** Better understanding the KSAs associated with PDP training will allow for a better training effectiveness evaluation. In addition, a more nuanced look at parachute training systems currently on the market will allow for further critique of the two systems in question and perhaps iterative updates to integrate new capabilities where possible and appropriate. Future research in this vein will focus on a training effectiveness evaluation. The proposed design of the effectiveness study will be discussed, as well as any planned updates to the systems based on a CTA and market research. Ensuring effective PDP training is instrumental in the safety of Naval aviators. **NOTES:** NAWCTSD Public Release 19-ORL085 Distribution Statement A – Approved for public release; distribution is unlimited. The views of the author expressed herein are do not necessarily represent those of the U.S. Navy or Department of Defense (DoD). Presentation of this material does not constitute or imply its endorsement, recommendation, or favoring by the DoD.

Learning Objective

1. Understand the current training objectives for parachute training and how existing training technologies address training needs.

[377] PERCEPTIONS OF AVIATION SURVIVAL TRAINING: A REVIEW OF STUDENT FEEDBACK

Zachary Johnson[1], Chad Milam[2], Natalie Ireland[3], Shannon Clough[4], Brooke Barnson[5], Patrick Martin[6], Angelita Moreno[7], Luke Scripture[1]
[1]Department of Defense, Pensacola, FL, USA; [2] Department of Defense, Jacksonville, FL, USA; [3] Department of Defense, Miramar, CA, USA; [4] Department of Defense, Norfolk, VA, USA; [5] Department of Defense, Whidbey Island, WA, USA; [6] Department of Defense, Patuxent River, MD, USA; [7] Department of Defense, Cherry Point, NC, USA

(Original Research)

INTRODUCTION: The mission of the Aviation Survival Training Centers (ASTCs) is to provide both initial survivability training as well as refresher training, with the goal of maintaining Warfighter readiness and proficiency. Annually, the ASTCs train approximately 18,000 students with a wide variety of backgrounds ranging from new recruits to advanced aviators. During this training, students learn and practice survival skills that include seat ejections, parachute descent and landing procedures, aeromedical impacts (e.g., hypoxia, hyperventilation, decompression illness, G-LOC, spatial disorientation), and open water survival. **METHODS:** Though these classes provide the means by which to establish and maintain skill proficiency for aircrew, a preliminary review of student feedback from a single ASTC highlighted several areas for improvement. To ensure that training meets the changing needs of the Warfighter and considers constantly evolving technologies, there is a need to find mechanisms to understand the areas of opportunity for further development and design (or redesign) of training. This analysis involved a review of ASTC Student feedback, completed by both initial and refresher students post-training, across multiple ASTCs to identify opportunities for where to target new developments in training. This feedback might range from areas where students felt a lack of engagement, to gaps in training content, as well as inputs on how to enhance training in the future. **RESULTS:** Preliminary data highlighted the top five areas for improvement as: 1) Increased opportunity for hands-on training with specific gear; 2) Update videos used in briefs; 3) A updated Virtual Reality parachute descent trainer; 4) Inclusion of more mishaps/real-world scenarios; 5) Provide informational materials to take home. **DISCUSSION:** Additional feedback from all eight ASTCs will provide a more comprehensive look at the "needs of the Warfighter" as each geographical location trains a unique set of students with varying backgrounds, platform communities, and operating environments. Ideally, student feedback from all ASTCs will be compiled, analyzed, and used to guide new efforts and make changes to existing training. **NOTES:** NAWCTSD Public Release 19-ORL085 Distribution Statement A – Approved for public release; distribution is unlimited. The views of the author expressed herein are do not necessarily represent those of the U.S. Navy or Department of Defense (DoD).

Learning Objective

1. Understand perceived areas of improvement from student and instructor perspectives to advance aviation survival training and increase human performance.

[378] COMPARATIVE ANALYSIS OF HYPOXIA TRAINING SYSTEM: REDUCED OXYGEN BREATHING DEVICE (ROBD) AND ON-DEMAND HYPOXIA TRAINER (ODHT)

Chris Gilg[1], Emily Anania[2], Beth Atkinson[2], Timothy Welsh[1]
[1]Aviation Survival Training Center Pensacola, Pensacola, FL, USA; [2] Naval Air Warfare Center Training Systems Division, Orlando, FL, USA

(Original Research)

INTRODUCTION: Hypoxia is an issue at the forefront of Naval aviation research and training, and is a biannual training requirement for aviators as part of the Naval Aviation Survival Training Program (NASTP). Current hypoxia training for mask-on aviators is completed almost exclusively using the Reduced Oxygen Breathing Device (ROBD). The fidelity of training using ROBD is in question, as certain symptoms are exacerbated or suppressed by the lack of a pressure-on-demand system. In order to overcome this particular issue, the On-Demand Hypoxia Trainer (ODHT), is currently in iterative testing and development. The ODHT has a smaller physical footprint than the ROBD, and is designed to provide a higher fidelity experience. In order to justify the full transition of this new technology, it is important to fully understand the differences between systems, from the perspective of the students and instructors. **METHODS:** To compare the capabilities of the ROBD and ODHT, observations, focus groups, and surveys were utilized. Hypoxia training using both the ROBD and ODHT were observed by NASTP instructors and Research Psychologists. In addition, informal focus groups were conducted with instructors who have been trained on and trained students using both systems, have a direct comparison. Surveys are currently being developed and distributed to instructors and students to complete regarding the usability and breathing experience of each system. **RESULTS:** Observations and focus groups indicate the ODHT provides a better breathing experience, reduces the physical footprint, and provides enhanced debriefing capabilities. Instructors and students note that there is significantly less "air hunger" experienced on the ODHT. Should instructors need to rearrange the room or transport the systems, the ODHT is much more portable than the ROBD with its associated compressed gas tanks. Results from the observations and focus groups have informed survey creation. **DISCUSSION:** Improved fidelity of hypoxia training will better prepare aviators to recognize and perform their emergency procedures while in the aircraft. Further research on this topic will involve distribution of surveys to those who breathe or train on the ODHT and have also experienced ROBD training, in order to have a

quantitative analysis of the differences in systems, in terms of usability and breathing experience. Overall, preliminary results indicate that the ODHT fills several current training gaps for the NASTP.

Learning Objective

1. Understand the current strengths and limitations of available training technologies for mask-on hypoxia training.

[379] CURRICULUM ANALYSIS OF SPATIAL DISORIENTATION TRAINING: COMMERCIAL-OFF-THE-SHELF OPPORTUNITIES

Kerri Chik[1], Jordan Haggit[2], Camilla Knott[2], Joseph Keebler[3], Gabriella Severe-Valsaint[4], Beth Atkinson[4], Lee Sciarini[5]
[1]East Carolina University, Greenville, NC, USA; [2]TiER1 Performance, Covington, KY, USA; [3]Embry Riddle Aeronautical University, Daytona Beach, FL, USA; [4]Naval Air Warfare Training Systems Division, Orlando, FL, USA; [5]Naval Survival Training Institute, Pensacola, FL, USA

(Original Research)

INTRODUCTION: Spatial disorientation (SD) and situational awareness (SA) are major contributors to aviation mishaps. Currently, SD/SA training is delivered largely via classroom-based lectures and limited experiential opportunities through the various Aviation Survival Training Centers (ASTCs). However, due to the prevalent and dangerous nature of SD/SA mishaps, it is important to review and update training as available. Due to constantly advancing technologies, and increased understanding of the ways SD/SA contribute to mishaps, it is likely that training can be further improved. **METHODS:** The current SD/SA curriculum was reviewed in order to better understand trainee needs, trainee experience, and opportunities for future curriculum and technological advancements. The current curriculum was reviewed and observed by both subject matter experts (SMEs) in aviation survival training, as well as SMEs in training development and design. Methodologies included observations, review of materials, and review of trainee evaluations in order to better understand the current training and options for enhancing this training. **RESULTS:** A comprehensive analysis was performed in order to generate areas of opportunities and potential new technologies, including commercial-off-the-shelf (COTS) fixes. Trainee evaluations were indicative of a need for more experiential and hands-on learning, as well as a desire for more engaging and immersive experiences. Review of the curriculum and observations also noted a lack of immersion – though classroom lectures are important methods of information dissemination, there is a significant opportunity to enhance SD/SA training in the classroom, to provide immersive and experiential learning. Current technologies would allow for recreation of mishaps in the classroom, in a 360° video simulated environment. **DISCUSSION:** In order to maintain and increase readiness, it is important that training be continuously reviewed and revitalized. Due to the dangerous nature of SD/SA in the cockpit, it is vital for aviators to receive accurate, effective training. Results from the curriculum analysis can be applied to better understand the current opportunities for integrating new technologies and instructional strategies into the curriculum in order to provide immersive experiences for students to experience SD/SA mishaps while in a controlled, simulated environment.

Learning Objective

1. Understand the current strengths and limitations of existing training technologies based on a review of training objectives and curriculum.

Thursday, 05/21/2020 ***10:00 AM***
Centennial III

[S-71]: PANEL: PAST, PRESENT, & FUTURE OF NASA'S BIOMEDICAL FLIGHT CONTROLLERS

Chair: Duane Chin

Co-Chair: Rebecca Tidman

PANEL OVERVIEW: The Biomedical Engineer Flight Controllers (call sign: BME) support the Mission Control Center (MCC) operations at NASA Johnson Space Center (JSC). Together with the Flight Surgeons, BMEs serve as the Medical Operations representatives to the Flight Director and the rest of the Flight Control Team in MCC. The primary responsibility of the BME position is to ensure that all medical requirements are implemented appropriately for in-flight crewmembers. In doing so, the BME supports the Flight Surgeon and the rest of the NASA medical community in ensuring medical hardware operability, medical monitoring activity scheduling, medical data downlink and distribution, among other duties. The BMEs have a long history of supporting astronaut health during spaceflight, starting with the inception of the Space Shuttle Program, continuing support and adding an expansion of scope throughout the International Space Station (ISS) Program, where BME support was extended to NASA's International Partners (IPs), and currently planning to continue forward towards NASA's future lunar and exploration programs. The BME team has continued to evolved through the years, by incorporating new technologies in the MCC environment, taking on new and expanding console responsibilities, and furthering collaboration between teams. Each phase of BME flight control and the evolution of the role will be discussed if the following five areas: (1) Shuttle-era BME Flight Control; (2) Early ISS-era BME Flight Control; (3) Current ISS BME Flight Control; (4) IP BME Flight Control; and (5) Future of BME Flight Control. The service that the BMEs provide is critical to the continued success of protecting astronaut health during spaceflight, and the BME position's evolution through the years has allowed for more advanced medical operations support, with lessons learned that would carry forward to future space programs.

[380] FUTURE OF BME FLIGHT CONTROL (ORION, GATEWAY, LUNAR)

Christopher Van Velson[1]
[1]KBR, Houston, TX, USA

(Education - Program / Process Review Proposal)

BACKGROUND: The Biomedical Engineer Flight Controllers (call-sign: BME) have a vast history of providing flight controller support in the Mission Control Center (MCC) for crewed missions from Shuttle to ISS, and now plans for Exploration. BME responsibilities have evolved over the past 3 decades and will continue to evolve for Exploration (Orion, Gateway, Lunar), the future of Medical Operations support. **OVERVIEW:** The Exploration missions will bring new challenges and some challenges not experienced since the Apollo program. BMEs will need to adapt while still continuing to maintain a strong, trusted relationship with the Flight Surgeons in order to provide optimal medical operations for the astronauts. **DISCUSSION:** Having astronauts travel in the Orion capsule, dock to Gateway, travel to the lunar surface, and perform EVAs on the lunar surface will be both exciting and challenging. The BME will continue to play a vital role in ensuring in-flight astronaut health for Exploration missions, the future of human spaceflight.

Learning Objectives

1. Understand the Exploration Design Reference Missions and how differ from other current and previous Programs.
2. Understand how the Exploration Design Reference Missions will drive changes in the BME Flight Controller support.

[381] SPACE SHUTTLE BME FLIGHT CONTROL

Robert Janney[1]
[1]KBR, Houston, TX, USA

(Education - Program / Process Review Proposal)

BACKGROUND: The Biomedical Engineer Flight Controllers (call-sign: BME) have a extensive history of providing flight control support in the Mission Control Center (MCC) at Johnson Space Center (JSC) for crewed missions. For the Space Shuttle Program, the BME position was developed and implemented as a real-time support position for the Flight Surgeon (call sign: SURGEON). The primary responsibility of the Shuttle BME flight controller was to offload many of the non-medical requirements of the SURGEON Flight Control Room (FCR) position, allowing for enhanced focus on the medical aspects of the mission. **OVERVIEW:** This briefing will discuss the roles and responsibilities of the Shuttle BME flight controller, starting in the early part of the Space Shuttle Program; followed by the evolution of the position from the days of analog flight control through the digital transformation of Mission Control and into longer duration missions, concluding with joint missions with the ISS flight control team and the close out of the Space Shuttle

Program. **DISCUSSION:** To understand the evolution of the BME flight control position in MCC through multiple spaceflight programs, it is important to establish a baseline reflecting how and why the position was established. This briefing will set the stage for the follow-on presentations, tracing the growth of the BME flight controller position from a one-person backroom support arrangement to a critical FCR discipline team with substantial responsibilities directly reporting to the Flight Director.

Learning Objective

1. Understand the roles and responsibilities of the Biomedical Flight Controllers that supported the Space Shuttle Program.

[382] CURRENT ISS BME FLIGHT CONTROL

Rebecca Tidman[1]
[1]KBR, Houston, TX, USA

(Education - Program / Process Review Proposal)

BACKGROUND: The Biomedical Engineer Flight Controllers (call-sign: BME) support International Space Station (ISS) Mission Control Center (MCC) operations at NASA Johnson Space Center (JSC). Together with the Flight Surgeons, ISS BMEs serve as the Medical Operations representatives to the Flight Director and the rest of the Flight Control Team in ISS MCC. The primary responsibility of the ISS BME position is to ensure that all medical requirements are implemented appropriately for in-flight crewmembers. In doing so, the ISS BME supports the ISS Flight Surgeon and the rest of the NASA medical community in ensuring medical hardware operability, medical monitoring activity scheduling, medical data downlink and distribution, among other duties. **OVERVIEW:** To look at the current posturing of ISS BME console support requires a comparison against past console support. In the previous panel presentation, the genesis of ISS BME support and 3-crew ISS operations were discussed. A turning point for the ISS BMEs began when the ISS transitioned from 3-crew to 6-crew operations. Since the ISS BME's duties revolved around the crewmembers, more crew equated to more work, and therefore the ISS BME team sought out efficiencies wherever possible. Also, as hardware and software technologies advanced, the ISS BMEs were dealing with an increased complement of medical devices and many upgrades to existing devices to better meet the medical needs of the crew and/or to test out new technologies for future space exploration programs. **DISCUSSION:** Understanding current ISS BME flight control support provides a basis for planning out efficient and effective future BME flight control in support of NASA programs currently in development, including Orion, Artemis, Gateway, and further exploration. By ensuring NASA's medical requirements are implemented operationally, the BMEs play a vital role in ensuring in-flight astronaut health, thereby supporting the future of human spaceflight.

Learning Objective

1. Understand how the current ISS BME flight controllers have adapted to increasing console demands due to transition to 6-person ISS crew and ever-changing technologies for ISS medical hardware/software.

[383] EARLY ISS BME FLIGHT CONTROL

Ted Duchesne[1]
[1]KBR, Houston, TX, USA

(Education - Program / Process Review Proposal)

BACKGROUND: The Biomedical Engineer Flight Controllers (call sign: BME) support International Space Station (ISS) Mission Control Center (MCC) operations at NASA Johnson Space Center (JSC). Together with the Flight Surgeons, ISS BMEs serve as the Medical Operations representatives to the Flight Director and the rest of the Flight Control Team in ISS MCC. The ISS BME shares two primary responsibilities, the first is to ensure the on-orbit crew properly implements the medical requirements. The second is to support and respond to on-orbit issues with the Crew Health Care System (CHeCS) Hardware on the ISS. **OVERVIEW:** To look at the initial concept of operations for ISS BME console support. In the previous panel presentation, the BME support of Shuttle missions was discussed. This panel will break down the primary differences between the Shuttle BME and the ISS BME, focusing on the broad scope of hardware supported by the ISS BME, the depth of medical requirements that needed to be implemented, and the difference in on-orbit duration of the crews. The panel will highlight how the initial plans of console support were developed. The initial support concept of operations had the ISS BME in charge of almost all aspects of hardware support and implementation of requirements. Eventually this support evolved as the on console and in office, workload was better understood. **DISCUSSION:** Understanding the initial ISS BME flight control support and how initial lessons learned were quickly implemented to create a better workload balance shows that one must be able to adapt their plans to reality. This panel will show that even the best-laid plans must be able to adapt to how the mission actually runs. The lessons learned and how they were implemented continue to have an effect on the planning of future BME flight control in support of NASA programs currently in development, including Orion, Artemis, Gateway, and further exploration. By ensuring NASA's medical requirements are implemented operationally, the BMEs play a vital role in ensuring in-flight astronaut health, thereby supporting the future of human spaceflight.

Learning Objective

1. Understand how the initial support operations for the ISS BME developed from the Shuttle BME era and how initial lessons learned were quickly implemented to develop a better workload balance both on console and in the office.

[384] INTERNATIONAL PARTNER (IP) BME FLIGHT CONTROL

Frits de Jong[1], Petra Mittler[2]
[1]European Space Agency/European Astronaut Centre, Cologne, Germany; [2]DLR, Cologne, Germany

(Education - Program / Process Review Proposal)

BACKGROUND: The International Partner (IP) Biomedical Flight Controllers (call sign: BME) support medical operations for their segments of the International Space Station (ISS) and for crewmembers representing their agencies, which includes the European Space Agency (ESA), Japanese Aerospace Exploration Agency (JAXA), and Canadian Space Agency (CSA). The IP BMEs work in close coordination with the BMEs that support NASA Mission Control Center (MCC) operations at Johnson Space Center (JSC). The coordination between the IP BMEs, the NASA BMEs, and the Flight Surgeons ensures that all medical requirements and issues are properly executed and addressed when an IP crewmember is onboard. An efficient collaboration between the NASA team and the different IP medical teams is crucial to ensure IP crewmember and overall mission success. **OVERVIEW:** The IP BME represents the entire IP medical team when they are on console at their respective Mission Control Center, and in their interactions with the NASA BME. The duties of an IP BME differ depending on if an IP crewmember is onboard or not. The IP BME team's support of an IP crewmember's mission includes pre-flight, in-flight, and post-flight support of the IP Space Medicine team and the crewmember. When an IP crewmember is not on orbit, the IP BME team's support scales back while maintaining operational awareness and preparation for the next IP crewmember. Console support varies from agency to agency. This pitch will focus on the IP BME support provided by ESA over a period of 15 years, how ESA's support concept developed over the years and how ESA dealt with operational budget restrictions. In addition, this pitch will provide some high-level insight on the way JAXA and CSA have implemented their BME responsibilities. **DISCUSSION:** It is likely that IP crewmembers will continue to be a part of NASA's future space programs. Understanding IP BME flight control support and how the cooperation between the IP and NASA BME teams have improved and developed will be useful in planning out efficient and effective BME flight control in support of the space programs currently in development, including Orion, Artemis, Gateway, and further exploration. Through the years, the IP BMEs and NASA BMEs have developed into a cohesive team who play a vital role in ensuring in-flight health and well-being for all astronauts from all IPs, thereby supporting a truly collaborative and international effort in human spaceflight.

Learning Objective

1. Understand how the collaboration between IP BME flight controllers and NASA BME flight controllers contributes to the successful continuation of keeping all astronauts healthy during spaceflight.

Thursday, 05/21/2020 ***10:00 AM***
Centennial IV

[S-72]: SLIDE: PILOT ASSESSMENT & SELECTION CONUNDRUMS

Chair: Carol Ramsey

[385] THE UNIQUE ETHICAL SITUATION OF TRIPLE AGENCY IN THE ROLE OF MILITARY FLIGHT SURGEONS

Jonathan Beich[1], Ryan Peirson[2]
[1]Wright Patterson AFB/Wright State University Residency Program, Dayton, OH, USA; [2]711th Human Performance Wing, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Education - Tutorial Proposal)

THE UNIQUE ETHICAL SITUATION OF TRIPLE AGENCY IN THE ROLE OF MILITARY FLIGHT SURGEONS

INTRODUCTION: The concept of *dual agency* in the context of medicine describes the divided roles of simultaneously serving the best interests of a patient and of a forensic investigation. An even more complicated situation of *triple agency* may occur when the provider is a military flight surgeon who additionally has an obligation to a unit commander and mission. In matters of ethical uncertainty and unclear or confusing boundaries, it behooves the physician to carefully consider ahead of time how they will satisfy their responsibilities to patients, the law, the military mission, and their own conscious. **TOPIC:** Quandaries arising from triple agency may present the flight surgeon with a source of difficulty and frustration. Currently, there is little to no published work that might be consulted in these potentially delicate situations. There exists a need for accurate, current, and straightforward guidance for military flight surgeons. This work defines the triad components of triple agency, describes potential conflicts (actual and perceived), and suggests methods for physicians to confidently arrive at their own conclusions and courses of action. Practical example scenarios will be provided as exercises. The overall intent is to provide a framework that invites the reader to think deeply on initial consideration, and can serve as a quick reference for just-in-time knowledge refreshment out in the squadrons and clinics. **APPLICATION:** While the career of a military flight surgeon is niche, it is not rare with several hundred specially-trained men and women serving across all branches of the U.S. military. It is inevitable for this population that situations will arise that make them feel "caught in the middle" of competing professional military and medical values and principles. The intent of this work is to 1) assist in clarifying roles and responsibilities of the players in a triple agency situation and 2) to stimulate self-directed reflection of how a provider may carry out their Hippocratic duties in equilibrium with legal requirements and loyalty to the military mission. The scope of this work is intentionally limited to the unique role of military flight surgeons which would likely include those of any service branch or nationality, but may have extended significance to providers within or associated with commercial or civil aerospace institutions.

Learning Objective

1. The audience will learn about the uncommonly discussed, but commonly encountered, situation of triple agency in duties of a military flight surgeon.

[386] WRONGFUL AEROMEDICAL DECISIONS: AEROMEDICAL EXAMINER GETS JAIL SENTENCE

Ulrich Werner[1]
[1]German Air Force Centre of Aerospace Medicine, Cologne, Germany

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: An accident investigation team had to look at the crash scene after a midair collision of 2 GA-aircraft with 8 casualties. Prescriptions and tools were found on scene which indicated that one pilot suffered Insulin treated diabetes. Civil European aviation law does not allow waivers for Insulin treated type 1 diabetes. The district attorney immediately accused the AME of negligent homicide. **BACKGROUND:** The accident investigation revealed that the pilot's medical condition was not the cause of the accident, but dead reckoning of the two aircraft tracks. Thus negligent homicide was no longer accused. Nevertheless, wrongful medical certification in very many cases was still suspected. Wrongful medical certification is a case of prosecutable charge. German law impends up to 2 years jail sentence in such cases. A criminal trial was opened. **CASE PRESENTATION:** All medical files of the AME were sequestrated and given to an expert witness by the prosecutor. Many files, a 3 digit number, looked suspicious. 117 of those cases were taken to court. Examples of accused cases were (aeromedical certificate given regardless of): malign arrythmia with ICD implantation; brain infarction, arteria carotis bypass, prostate melanoma; and insulin treated diabetes type 1. The prosecutor considered it to be telltale that some of the AME's customers came from afar to his office. Medical confidentiality ends in conjunction with a criminal trial. All accused cases where read aloud at court, following the code of criminal procedure. The court sentenced the AME to 1-1/2 years in jail on probation, which he immediately appealed. The appellate court confirmed the former decision in principal, but reduced the sentence to 1 year on probation. Again the defendant appealed to the higher court, who disallowed the petition. Following this, the sentence became effective. **DISCUSSION:** Criminal accusations of physicians of wrongful medical certifications are rare cases. But AMEs must be aware that correct work in this field of medical practice is particularly enforced by penalty.

Learning Objective

1. The audience will learn about the judicial consequences against an Aeromedical Examiner who granted wrongful aeromedical certificates

[387] DOES GENETIC OR BODY COMPOSITION FACTORS COULD BE CONSIDERED AS INDICATOR OF 9GZ+ TOLERANCE?

SeungHwan Shin[1]
[1]Korea Air Force Academy, Cheongju, Chungbuk, Republic of Korea

(Original Research)

INTRODUCTION: Korea Air Force Pilot need to pass 9gz+ test for operating F-15/16. In former research, ACTN-3 genotype is related with F-15/16 pilots' 9gz+ tolerance, but, not with cadets' 6gz+ tolerance. It could be inferred by exercise intensity. 9Gz+ tolerance is related with muscle mass and BMR in 30s F-15/16 pilots, but not in 20s. 30s XX type showed dramatic weight decrease compared with 20s cross sectionally. This research was investigate the relations among ACTN-3/ACE genotype, body composition factors and 9gz+ tolerance of novice pilots. it's very interesting for selecting and training pilot(candidates) for their gz+ tolerance and long-term stay in aerospace. **METHODS:** 20 male pilots (age 25.6/IRB:ASMC-17-009) performed actual 9G-test (15sec) voluntarily in Korea Air Force Aeromedical Center with G-suit, L-1 AGSM (Anti-G Straining Maneuver). Breath interval was measured using stopwatch (CASIO) by researcher and body compositions(height(cm), weight(kg), muscle mass (kg), fat (%), BMI(kg/m2)) were measured by BIA device (Inbody720, Biospace, Korea) by professional. ACTN-3/ACE Genotype was analyzed by Hugenbio institute, an authorized agent. G-tolerance(breath interval) by ACTN-3(RR, RX, XX)/ACE(DD, DI, II) was analyzed by One-Way ANOVA. Correlations between gz+ tolerance and body composition factors' was analyzed by SPSS 21.0 (for Windows). **RESULTS:** 20 pilots showed mean values as 175.03(cm), 74.07(kg), 34.09(kg/muscle mass), 18.82(% fat) and 1663.4(Kcal/BMR). ACTN-3's XX and ace's DI genotype showed smallest body weight(69.86 and 68.62kg). In actn-3, RR and RX showed similar, but, in ace, DD showed large differences with II and DD genotype. Among 20 pilots, Actn-3(4RR,11RX, 5XX) and ace(4DD, 6DI, 10II) is analyzed, and 10 pilots are passed in 9gz+ test(Actn-3(1RR,7RX, 2XX) and ace(3DD, 4DI, 3II). Gz+ tolerance is not correlated with body composition factors in 10 passed pilots. **DISCUSSION:** There is no research performed about Gz+ tolerance and plural genetic factor. In Korean novice Pilots in 9gz+ tolerance, 50% is passed. In genetic factors, RX in actn-3 showed 63%, but RR 25%(XX 40%), DD in ace showed 75%, but II 30%(DI 66%) pass rate. It is different with F-15/16 pilots' 9gz+ tolerance in former research, it showed gz+ tolerance RR, XX, RX, sequentially and significance ($p<.05$). This research is pilot study, but in selecting phase, RX(actn-3) and DD(ace) showed highest passing rate is need to be more studied for selecting and training pilots.

Learning Objective

1. Investigate gz+ tolerance could be considered from genetic or body composition factors

[388] INDIVIDUAL-LEVEL FACTORS ASSOCIATED WITH FAILURE OF HYPOBARIC CHAMBER ASSESSMENT FOR OTORHINOLARYNGOLOGICAL CONDITIONS

Tabitha Ang[1], Dominic Tan[1], Bernice, Lin Ying Goh[1], Brian See[1]
[1]*Republic of Singapore Air Force Medical Services, Singapore, Singapore*

(Original Research)

INTRODUCTION: Individuals with otorhinolaryngological conditions may be medically unfit for aircrew vocations due to the increased risk of sinus or middle ear barotrauma. To address this concern, the Republic of Singapore Air Force (RSAF) employs a risk stratification approach for aircrew medical selection based on symptomatology, past medical history and physical examination. Applicants assessed to be at low risk of barotrauma on exposure to pressure are accepted, while those assessed to be at high risk are rejected. Those assessed to be at intermediate risk are required to undergo a hypobaric chamber assessment to evaluate their suitability for aircrew vocations. **METHODS:** This is a retrospective case series of 238 applicants who underwent hypobaric chamber assessments over a five-year period from August 2013 to July 2018. The data was extracted from paper-based medical records held by the RSAF Aeromedical Centre. The following variables were analyzed for any association with hypobaric chamber assessment failure: demographic data; medical history (history of atopy, previous treatments received; and (c) clinical examination findings. **RESULTS:** 43 applicants (18.1%) failed their hypobaric chamber assessments. Of these failed applicants, 22 (51.2%) were for sluggish tympanic membrane movement on Valsalva maneuver, 13 (30.2%) were for absent tympanic membrane movement on Valsalva maneuver, and 6 (14.0%) were referred due to a history of moderate allergic rhinitis. Sub-group analysis among the applicants with bilateral absent tympanic membrane mobility on Valsalva maneuver (n = 131, 21 failures) found a significant correlation between having a deviated nasal septum and failure of hypobaric chamber assessment ($r=0.239$, $p<0.001$). **DISCUSSION:** Aviation regulatory authorities have implemented varying aeromedical guidelines to screen for individuals at risk of barotrauma, with most utilizing clinical history and examinations for risk stratification. Our finding that individuals with absent tympanic membrane movement on Valsalva maneuver and concurrent nasal septum deviation were associated with failure of hypobaric chamber assessment suggests that such applicants should be considered to be at higher risk of barotrauma. Conversely, the absence of any other associations suggests that the RSAF should continue to employ hypobaric chamber assessments for all other medical selection indications.

Learning Objective

1. The audience will learn about the various individual-level factors associated with failure of hypobaric chamber assessment for otorhinolaryngological conditions.

[389] AEROMEDICAL FITNESS ASSESSMENTS IN PILOTS OF REMOTELY PILOTED AIRCRAFT /DRONES

Caron Jander[1]
[1]*Civil Aviation Safety Authority (CASA), Sydney, Australia*

(Education - Program / Process Review Proposal)

BACKGROUND: The Airspace aeromedical professions know is changing as we speak. Internationally there is a mushrooming population of Remotely Piloted Aircraft (RPA) all being operated by 'Pilots'. In Australia alone there are over 13533 RPA license holders. This begs the question as to what medical standards are required, who will assess and regulate the medical examinations. This presentation will present a possible solution and hopefully stimulate hours of collaborative discussion. **OVERVIEW:** Aerospace safety is critical, and as such, ensuring the safe operation of RPA should be a top priority. Recent surveillance in Australia has shown that at times RPA are being operated well out of sight and above 400ft. The inherent requirements of operating RPA may not seem safety critical on the surface however, the environment in which they operate is unpredictable. Just the simple act of misdirection of an RPA could fly it into traffic, powerlines and even surrounding public. We therefore have a duty of care to make sure that RPA are being operated by individuals who have the capacity to do so in a safe manner without discrimination. Several Military organizations have highly technical assessments for Unmanned Aircraft Pilots however; there are not suitable for the general population who fly RPA. The key functions required to operate an RPA relate to hand-eye co-ordination and cognitive function. Depending on the size and type of RPA, the controller may require fine motor co-ordination of the hands and fingers with strength, dexterity and endurance requirements. **DISCUSSION:** I have formulated a Remote Pilot Medical Assessment (RPMA) proposal with a set of Medical Standards which are based on the inherent requirements of safely operating an RPA in a non-military setting. The RPMA standard divides medical conditions into four categories, including: medical conditions which are Acceptable (A), Acceptable with restrictions or accommodations (AR), Deferred (D) requiring further medical information or testing and medical conditions that are Refused (R). This work will be of interest to those professionals planning on conducting assessments of the aeromedical fitness of RPA pilots.

Learning Objectives

1. The participants will become aware of the implications of Medical fitness of Pilots who operate Remotely Piloted Aircraft (RPA).
2. The audience will start to become more aware of the implications of RPA on society and the role that they can play in keeping our skies safe.

[390] WHAT YOU NEED TO KNOW ABOUT THE BALDRIGE EXCELLENCE FRAMEWORK TO SELECT AND TRAIN INDIVIDUALS FOR MAXIMUM PERFORMANCE

Mary Ann Orzech[1]
[1]*Retired U.S. Air Force, Albuquerque, NM, USA*

(Education - Tutorial Proposal)

INTRODUCTION: In order to sustain operational excellence by selecting and training individuals for maximum human performance within aerospace medicine operations, it is critical to understand and evaluate the processes and results using a proven framework. **TOPIC:** Many national organizations use the Baldrige Excellence Framework to improve their processes and attain sustainable results. The Baldrige Framework helps organizations answer three questions about the selection and training of individuals: 1) Is your organization doing as well as it could to select and train the workforce? 2) How do you know? 3) What and how should your organization improve and change? The Baldridge Framework helps organizations explore how they are accomplishing what is important to their mission. The selection and training of individuals for maximum performance is evaluated under the category of workforce. The framework is in the form of questions which leads you through a self-assessment to identify your strengths and opportunities for improvement. The workforce category asks how your organization assesses workforce capability and capacity needs and how you build a workforce environment that is conducive to high performance. The category also asks how your organization engages, manages and develops your workforce to utilize its full potential in alignment with your organization's overall needs. The Baldrige Framework can support aerospace medicine operations to assess and improve their processes for selection and training of flight surgeons. The workforce results category examines your organization's performance and improvement in key areas. This framework can also be used to evaluate processes for better selection and training of individuals for maximum performance both within the aerospace medicine world and other operations that have high-performance demands. **APPLICATION:** How aerospace medicine operational programs can use this proven and systematic framework to evaluate performance will be discussed. In particular, how this framework can be applied to the selection and training of flight surgeons will be presented. **RESOURCE:** Baldrige Performance Excellence Program. 2019. 2019-2020 Baldrige Excellence Framework (Health Care): Proven Leadership and Management Practices for High Performance. Gaithersburg, MD: U.S. Department of Commerce, National Institute of Standards and Technology. https://www.nist.gov/baldrige.

Learning Objectives

1. The audience will be able to understand the components of the Baldrige Excellence Framework.
2. The participants will be able to apply the framework to the aerospace medicine workforce to select and train individuals for maximum performance.

Thursday, 05/21/2020 ***10:00 AM***
Regency 6

[S-73] SLIDE: GLOBAL CONTINUUM OF CARE

Chair: Ann Hoyniak-Becker

[391] AEROMEDICAL EVACUATION LINE OPERATIONS SAFETY AUDIT

Daniel Wyman[1], Stephen Powell[2], Kathleen Flarity[3]
[1]Synensys LLC, Peachtree City, Georgia, United States); [2]Synensys LLC, Peachtree City, Georgia, United States); [3]University of Colorado, Anshultz Medical Campus, Aurora, Colorado, United States

(Education - Program / Process Review Proposal)

BACKGROUND: The Line Operations Safety Audit (LOSA) is a proactive safety assessment process developed by the FAA (2005) and implemented across aviation to improve safety and enhance performance. During normal operations, peer-to-peer observations are conducted using the Threat and Error Management (TEM) framework to collect and analyze LOSA data for trends and opportunities for improvement. USAF Air Mobility Command (AMC) has conducted LOSAs across multiple different aircraft/crew positions. AMC is piloting the first-ever LOSA within the Aeromedical Evacuation (AE) environment. Since 2001, more than 32,000 patients have been transported in the AE system. Today's contingency operations continue to be challenging and require radical innovation as AE professionals seek new and creative ways to improve survival and quality of life for those entrusted to their care. This presentation will describe the stages of AE LOSA and highlight anticipated results. **OVERVIEW**: The AE LOSA began with the formation of a Steering Committee with members from AMC Safety, Operations, Command Surgeon, and AOC and Synensys (LOSA Contractor) to develop the goals and provide project oversight. During the initial TEM development phase, Threats, Errors, and Undesired States (US) are codified into a TEM Matrix. Selected AE nurse/technician total force observers are then trained to conduct AE operational observations using TEM software. These observations are reviewed in real-time for data integrity, then validated via a subject matter expert roundtable. Finally, the aggregated data is analyzed and presented using descriptive techniques, comparisons, and trends. Upon AE LOSA completion, we will determine the prevalence of Threats, Errors, and USs and examine effective management strategies within current USAF AE operations. Additional CRM, fatigue, mission complexity, and AE demographic data will be collected and analyzed. **DISCUSSION**: LOSA is a well documented powerful tool applied by the aviation community to proactively highlight and correct safety and performance issues. Numerous En Route Care forums have identified the need for a better understanding of patient safety within AE operations. An AE LOSA will provide foundational safety management information regarding the Threats, Errors, and USs within USAF AE and assess effective management tactics, techniques, and procedures, thus paving the way for future AE operations in a contested environment.

Learning Objectives

1. The audience will learn about the Line Operational Safety Audit (LOSA) process developed by the FAA in 2005 and implemented across aviation organizations to improve safety and enhance performance and its value as a proactive safety assessment process within Aeromedical Evacuation.
2. The audience will learn about the Threats, Errors and Undesired States within Aeromedical Evacuation operations and Aeromedical Evacuation management strategies.

[392] U.S. ARMY GROUND EVACUATION ENROUTE CRITICAL CARE VALIDATION STUDY

Matthew Davenport[1], Rachel Kinsler[1], Amy Lloyd[1], Sandra Conti[1], Jeffrey Molles[1]
[1]U.S. Army Aeromedical Research Laboratory, Enterprise, AL, United States

(Original Research)

INTRODUCTION: The U.S. Army Medical Materiel Development Activity requested that the U.S. Army Aeromedical Research Laboratory (USAARL) perform test and evaluation of medical ground evacuation vehicle interiors. Previous air ambulance studies have suggested that the vertical separation between litters affects the care-giver's ability to perform medical tasks properly. This study investigated whether or not the limited vertical space (VS) above litters in an M997 ambulance affects the ability of Medics to provide adequate patient care. **METHODS**: USAARL conducted a study of 13 (12 male, 1 female) U.S. Army Ground Medics. Each test participant (TP) wore their Army combat uniform, an Army-issued body armor vest, and combat helmet. Two medical manikins were placed on litters on the top and bottom litter berths of a modified Medium Troop Transport System (MTTS), configured to simulate the interior of an M997. The TPs performed 36 medical tasks per manikin. Retired U.S. Army Medics served as medical validators (MVs) to ensure that the TPs performed all tasks to standard and determine whether the TP passed or failed each task. The VS above the top and bottom litters was limited to 19.5 and 18.5 inches, respectively. If a TP failed a task due to limited space, the VS was increased until the task was completed successfully or the VS limit was reached. Video data taken during testing were analyzed to determine the TPs' use of VS per task at the standard height. Comments and observations from the MVs, TPs, and research technicians were recorded for each task. **RESULTS:** Of the 936 medical tasks evaluated at both standard litter heights, 78.4% were passed, 12.8% were marginally passed, 3.3% were failed due to technique, and 5.4% were failed because of space constraints. The TPs required the entire standard height to perform 33.3 and 13.9% of the tasks on the manikins occupying the top and bottom litters, respectively. Of the tasks failed at standard height, 85.7 and 95.7% of tasks repeated on the top and bottom litter, respectively, were still failed after increasing VS to maximum. **DISCUSSION:** Increasing the VS in the ground ambulance resulted in the failure of fewer medical tasks, though more space would be needed to significantly increase the pass rates. A reconfigured ground ambulance with optimum VS in the patient litter compartments is likely to increase patient survivability when providing medical care during transport.

Learning Objective

1. Determine if experienced Ground Medics are affected by limited vertical space in a U.S. Army M997 ground ambulance while providing patient care.

[393] CONSEQUENCE OF IN-FLIGHT MEDICAL INCIDENTS AFTER LANDING AT TAOYUAN INTERNATIONAL AIRPORT

Chin-Hsiang Lo[1], Shih-Tien Hsu[1]
LLandseed Medical Clinic at Taoyuan International Airport (TIA), Taoyuan, Taiwan

(Original Research)

INTROUDCTION: The amount of air travel is increasing every year, which is accompanied by a rising number of in-flight medical incidents. In-flight medical emergencies can require the patient to be transferred to a hospital or even require emergency diversion of the flight. The aim of this study was to gather data on in-flight medical incidents which required a ground team to stand before landing. **BACKGROUND:** We analyzed emergency medical records from the medical clinic of Taoyuan International Airport (TIA). The records were collected from January 1, 2017, to December 31, 2018. Emergency medical records refer to the records of patients who needed emergency medical services but were unable to reach the airport clinic by themselves. We collected the events in which our medical team received a notification before landing, the medical team stood by at the gate, and there were no changes in destination or diversions. **RESULTS:** TIA handled approximately 91 million passengers and 502,173 flights during the study period. A total of 273 cases were included of this study (2017: 139 cases, 2018: 134 cases). Among those cases, 252 (92.3%) involved passengers, and 21 (7.6%) involved members of the aircraft crew. The top three most commonly diagnosed conditions were gastrointestinal disease (60, 22.0%), neurological disease (53, 19.4%), and trauma (49, 17.9%). Following these emergencies, 132 (48.5%) passengers continued their scheduled trip or went home, 135 (49.4%) were recommended for transfer to the emergency department of a hospital for further care, and 6 (2.1%) died. Although gastrointestinal disease was the most common diagnosis, we

compared the severity according to the rate of emergency department admissions, which suggested that cases of gastrointestinal disease had lower severity than cases of neurological disease (gastrointestinal disease: 16 emergency cases (26%), neurological disease: 41 emergency cases (75.9%)). **DISCUSSION:** As the number of passengers increases, outreach emergency medical services and in-flight medical support are important for maintaining the health of passengers and aircraft crew members. Efforts are being made to improve the effectiveness of airline, aircraft, and medical team cooperation.

Learning Objective

1. The audience will learn about the consequence of in-flight medical incidents after landing at Taoyuan International Airport.

[394] FACTORS AFFECTING MEDICAL INCIDENTS ON-BOARD COMMERCIAL AIRCRAFT, INCLUDING THE USE OF INFLIGHT TELEMETRY/CARDIAC MONITORING DEVICES

Kapil Ojha[1,2], Justin Flatt[2], Michael Harrigan[2], Linda Porter[3], Stephen Houston[2], Ashvini Keshavan[4]
[1]King's College London, London, United Kingdom; [2]British Airways Plc, London, United Kingdom; [3]Virgin Atlantic Airways Ltd., Crawley, United Kingdom); [4]University College London, London, United Kingdom

(Original Research)

INTRODUCTION: 4.3 billion passengers travel by air annually, with medical incidents reported for 1 in every 14,000 passengers. The advent of ground-to-air medical services (GAMS) and inflight telemetry devices (IFTD) aimed to improve passenger safety but few studies have examined their impact on outcomes. **METHODS:** This study examined two large European carriers recording 1,239 medical incidents in 240 million passengers over four years. Databases and flight operation records were reviewed; medical conditions, volunteer healthcare professional (HCP) involvement, GAMS involvement, AED and IFTD use were documented alongside demographic and geographical data. Three outcomes were examined: medical diversion, death on-board and transportation to hospital. **RESULTS:** Carrier A and Carrier B had 1.27 incidents and 46 incidents per million passengers respectively. Multivariate logistic regressions showed AED use was significantly associated with outcomes ($p<0.0001$). Cardiological presentations were associated with less frequent diversion (log odds ratio -2.522) but more frequent transport to hospital (1.330) and were linked to AED use. GAMS involvement was associated with lower odds of death on-board (Carrier A, -7.116) and higher odds of a medical diversion (Carrier B, 1.748). HCP involvement decreased the odds of diversion in Carrier A (-1.939) but increased them in Carrier B (1.913). Geographical sector (in both carriers) and IFTD use (in carrier B) had no significant effect on outcomes. **DISCUSSION:** AED, GAMS and HCP involvement could help carriers mitigate risks associated with medical incidents. Objective physiological data from IFTDs may support flight operations and clinical care but large-scale prospective studies are required to assess efficacy.

Learning Objectives

1. Establish if there are any predictors of major outcomes of a medical incident; namely medical diversion, death on-board or transport to hospital.
2. Establish if there is an association between the involvement of ground-to-air medical services and outcomes.
3. Establish if the use of inflight telemetry devices can influence outcomes.

[395] BENEFITS OF APP-BASED ECG ON BOARD: RESULTS FROM MHEALTH IMPLEMENTATION ON LUFTHANSA'S LONG-HAUL FLEET

Sven-Karsten Peters[1], André Gomola[2]
[1]Deutsche Lufthansa AG, Frankfurt am Main, Germany; [2]Lufthansa Industry Solutions, Raunheim, Germany

(Education - Tutorial Proposal)

INTRODUCTION: This case reports results from Lufthansa after implementing a new App-based, mHealth ECG solution to its "first aid crew process" in May 2019. Cardiovascular conditions amount for 7.7% of all in-flight medical emergencies and 18% of medical diversions in 2013. This trend is expected to more than double in the near future due to the demographic change in air travel and higher purchasing power of the 50+ passenger segment. This encourages airlines to focus on improved medical care and reliable ECG diagnostics on board. However, most available diagnostic technology is too cumbersome and neither cost effective nor easily integrated into existing on-board processes. **TOPIC:** Lufthansa addressed the challenge to improve first aid care for cardiovascular conditions and decision making for medical diversions by implementing a new App-based ECG solution. The system consists of an App on the cabin crew mobile device and a cable with four electrodes, providing a 12-lead ECG. All ECGs are automatically transmitted to ground-based medical support (GBMS) and are stored on backend servers for evaluation and reporting. **APPLICATION:** In 2018 the App-based ECG was piloted on 14 A380 planes followed by a rollout to 110 long-haul planes in May 2019. Lufthansa analyzed all GBMS and crew reports since implementation to evaluate the impact and quality of mHealth on board. Since May 2019, 63 passengers were examined. Major cardiovascular diseases could be excluded in 50% of all cases. During 15 flights the system was used to continuously monitor the heart condition and therefor prevent unwarranted diversions and 5 medical diversions were based on pathological ECG data. Due to the high quality of the 12-lead ECG data (96% of ECGs were evaluable) and the effortless implementation and minimal staff training, Lufthansa was able to increase passenger safety and flight OPS stabilization. The ECG system sees high utilization by cabin crew and integrates seamlessly into existing on board emergency procedures. Lufthansa's experience shows how mHealth can provide high quality medical diagnosis for in-flight first aid crew processes of civil aviation.

Learning Objective

1. The participant will be able to learn about the potential of mHealth used by medical non professionals, providing high quality results for both medical diagnosis and flight ops decision making.

Thursday, 05/21/2020 ***10:00 AM***
Regency 8

[S-74]: SLIDE: SUGAR AND STONES

Chair: Thomas Hoffman

Co-Chair: Michael Harrison

[396] RISK MANAGEMENT OF INSULIN TREATED DIABETIC AIRCREW IN CANADA

Rani Tolton[1], Edward Brook[2]
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(Education - Program / Process Review Proposal)

BACKGROUND: Diabetes mellitus (DM) is increasing throughout the world. In 2015 The Organization for Economic Cooperation and Development (OECD) countries had a prevalence of DM of 7% (93 million) of all adults. In Canada in 2018, 7.1% of the population aged 12 and older (2.24 million people) reported being diagnosed with DM. Five to 10% of people with diabetes in Canada have Insulin Dependent Diabetes Mellitus (IDDM). With the aging pilot and air traffic controller population, the number of aircrew treated with insulin is increasing and this trend is expected to continue. **OVERVIEW:** Many aviation authorities would assess applicants with Insulin Treated Diabetes Mellitus (ITDM) to be unfit with the major issue being the risk of hypoglycemia. Since 1992 Transport Canada has allowed selected ITDM pilots/controllers to safely fly and control aircraft. A risk assessment framework can help guide and identify low risk ITDM applicants. Included in the assessment is the positive attitude of the applicants towards monitoring their health status including glucose levels while flying/controlling. A comprehensive assessment assists in mitigating any adverse effects to flight safety. **DISCUSSION:** This presentation will describe the ITDM risk assessment process, including key factors that must be considered to ensure flight safety. It will also describe how technology is assisting pilots/controllers in preventing hypoglycemia. Updated data on ITDM applicants will also be presented including information on Canada's

recent decision to allow *ab initio* ITDM applicants to progress to Class I medical certificates.

Learning Objective

1. The audience will learn the risk assessment process for selection and monitoring used to allow applicants with insulin treated diabetes mellitus to safely fly or control aircraft in Canada.

[397] THE BRITISH, IRISH AND AUSTRIAN JOINT PROTOCOL FOR THE CERTIFICATION OF PILOTS WITH INSULIN-TREATED DIABETES: RESULTS SO FAR

Ewan Hutchison[1], Gillian Garden[2], Julia Hine[2], Tom Gaffney[3], Veronika Hofmann[4], Stuart Mitchell[1], Gerd Koehler[5], Graham Roberts[6], David Russell-Jones[2]

[1]UK Civil Aviation Authority, Crawley, United Kingdom; [2]University of Surrey, Guildford, United Kingdom; [3]Irish Aviation Authority, Dublin, Ireland; [4]Austrocontrol, Vienna, Austria; [5]Medical University of Graz, Graz, Austria; [6]CRF-C University College Cork, Cork, Ireland

(Original Research)

INTRODUCTION: The UK Civil Aviation Authority (CAA), Irish Aviation Authority (IAA) and Austrocontrol are issuing EU Class 1 and 2 medical certificates to applicants with insulin treated diabetes mellitus. Pilots in the protocol are subjected to regular oversight, including review of each blood glucose measurement made pre-flight and in-flight. Data from blood glucose measurements has been reviewed to evaluate the performance and safety of the protocol. The protocol includes a traffic-light system for determining whether and what further action is required following measurement of blood glucose. **METHODS:** Clinical details, pre-flight and in-flight blood glucose monitoring values and information from flight log books were correlated against the traffic light system of "Green" (5-15mmol/l), "Amber" (low 4-5 and high 15-20mmol/l), and "Red" (low <4 or high >20mmol/l) ranges. **RESULTS:** 42 pilots (24 class 1, 18 class 2), average age 45, (86% type 1, 14% type 2) were studied. The average HbA1c pre-certification was 55.3mmol/mol and following certification (average 5 years) 55.1mmol/mol. 24823 pre-flight and in-flight blood glucose monitoring values have been recorded. Overall 24226 (97.59%) of blood glucose readings were within the 'green' range. 382 (1.54%) in the low 'amber' range, 180 (0.73%) in the high 'amber' range. 29 (0.12%) readings were in the low 'red' range (22 pre-flight; 7 in-flight) and 6 (0.02%) in the high 'red' range (3 pre-flight; 3 in-flight). There have been no pilot incapacitations due to low or high blood glucose and no deterioration in individuals' diabetes control. **DISCUSSION:** The Diabetes protocol that enables the UK CAA, IAA and Austrocontrol to issue medical certificates to pilots with insulin treated diabetes continues to operate with no reported safety events or adverse health effects.

Learning Objectives

1. The audience will learn about the protocol used by the UK CAA, Irish Aviation Authority and Austrocontrol for the aeromedical certification of insulin treated diabetic pilots.
2. The audience will learn about the findings of an audit of blood glucose measurements recorded as part of the protocol.

[398] HYDRATION AND BLADDER RELIEF IN MICROGRAVITY

Mark Plante[1]

[1]University of Vermont, Burlington, VT, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Maintenance and optimization of aircrews' physiologic state remains of paramount importance both in military and space theatre. Given both technologic advances and demographic evolution, both the requirements and the diversity of the aircrews has expanded. Hydration, and in turn, management of bladder evacuation, are well known to be very important and central themes to ensure optimal human performance. **OVERVIEW:** Homeostasis, as relates to one's absolute need to remain normally hydrated, has the resultant consequence of normal renal blood flow and urine production. Efforts to reduce or eliminate urine production by way of dehydration are doomed to fail given renal blood flow and urine production are maintained in all but more severe hypovolemic states. Also well established, by way of controlled trials, is that both mild and moderate degrees of dehydration can measurably reduce G-force tolerance and overall performance. Adding to this are the fact that both military and space aircrew diversity and the flight times required of them have increased significantly. The maintenance of high function in theatre dictates that the physiologic life support community be left to address pilot needs for hydration both before and during flight as well as the need for management of the resultant urinary production and, in turn, the need for its evacuation. **DISCUSSION:** Increasing integration of mechanistic solutions for pilot hydration in theatre as well as bladder waste management have seen a paradigm shift in recent years with the advent of important technological advances. Related to urinary evacuation, personalized urinary collection garments, self priming automated pumps, and secure connectors to allow for safe and reliable transmittal of fluids across the closed suit environment to the exterior represent some of the important advances central to ensuring optimization of aircrew comfort and safety.

Learning Objectives

1. The audience will learn how bladder evacuation devices optimize aircrew flight safety, comfort and human performance.
2. The audience will learn about the importance of hydration before and during flight to maintain maximal performance.

[399] EFFECTS OF AN 11-HR SIMULATED FIGHTER MISSION ON FLUID BALANCE, G-TOLERANCE, COGNITIVE PERFORMANCE, AND COMFORT

Mikael Gronkvist[1], Ola Eiken[1], Eduardo Rosa[2], Johan Willander[2], Roger Kolegard[1]

[1]Royal Institute of Technology (KTH), Stockholm, Sweden; [2]University of Gavle, Gavle, Sweden

(Original Research)

INTRODUCTION: Modern fighter aircraft with in-flight refueling capacity enable long-duration flight missions. The aim was to investigate the effects of an 11-hr simulated flight mission (FM) on comfort and physical and cognitive functions. **METHODS:** 12 subjects performed a simulated patrol mission in a dynamic flight simulator (DFS) with a gondola mock-up of the Swedish fighter 39 Gripen. Each subject was wearing complete pilot personal equipment and was provided with 1.5 L of drinking water and 6 protein/energy bars. The DFS was standing still throughout the test, apart from the first and last 45 min during which it was spinning for determination of the subjects' relaxed G-tolerance with and without anti-G suit (AGS), as well as his/her spatial orientation in terms of ability to perceive roll tilt during a simulated coordinated turn without visual cues. Every second hour, the subject performed cognitive tests and rated sleepiness, fatigue, and discomfort. Urine was collected throughout and venous blood was sampled before and after the FM, for assessment of fluid balance. **RESULTS:** One subject discontinued prematurely due to urinary retention. FM caused a 5% reduction in plasma volume and reduced G-tolerance without AGS by14%. FM did not affect spatial orientation nor cognitive functions, apart from a 10-15% increase in reaction time about seven hours in to the mission, coinciding with a higher rating in fatigue. FM caused moderate discomfort in the lower back and buttocks. **CONCLUSION:** It seems feasible to perform an eleven-hour flight mission in a fighter with only minor reductions of physical and cognitive performance.

Learning Objective

1. The audience will get an insight in the physiological and cognitive effects of an 11-hr long flight mission in a single seat fighter.

[400] ESTABLISHMENT AND STANDARD DISCUSSION OF AEROMEDICAL CERTIFICATION SYSTEM FOR SUSPECTED RENAL CALYCEAL CALCULI IN CIVIL AVIATION PILOTS

Liang Cui[1], Jingmin Li[1], Xun Zhang[1], Wei Zhou[1], Ying Xiong[1], Qing Wang[1], Haifeng Zhu[1]

[1]Civil Aviation Medicine Center of China, Beijing, China

(Original Research)

OBJECTIVE: This prospective study was performed to evaluate diagnostic value of diuresis ultrasound, CTU (enhanced CT of urologic system) and flexible ureteroscopy in civil aviation pilots with renal caliceal calculi. We present new aeromedical diagnosis system, procedures and norms about civil aviation pilots with renal caliceal calculi. We proposed

to amend the aeromedical certification standard about renal caliceal calculi. **METHODS:** To analyze the clinical data of 316 civil aviation pilots with renal caliceal calculi, who was diagnosed and treated from May 2013 to Oct 2019 in General Hospital of CAAC. **RESULTS:** 316 civil aviation pilots with renal caliceal calculi underwent diuresis ultrasound, CTU and metabolic evaluation. Among them, 252 cases (79.8%, 252/316) underwent Flexible ureteroscopy, 239 cases (94.8%, 239/252) were confirmed to be calyceal calculi and removed, and 13 cases (5.6%, 13/252) were not calculi. Combined with preoperative examination and intraoperative findings, 5 cases (2.0%, 5/252) were considered to be diverticular calculi, and 8 cases (3.2%, 8/252) were renal papillary calcification. All of the above patients passed physical examination after operation, and the conclusion was satisfactory, all are allowed to fly. 64 cases (20.2%, 64/316) did not receive flexible ureteroscopy, of which 8 cases (12.5%, 8 / 64) were treated with conservative stone removal (oral medicine, extracorporeal lithotripsy), 10 cases (15.6%, 10 / 64) were confirmed as asymptomatic diverticulum stones by examination, and 20 cases (31.3%, 20 / 64) were special authorized to fly. 26 cases (40.6%, 26 / 64) were excluded from the possibility of calyceal calculi by systematic examination and passed the physical examination directly. **CONCLUSION:** We suggest to establish new diagnostic aeromedical examination system about civil aviation pilots with renal caliceal calculi. Diuresis ultrasound and CTU can be as diagnostic standard. But flexible ureteroscopy is "Golden standard" to make differential diagnosis of suspected renal caliceal calculi of civil aviation pilots. Under the premise of ensuring the safety of flight, the aeromedical certification standard of civil aviation pilots with renal caliceal calculi should to be further refine.

Learning Objectives

1. The participant will be able to evaluate diagnostic value of diuresis ultrasound, CTU and flexible ureteroscopy in civil aviation pilots with renal caliceal calculi. We present new aeromedical diagnosis system, procedures and norms about renal caliceal calculi. We proposed to amend the aeromedical certification standard about renal caliceal calculi.
2. The audience will learn about diuresis ultrasound and CTU can be as diagnostic standard. But flexible ureteroscopy is "Golden standard" to make differential diagnosis of suspected renal caliceal calculi of civil aviation pilots. The aeromedical certification standard of civil aviation pilots with renal caliceal calculi should to be further refine.

[401] AEROMEDICAL DECISION MAKING: RETAINED RENAL CALCULI

Sri Hari Enakal[1], Yashvir Dahiya[1], Sneha Dinakar[1]
[1]Institute of Aerospace Medicine, Bangalore, India

(Original Research)

INTRODUCTION: Nephrolithiasis in aircrew can cause sudden incapacitation in flight and the pilots are assessed unfit for flying till the aviators are completely stone free. The calculi in renal parenchyma, renal cyst, or calyceal diverticulum which are long standing, stable and retained have minimal possibility of migrating into the collecting system thus having a remote chance of causing sudden incapacitation in flight. However, there is dilemma on disposal of such pilots due to the following challenges: Duration to be observed before assessing fit for flying; Imaging studies required and its frequency to assess the size and position of calculi; Metabolic and renal function tests and its frequency; Aeromedical evaluation by exposure to high G forces and vibration stress. **METHODS:** A case (Fighter pilot) of retained renal calculi was followed up for a duration of 24 months and aeromedical evaluation policies of different countries were analyzed. **DISCUSSION:** This paper shows the challenges faced in ADM of pilots with stable retained renal calculi and outlines the role of Renal Stone Risk assessment index score and the average mean values of the solutes in 24 hr urine collection, imaging studies and the aeromedical evaluation in assessing the aircrew for flying.

Learning Objectives

1. The participants will understand the role of Renal Stone Risk assessment index score in evaluating the aircrew with impacted or long standing retained renal calculi and thus helps in Aeromedical Decision making of such aircrew by Aerospace Medicine Specialists.
2. The participants will understand the role of Average mean values of the solutes in 24 hr urine collection and correlation with the imaging studies in evaluating the aircrew with impacted or retained renal calculi in the Aeromedical Decision making of aircrew by Aerospace Medicine Specialists.
3. The participants will understand the role of aeromedical evaluation by High Performance human centrifuge and Vibration simulator platform in evaluating the aircrew with impacted or retained renal calculi which plays a pivotal role in the Aeromedical Decision and insight into the aeromedical policies of different countries.

Thursday, 05/21/2020 ***1:30 PM***
Centennial I

[S-75]: PANEL: CHALLENGING CASES AND AEROMEDICAL DISPOSITIONS FROM THE U.S. NAVAL AEROSPACE MEDICAL INSTITUTE (NAMI)

Sponsored by Society of US Naval Flight Surgeons

Chair: Kimberly Everett

PANEL OVERVIEW: This panel represents a select group of challenging cases and aeromedical dispositions from the Naval Aerospace Medical Institute (NAMI). NAMI is the center of excellence for Navy aerospace medicine and handles all initial flight physicals and aeromedical dispositions for the Navy and Marine Corps. This multidisciplinary panel will focus on cases that have forced us to confront and reevaluate our waiver guide due to changes in technology, treatment, or underlying epidemiology. Case 1 will highlight the complex disposition of an asymptomatic pilot who had a screening CT-angiogram performed and subsequent stenting, challenging our historical denial of post-stent aviators to fly in single seat aircraft. Case 2 concerns the case of a pilot with back pain who went abroad for a non-FDA approved multilevel artificial disk replacement with an excellent outcome and wished to return to flying status. Case 3 pertains to an enlisted aircrew with a diagnosis of acute eosinophilic pneumonia after starting smoking whom continued to vape despite medical recommendations, and will address changing epidemiology of e-cigarette use in our population. Case 4 will discuss an aviator with malignant melanoma and aeromedical challenges related to the morbidities associated with the advances in treatment. Case 5 will highlight advances in refractive surgery with newer techniques that have not been well studied in aviation.

[402] CARDIAC COMPUTED TOMOGRAPHIC ANGIOGRAPHY (CTA) SCREENING IN THE ASYMPTOMATIC NAVAL AVIATOR: CASE STUDY AND IMPLICATIONS FOR FUTURE APPLICATIONS

Roderick Borgie[1], Gil Boswell[2], Anthony Choi[2]
[1]Commander Naval Air Forces Reserve, Coronado, CA, USA; [2]Naval Medical Center San Diego, San Diego, CA, USA

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This novel case presents the unique disposition challenges of screening for Coronary Artery Disease (CAD) in asymptomatic individuals with risk factors. A senior naval aviator underwent screening cardiac CTA with significant findings eventually resulting in stent placement. **BACKGROUND:** Atherosclerotic coronary artery disease is well known to the aviation community. Standard protocol to address this pathology has been in identification and modification of risk factors predisposing to heart disease. Typically, screening can include questionnaires and identifying co-morbities (DM and HTN), as well as various screening tests for symptoms to include stress test utilizing EKG, echocardiogram, and nuclear medicine. Newer technologies such as cardiac CTA offer a new modality to identify disease in asymptomatic individuals. Disposition of these individuals may need different consideration than traditionally used. **CASE PRESENTATION:** 50 y/o male Naval Aviator (single seat F/A-18 Hornet) with 3800 hours presented for annual flight physical. Patient had waivers previously granted for Atrioventricular Nodal Reentrant Tachycardia status post ablation, hypertension controlled with lisinopril, and gastroesophageal reflux disease. The examination revealed cardiac risk factors of mother with myocardial infarct in her 50's and significant oral tobacco use that was previously undisclosed. In addition to the usual age appropriate health screenings, such as colonoscopy, a cardiac CTA was performed which showed significant 3 vessel calcified and non-calcified CAD with >75% stenotic lesion of proximal left anterior descending (LAD) artery.

A follow on stress echocardiogram was normal. Cardiology performed cardiac catheterization which confirmed the lesion on CTA and patient elected for percutaneous coronary intervention (PCI) with stent placement. The patient tolerated the procedure well and noted improved exercise tolerance. The patient quit tobacco and did standard post stent medical therapy. A 6 month post stent stress echo remained normal. Member was granted waiver to Service Group III (dual pilot). **DISCUSSION:** This case is significant in that the Navy does not traditionally waiver patients post stent placement to Service Group I status in single seat. This case challenges the historical disposition and argues for updated criteria regarding flight status as new technology can improve detection leading to earlier treatment and improved risk mitigation.

Learning Objectives

1. The audience will learn about factors leading to the aeromedical dispositions of aviators who have undergone stenting.
2. Gain a better understanding of the role of cardiac CTA in identifying coronary artery disease and other screening benefits.

[403] AEROMEDICAL DISPOSITION OF HEAD AND NECK MELANOMA

George Conley[1]
[1]*U.S. Naval Aerospace Medical Institute, Pensacola, FL, USA*

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This case describes the medical management of a military pilot with facial melanoma. In particular, it focuses on the aeromedical considerations regarding fitness for flying duty and how this disposition evolves as a result of latent treatment morbidity. **BACKGROUND:** Malignant melanoma is the sixth most common cancer in the USA with approximately 25-30% of melanomas located in the head and neck region. The incidence of malignant melanoma has recently increased with head and neck sites having the worst prognosis. Due to the aggressive nature of head and neck melanoma, management is typically more aggressive and higher morbidity should be anticipated as a major determinant for aeromedical disposition. **CASE PRESENTATION:** A 33 year old active duty USN F-18 pilot identified a small, inflamed, non-pigmented left cheek lesion that was present for several months. A shave biopsy determined a 2.8mm melanoma from skin surface to involved deep margin. He was treated via a wide local excision (WLE) of the melanoma along with a sentinel lymph node biopsy demonstrating 2 positive nodes. Next, he had a left parotidectomy and neck dissection that was negative for malignancy. His defect was reconstructed using a left supraclavicular island flap and he was classified as having AJCC stage IIIc (pT3N2a) melanoma. After receiving 7 months of interferon, an in-transit metastases was found along the flap margin. This led to a second WLE biopsy, 48 Gy of adjuvant radiation, and concomitant immunotherapy with ipilumab. He remained in remission for 5+ years and resumed flying without event. Throughout his recovery, morbidity was primarily related to his surgical and radiation therapy. Surgical scarring and radiation fibrosis led to neck discomfort requiring extensive physical therapy. Radiation induced mucosal changes of his sinuses required surgical intervention and daily irrigations to improve function and prevent barotrauma. **DISCUSSION:** This case reviews the complex medical management for advanced staged (AJCC IIIC) head and neck melanoma. It highlights the aeromedical concerns related to treatment of a common malignancy. Although this patient had over 5 years of tumor free surveillance, treatment sequela dominated his recovery and aeromedical disposition. The presentation will illustrate the importance of managing treatment associated morbidity and its significant impact on fitness for flying.

Learning Objective

1. The audience will learn about the unique management considerations of head and neck melanoma and be able to predict potential aeromedical consequences for common therapies used to treat head and neck malignancy.

[404] NAVAL AVIATION WAIVER GUIDELINE UPDATES FOR SMALL INCISION LENTICULE EXTRACTION AND IMPLANTABLE COLLAMER LENSES

Amanda Jimenez Myers[1], Matt Rings[1], Kevin McGowan[1]
[1]*Naval Aeromedical Institute, Pensacola, FL, USA*

(Education - Case Study: Clinical / Human Performance)

BACKGROUND: Eliminating dependence on spectacles or contact lenses through corneal refractive surgery has become an increasingly common practice in Naval Aviation. Newer refractive surgery options such as Small Incision Lenticule Extraction (SmILE) as well as Implantable Collamer Lenses will continue to be evaluated for safety, efficacy, and long term stability in Naval Aviators. **CASE PRESENTATION:** The first case describes a 27-year-old Marine Corps Officer Candidate who underwent SMILE corneal refractive surgery, and met visual standards post-surgery to become a qualified Student Naval Aviator. The other case discusses a 31-year-old designated Flight Surgeon who received bilateral Intraocular Collamer Lens implants and was able to return to flight status with a waiver as a Class II Naval Flight Surgeon. **DISCUSSION:** Refractive surgery (LASIK/PRK) has been extensively studied in the aviation environment and has yielded highly satisfying results for vision, comfort, and performance. While these options for refractive surgery are still the cornerstone for Naval Aviation, new technologies and techniques are ever evolving in the refractive surgery world. SmILE has become an attractive refractive surgery option compared to LASIK with the biggest advantage being the lack of a flap. The small corneal incision eliminates flap dislocation potential, decreases dry eye symptoms, and creates a larger optical zones which improves night vision results, with very little pain. Studies have shown that SmILE has as high quality of vision with fewer aberrations than wavefront guided LASIK, and long-term stability in high myopia is improved. ICLs have become increasingly popular over the last ten years. For patients with very high myopia or thin corneas who cannot undergo LASIK or PRK, the ICL is a viable surgical option. Other advantages of having an ICL implant over corneal refractive surgery are fewer dry eye symptoms, ultraviolet protection from the lens, fewer distortions, haloes, and less sensitivity to lights especially at night, and lastly, it is reversible if necessary. As new refractive surgery techniques are introduced, evaluating safety, long term efficacy, and overall vision outcomes will be paramount when considering updates to the Naval aeromedical policy and waiver guidance.

Learning Objective

1. Understand Naval Aviation Refractive Surgery waiver guidelines for Small Incision Lenticule Extraction and Implantable Collamer Lenses.

[405] A CASE OF ACUTE EOSINOPHILIC PNEUMONIA IN A NAVAL AIRCREW

Kimberly Everett[1], James McNicholas[1]
[1]*Naval Aerospace Medical Institute, Pensacola, FL, USA*

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This case report describes a military aircrew who experienced acute eosinophilic pneumonia (AEP) ten days after starting to smoke menthol cigarettes. **BACKGROUND:** AEP is a rare type of pulmonary eosinophilia that has been associated with inhalation of various toxins, including changes in smoking habits. Diagnosis is based on an acute onset febrile respiratory disease with bilateral infiltrates on chest X-ray, hypoxemia, pulmonary eosinophilia, and an absence of other causes of pneumonia. Steroids and supportive care are the principal components of treatment. Some patients with smoking-related AEP avoid recurrence if they continue smoking, however they may still be at increased risk especially with any change to their smoking status. **CASE PRESENTATION:** The subject is a 24-year old female Naval Aircrew who experienced acute onset of dyspnea and pleuritic chest pain. She had no known pulmonary history, but was a regular user of e-cigarettes and had started smoking menthol cigarettes 10 days prior to the episode. She had a witnessed syncopal event and was taken to Naval Hospital Okinawa, where she was found to be tachypneic, tachycardic and hypoxemic. Her CT chest demonstrated bilateral patchy peripheral consolidation, ground glass opacities, and small bilateral pleural effusions. Bronchoalveolar lavage revealed 51% eosinophils. She was diagnosed with acute eosinophilic pneumonia. The patient improved over the course of several days with steroids and antibiotics. She was advised to never smoke or vape again as this could precipitate another episode. The patient applied for a waiver to return to flight status, however notes reveal that she is still using e-cigarettes. **DISCUSSION:** This case highlights the diagnosis of AEP, a rare cause of pulmonary distress in otherwise healthy patients. The aeromedical disposition of this patient is challenging, as her symptoms from her acute event have resolved, but she continues to smoke

e-cigarettes despite medical recommendations to stop. Additionally, her work environment as aircrew may at times involve exposure to smoke or fumes. Although many patients do not have recurrence, AEP is poorly understood, so long-term prognosis with continued exposure to the inciting agent is difficult to determine. In this case, the patient is currently being denied a waiver to continue flying until she demonstrates abstinence from vaping.

Learning Objectives

1. The audience will learn about the presenting symptoms of acute eosinophilic pneumonia.
2. The audience will learn about the aeromedical concerns after a resolved case of acute eosinophilic pneumonia.

[406] MULTILEVEL ARTIFICIAL DISC REPLACEMENT IN A NAVAL AVIATOR

Jeremy McCullough[1], Peter Kovats[1]
[1]*Naval Aerospace Medical Institute, Pensacola, FL, USA*

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: The scope of this case is to discuss the aeromedical implications of a multilevel artificial disc replacement (ADR), also referred to as a total disc replacement in some literature. **BACKGROUND:** Low back pain is an extraordinarily common reason for patients to present to primary care. In fact, multiple sources have estimated the lifetime prevalence of low back pain from 85% to 89%, with 25% having chronic symptoms, and 10% that are disabled. The vast majority of low back pain will resolve without treatment or further intervention. However, some patients will continue to experience pain symptoms and surgical interventions have been increasing in the USA over the past decade. **CASE PRESENTATION:** This case involves a 38-year-old male C-130J pilot with 1900 flight hours and no pertinent past medical history. He had an acute episode of low back pain in 2001 without clear mechanism of injury. The patient was treated conservatively and was doing well until a fall from an aircraft in 2011, which left him with chronic low back pain. He continued conservative treatment with NSAIDs and chiropractic care until 2017, when he endorsed radicular symptoms. An MRI demonstrated "multi-level degenerative changes, most pronounced at L5-S1 level, mild canal narrowing." The patient was evaluated by a spine surgeon with a recommendation of continued conservative treatment with the discussion of surgical options of anterior lumbar interbody fusion or a posterior lumbar interbody fusion. However, the patient did not wish to undergo a spinal fusion procedure and instead travelled to Germany for a double artificial disc replacement (L4 & L5). His surgery and recovery were uncomplicated and the patient reported a marked improvement is his quality of life with no pain or radicular symptoms following surgery. **DISCUSSION:** There are no active duty military aviators with a multilevel ADR, nor has the FAA granted a special issuance for such a procedure. While the artificial disc device is FDA approved, only a single level replacement is approved in the USA. Multilevel ADRs are more commonly performed in Europe. A Special Board of Flight Surgeons (SBFS) was convened to disposition the case. Factors that the board considered were his non-ejection seat aircraft platform, excellent surgical outcome, and the limited data available on device failure. Ultimately the SBFS approved a waiver to return to flight duties with annual follow up.

Learning Objective

1. The scope of this case is to discuss the aeromedical implications of a multilevel artificial disc replacement (ADR), also referred to as a total disc replacement in some literature

Thursday, 05/21/2020 ***1:30 PM***
Centennial II

[S-76]: SLIDE: PHYZ TRAINING: BACK TO THE FUTURE

Chair: Nereyda Sevilla

Co-Chair: Emmanuel Urquieta

[407] PHYSIOLOGICAL EPISODE RECOGNITION AND RECOVERY TRAINING (PERRT) IN ROYAL AUSTRALIAN AIR FORCE ABINITIO PILOTS TRAINEES

David Emonson[1], Gordon Cable[2]
[1]*Royal Australian Air Force, RAAF Base East Sale, Victoria, Australia;* [2]*Royal Australian Air Force, RAAF Edinburgh, South Australia, Australia*

(Education - Tutorial Proposal)

INTRODUCTION. This paper is the first of two papers which will describe the evolution of simple hypobaric chamber based hypoxia recognition training which has been practiced in the RAAF since 1941, to the current sequential continuum of Physiological Episode Recognition and Recovery Training (PERRT). **TOPIC:** Physiological Episode Recognition and Recovery Training (PERRT) in Royal Australian Air Force abinitio pilots trainees. **APPLICATION:** Under the new PERRT training paradigm, abinitio aircrew in ground school, are initially provided instruction on hypoxia and its threats in the aviation environment; before being exposed to a controlled normboaric hypoxic experience with the intention that students recognise their individual and reproducible symptoms of hypoxia. Subsequently, in the early weeks of actual flight training, students are again exposed to normobaric hypoxia, this time whilst manipulating a moderate fidelity flight-training device. On the second occasion, students recognise hypoxia based on their previous recognition training experience and implement basic checklist driven response actions. Some weeks later, and prior to going SOLO, students are again exposed to normbaric hypoxia, but this time in a more complex operational context. Using hypoxia as an analogue of a physiological event, students are expected to identify the possibility of a PE and react accordingly; whether the event results from simulated engine failure, OBOGS failure, smoke and fumes or other circumstances. In the simulated environment students are able to develop airmanship skills as checklist responses drive decisions beyond initial hypoxia IAs, though exhaustion of EO supply to the ejection decision. PERRT training as component of abinitio flight training will form the foundation of further physiological event training in future operational flight systems.

Learning Objective

1. To describe the process and objectives of Physiological Recognition and Recovery Training as practiced in the Royal Australian Air Force with respect to abinitio military pilot trainees.

[408] PHYSIOLOGICAL EPISODE RECOGNITION AND RECOVERY TRAINING IN ROYAL AUSTRALIAN AIR FORCE F/A-18F AND EA-18G AIRCREW

Gregory Hampson[1], Adrian Smith[2]
[1]*Royal Australian Air Force, Amberley, Australia;* [2]*Royal Australian Air Force, Adelaide, Australia*

(Education - Program / Process Review Proposal)

BACKGROUND: Royal Australian Air Force 82WG F/A-18F and EA-18G aircrew experience in flight physiological episodes (PE) similar to the USN. Historic training, academic and practical did not optimally prepare aircew for the range of PEs experienced in these modern high performance aircraft. Aircrew confidence and ability was not enhanced by the standard 25,000 ft. equivalent hypoxia awareness training. **OVERVIEW:** This presentation will outline the evolving PE(hypoxia induced) recognition and recovery training, PERRT (aka Hypoxia RRT) and reflect on an airborne physiological episode to highlight aircrew confidence and management of airborne PE post PERRT. **DISCUSSION:** 82WG in collaboration with the RAAF Insitute of Aviation Medicine (IAM) sought to enhance aircrew training to mitigate the flight safety risk posed by PEs. This has evolved over a seven year period to the current high fidelity PERRT system implemented in the F/A-18F, EA-18G full tactical flight trainer (TOFT) during realistic operational mission training. By using hypoxia as an analogue of a physiological episode, PERRT facilitates recognition of degraded performance by aircrew while operating their platform in a realistic operational environment. It reinforces consideration of symptoms and facilitates positive communication between crew so that both are optimally involved in recognition of a PE and institution of appropriate recovery actions. PERRT rehearses optimal recovery techniques including; emergency oxygen, control of the rate and deptyh of breathing (RAAF Aicrew Controlled Breathing

Cycle ACBC) and allowance of time for recovery. "Flying" the aircraft during PE recognition and recovery allows aircew to practice airmanship in complex emergencies, including simulation of exhaustion of emergency oxygen supply and execution of further checklist actions to safely recover the aircraft. The presentation will review the experience of RAAF aircrew involved in PE events during 2019 and their subsequent consideration of the PERRT program. PERRT is now mandatory annual training requirement for all 82 WG aircrew. PERRT has recently been introduced at number 1 Flying Traing School (abinitio students flying PC-21 aircfrat), in a phased in approach which first teaches hypoxia awarenss before introducing recovery responses in increasing complex simulated environment. In time it is expected that RAAF aircrew will undergo a continnum of PERRT training regularly throughout their military flying careeer.

Learning Objectives

1. The audience will learn about the evolution of physiological episode recognition and recovery training (PERRT) to a physiologically credible, platform specific and operationally relevent training system, that is used to mitigate organisational risk and improve aircrew confidence and performance.
2. The audinece will learn of PE aircrew reflections on the PERRT program following managing an airborne PE (post PERRT).

[409] ENGAGING NON-PILOT AIRCREW IN THE NORMOBARIC HYPOXIA TRAINING SYSTEM

Brennan Cox[1], John Milne[2], Clay Greunke[2], Lee Sciarini[3]
[1]Naval Postgraduate School, Monterey, CA, USA; [2]Air Test and Evaluation Squadron (VX) 1, Patuxent River, MD, USA; [3]Naval Survival Training Institute, Pensacola, FL, USA

(Original Research)

INTRODUCTION: Normobaric hypoxia trainers (NHTs) are replacing the decommissioned low pressure chambers at the eight Naval Aviation Survival Training Centers (ASTCs). Capable of simultaneously training four pilots and six aircrew members, the NHT will close a critical gap in the Naval Aviation Survival Training Program for Class 2/4 aviators. As delivered, the NHT uses a commercially-available flight simulator to engage pilots undergoing training. However, the NHT was not delivered with operationally-relevant tasking for non-pilot aircrew. Using principles of instructional system design and the systems approach to training, this study identified specific tasks performed by aircrew to integrate into the training system. **METHODS:** A front end analysis identified 61 knowledge, skills and abilities (KSAs) required by Class 2/4 aircrew in the conduct of their work. Based on these KSAs, separate surveys were developed and administered to Class 2/4 aircrew and aeromedical experts. For the aircrew survey, respondents rated the frequency and importance of each KSA; for the aeromedical survey, respondents rated the degree to which each KSA is susceptible to hypoxia. Responses were analyzed to identify those KSAs which rated highly across all three criteria: frequency, importance, and susceptibility to hypoxia. **RESULTS:** Participants included 35 aircrew (17 officers, 16 enlisted, 2 civilian) representing six Class 2/4 platforms, as well as 17 aeromedical experts (9 physiologists, 5 flight surgeons, 2 psychologists, 1 optometrist). Analyses identified 15 primary and 30 secondary KSAs from the combined data sets. Primary KSAs were those that rated highly in all three criteria while secondary KSAs rated highly in two of the three criteria. **DISCUSSION:** Results were delivered to the Modeling, Virtual Environments, and Simulation institute at the Naval Postgraduate School for incorporation into prototype computer-based tasks. These tasks are currently undergoing usability testing with Class 2/4 aircrew and ASTC personnel to evaluate their ease of use, relevance, and level of engagement, among other factors. This process is intended to yield a set of job-relevant, platform and position agonistic distraction tasks to engage non-cockpit aircrew as they undergo hypoxia training in the NHT, comparable to the flight simulation tasks used to engage pilots in the same training system.

Learning Objectives

1. The audience will learn about the systems approach to training within the context of aircrew survival training.
2. The audience will be able to identify job-relevant aircrew skills and abilities that are embedded within a series of computer-based tasks.

[410] A RETURN TO HIGH ALTITUDE TRAINING FOR THE ROYAL CANADIAN AIR FORCE

James Dalebozik[1], Monica Bradley-Kuhn[2]
[1]Canadian Special Operations Forces Command, Ottawa, Ontario, Canada; [2]Royal Canadian Air Force, Ottawa, Ontario, Canada

(Education - Program / Process Review Proposal)

BACKGROUND: The Royal Canadian Air Force (RCAF) ceased hypobaric high altitude training in 2008 with the implementation of the Combined Altitude Depleted Oxygen (CADO) system, and the Reduced Oxygen Breathing Device (ROBD). Currently, all ab initio aircrew receive hypoxia recognition training (HRT) on the CADO system, with a maximum altitude of 10,000 feet. Recertification HRT is delivered with CADO or ground based ROBD system. CADO and ROBD are common training methods for HRT among Allied Nations, and Canada has identified a training gap for RCAF personnel flying unpressurized high altitude missions in support of Special Forces. **OVERVIEW:** The Canadian Special Operations Forces Command (CANSOFCOM) conducts unpressurized airdrop operations above 18,000 feet. In 2016 there was a flight safety incident of suspected hypoxia and decompression sickness (DCS) for two aircrew members. The flight safety investigation initiated a review of the training aircrew receive for performing intentional high altitude unpressurized flight. A multi-disciplinary team conducted a risk/benefit analysis of returning to hypobaric high altitude training, resulting in the return of hypobaric high altitude training for personnel who fly in support of CANSOFCOM missions. **DISCUSSION:** The RCAF offered the first hypobaric high altitude training flight to 25,000 feet in December 2018, and will continue to offer this training to RCAF personnel who fly unpressurized high altitude missions. Canada's return to hypobaric high altitude training is of interest to Allied Nations as it is an aeromedical training course that addresses the purposeful exposure to high altitude training.

Learning Objective

1. The audience will learn how the RCAF train aircrew for the purposeful exposure to high altitude flights, and what oxygen pre-breathing tables are used.

[411] DYNAMIC FLIGHT SIMULATION CENTRIFUGE TRAINING FOR FAST JET AIRCREW

Edwin Loh[1], Brian See[1], Feng Wei Soh[1]
[1]Republic of Singapore Air Force Medical Service, Singapore, Singapore

(Education - Program / Process Review Proposal)

BACKGROUND: Most major military forces provide some form of centrifuge training as part of high-G preparedness programs for their fast jet aircrew with the objective of promoting awareness of the potential for G-LOC, and to train the aircrew members in confidently and effectively executing the Anti-G Straining manoeuvre. With advancements in human centrifuge technology in recent years, Dynamic Flight Simulation (DFS) has been proposed as a more realistic and acceptable mode for high-G exposure in G-preparedness training. **OVERVIEW:** The Republic of Singapore Air Force (RSAF) first introduced centrifuge training for its fast jet aircrew in 1996 to train and validate our aircrew's ability to function under high-G forces without experiencing incapacitating symptoms. To strengthen their G-instincts, the RSAF subsequently rolled out an additional Yearly Operational G-Assessment (YOGA) in the intervening years between the aircrew members' 3-yearly centrifuge qualification sessions. Previously, these YOGA sessions involved 'open-loop' standard profiles that could not be controlled by the aircrew members. More recently in 2018, the RSAF trialled and implemented DFS to enhance the centrifuge training experience of aircrew members undergoing YOGA. A structured questionnaire was administered to all aircrew members who underwent DFS centrifuge training over a 2-year period from January 2018 to December 2019 to collect subjective feedback. Our presentation will outline the RSAF's implementation journey of DFS for centrifuge training, as well as present the survey findings. **DISCUSSION:** Preliminary analysis of the survey results suggest that, when compared to the previous 'open loop' centrifuge training, DFS (1) enhanced training realism, (2) was more acceptable to the aircrew members, and (3) was viewed by aircrew members as providing more effective high-G training.

While the 'tumbling' arising from the Coriolis effect was identified as an area of concern for DFS training, newer centrifuge software algorithms could potentially address this issue.

Learning Objectives

1. To understand the implementation challenges of DFS centrifuge training.
2. To recognize that DFS centrifuge training was assessed by aircrew members to be superior to conventional 'open loop' centrifuge training.

[412] PREVENTING AND TREATING MOTION SICKNESS USING VIRTUAL REALITY

Meg O'Connell[1]
[1]*Monash University, Melbourne, Australia*

(Original Research)

INTRODUCTION: Motion sickness is significant medical issue that has a vast impact on human performance in the aerospace field. Space Motion Sickness is a subset of this that also has an impact on human performance in space. The ability to resist motion sickness may be associated with a level of vestibular development. Lately, Virtual Reality (VR) technology has been proposed and trialed in an attempt to help optimize performance for those suffering from motion sickness and to prevent motion sickness developing. This article aims to review of the current state of progress in the use of VR in preventing and treating motion sickness. **METHODS:** A search of MEDLINE, PUBMED, EMBASE, and Cochrane databases was conducted for studies in English evaluating the use of VR on Motion sickness. The term "VR" "Virtual Reality" and "motion sickness". Two research papers were identified that were included in this study. **RESULTS:** Two studies were found that examined the use of VR for motion sickness. The first eposing subjects pre-flight to variable virtual orientations, and found that training in a vvirtual environment effectively reduced nausea and improved task performance in disorientating surroundings. The second found that when using VR training for motion sickness, trained subjects were less susceptible to motion sickness, with symptom scores reduced by 40% when compared with untrained subjects. **DISCUSSION:** Both studies demonstrated that the use of training in VR had noticeable changes in outcome compared with those that were untrained. It should be mentioned that motion sickness is an illness that can also be treated with the placebo effect, so it maybe possible that the noticed improvement in symptoms was secondary to placebo. AVR can also cause virtual reality induced motion sickness (VIMS) headsets and games can also induce motion sicknes. As VR continues to be developed as a successful preventative and treatment, it has applications beyond aviation, into the hospital emergency department and even the primary care General Practitioners office. **CONCLUSION:** VR have been demonstrated in this review to be an emerging treatment and preventative measure for motion sickness. More research and development must be completed in order to allow this technology to become more optimal. The benefits of a VR treatment modality could be applied to aviation, road travel, ocean travel including cruises, and space tourism.

Learning Objective

1. Understand an emerging technology (VR) and how it can be used as a therapeutic and preventative for motion sickness.

Thursday, 05/21/2020 ***1:30 PM***
Centennial III

[S-77]: PANEL: CURRENT STATE OF KNOWLEDGE: SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME (SANS)

Chair: Tyson Brunstetter

PANEL OVERVIEW: First discovered in 2005, Spaceflight Associated Neuro-ocular Syndrome (SANS; formerly known as "Vision Impairment, Intracranial Pressure" or VIIP) is a condition unique to long-duration spaceflight. SANS is associated with a multitude of signs such as optic disc edema and retinal nerve fiber layer (RNFL) thickening; chorioretinal folds; globe flattening and hyperopic shifts in refractive error; and RNFL infarcts (i.e., cotton wool spots). Other potential signs include optic nerve tortuosity, optic nerve sheath distention, cephalad fluid shift, and lateral ventricle enlargement. However, it is unclear whether or not these signs are truly associated with SANS. While the pathogenesis and pathophysiology of SANS remain elusive, several theories exist. This panel will provide the current state of knowledge in detecting, defining, and diagnosing SANS; present the latest analyses of short- and long-duration crewmember data; and explore factors that may contribute to the generation and mitigation of SANS.

[413] A NEW CASE DEFINITION FRAMEWORK FOR SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME (SANS)

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(Original Research)

INTRODUCTION: Spaceflight Associated Neuro-ocular Syndrome (SANS) is associated with numerous signs; however, the official SANS case definition is limited to the presence of optic disc edema (ODE) as visualized by fundoscopy. While being the standard for terrestrial ODE cases, this protocol relies on subjective interpretation, lacks sensitivity in diagnosing SANS, and ignores other established SANS signs. An updated SANS definition is required to overcome these limitations. **METHODS:** Pre-, in-, and post-flight astronaut ocular data (n=78) were obtained from clinical records and analyzed for SANS signs and symptoms. In addition, SANS subject matter experts (SMEs) were consulted for recommendations on how best to transition towards a more comprehensive, objective-based SANS case definition. **RESULTS:** Four primary signs of SANS—ODE, choroidal folds, globe flattening, and hyperopic shifts in refractive error (RE)—each pose short- and long-term risks to crewmember vision and mission effectiveness. With regard to ODE, reversible visual field (VF) defects have been detected in at least one crewmember following long-duration spaceflight (LDSF). Chronic ODE could potentially induce permanent retinal nerve fiber layer thinning and VF defects similar to glaucoma. Severe, centrally-located choroidal folds could distort vision and reduce best-corrected visual acuity (VA), while chronic choroidal folds could damage overlying retinal pigment epithelial cells and photoreceptors. And finally, globe flattening induces hyperopic RE shifts which can reduce uncorrected VA. Other potential signs include optic nerve tortuosity, optic nerve sheath distention, cephalad fluid shift, and lateral ventricle enlargement; however, it is unclear whether or not these signs are truly associated with SANS. **DISCUSSION:** Based on these results, SANS Clinical and Research SMEs propose a new SANS case definition which is tied to the four primary SANS signs associated with vision/mission risk. That is, SANS would be diagnosed whenever one or more of the following signs are detected in an astronaut: ODE, choroidal folds, globe flattening, or hyperopic RE shifts. Based on this proposed case definition, using current data and diagnostic techniques, SANS has a 36% prevalence rate among LDSF crewmembers. It is expected that this number will change as objective measures are incorporated into the diagnosis (e.g., optical coherence tomography [OCT]).

Learning Objective

1. Understand the limitations of the current case definition of Spaceflight Associated Neuro-ocular Syndrome (SANS), and the rationale for selecting optic disc edema, choroidal folds, globe flattening, and hyperopic refractive error shifts as components of the proposed SANS case definition.

[414] PREVENTION AND MITIGATION STRATEGIES FOR CENTRAL NERVOUS SYSTEM EDEMA: POTENTIAL COUNTERMEASURES FOR SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME?

John Marshall[1], Tyson Brunstetter[2], Charles Gibson[3], William Tarver[4]
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(Original Research)

INTRODUCTION: Long-duration spaceflight is associated with optic nerve head (ONH) edema, globe flattening, hyperopic shifts in refractive error, choroidal and retinal folds, and nerve fiber layer infarction, i.e. cotton wool spots, as demonstrated by multiple imaging modalities. These findings reflect Spaceflight Associated Neuro-ocular Syndrome (SANS). The etiology behind SANS remains elusive, but novel research in terrestrial intracellular cerebral and ONH edema is advancing treatments that may be applicable to SANS. **METHODS:** A literature review was conducted on the pathogenesis and current and novel treatment strategies of terrestrial intracellular cerebral and/or ONH edema via PubMed and MEDLINE databases. Only literature related to cerebral and/or ONH edema in the context of idiopathic intracranial hypertension, cerebral venous sinus occlusion, acute mountain sickness, high altitude cerebral edema, acute liver failure, and traumatic and ischemic brain injury was included in this review. **RESULTS:** Gross pathophysiologic mechanisms proposed for terrestrial cerebral or ONH edema include increased central venous sinus pressures, cerebrospinal fluid overproduction or outflow obstruction, and altered oxygen/carbon dioxide tensions. Current day therapies for cerebral or ONH edema related to cerebral venous sinus occlusion, high altitude cerebral edema, or traumatic brain injury include acetazolamide, corticosteroids, hyperosmolar therapy, or surgical interventions. However, novel research in acute liver failure and ischemic/traumatic brain injury proposes differential expression and activity of channels such as NKCC1 and SUR1-TRPM4-AQP4 as possible etiologies. Consequently, there is interest in targeting the SUR1-TRPM4 channel via intravenous glibenclamide in ischemic and traumatic brain injury to reduce intracellular edema, which may reduce ONH edema as well. **DISCUSSION:** Many terrestrial instances of cerebral and/or ONH edema cluster around common channel mediators of intracellular edema, among which SUR1-TRPM4 is targeted in stroke- and TBI-induced cerebral edema by glibenclamide. Similarly, targeting SUR1-TRPM4 may be a promising countermeasure in reducing ONH edema, and further investigations into this treatment as a possible SANS countermeasure are recommended.

Learning Objective

1. Understand current-day strategies to mitigate cerebral and optic nerve head (ONH) edema related to cerebral venous sinus occlusion, high altitude cerebral edema, ischemic or traumatic brain injury, and acute liver failure, and the physiologic basis of targeting SUR1-TRPM4 channels to mitigate terrestrial cerebral edema and, potentially, ONH in SANS.

[415] IDENTIFYING REFERENCE POPULATIONS FOR THE ASTRONAUT CORPS: NEURO-OPHTHALMOLOGY DATA

Mary Van Baalen[1], Sara Mason[2], Tyson Brunstetter[1], Wafa Taiym[3], Jacqueline Charvat[3], William Tarver[1]

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(Original Research)

INTRODUCTION: Spaceflight Associated Neuro-ocular Syndrome (SANS) signs, symptoms, and/or potential outcomes have previously been thought to be most similar to those of terrestrial idiopathic intracranial hypertension (IIH), optic neuritis, and glaucoma. However, these disease analogs differ from SANS in presentation, and the populations exhibiting these outcomes can differ from the astronauts in health status. Moreover, the anatomical and physiological changes documented in SANS are generally compared to normal ranges described in the literature that are generated from populations with other health concerns. A robust understanding of the "normal range" for many of the SANS findings is warranted. The rigorous selection, frequent screening, and specialized medical care of the astronaut corps challenge the understanding of what are normal outcomes. The purpose of this project was to evaluate other longitudinal cohorts that include vision outcomes that are also highly selective and healthy. **METHODS:** Ten cohorts were evaluated as potential comparisons to the US astronauts. These cohorts included US military, Beaver Dam Eye Study, and European public health studies. Demographic and health outcome data in astronauts were compared with each of the cohorts. Further, study design characteristics included years of data collection, geographic location, and cohort inclusion/exclusion in order to identify appropriate longitudinal comparison cohorts. **RESULTS:** The resulting comparisons found that military cohorts tend to be younger while ocular studies tend to evaluate older individuals. Additionally, the level of specialized testing performed on astronauts, particularly for OCT and MRI, far exceed that in general population studies. The US Health and Retirement Study and two European public health studies, the Gutenberg Health Study and the Rotterdam Study hold promise for future studies. **DISCUSSION:** NASA is challenged to determine what SANS-related anatomical and physiological changes reach the level of "clinical significance" and require treatment. Results from these proposed comparison studies of terrestrial cohorts will enhance the understanding of the spectrum of findings that describe SANS, and may be critical to determining the pathological thresholds of SANS.

Learning Objective

1. Understand the limitations in the interpretations of SANS findings in relationship to the findings in a healthy population and explore cohort studies that might offer improved interpretations.

[416] QUANTIFICATION OF SPACEFLIGHT-INDUCED OCULAR CHANGES

Endorsed by the Space Medicine Association

Karina Marshall-Goebel[1], Tyson Brunstetter[2], Charles Gibson[3], Steven S. Laurie[1], Stuart M.C. Lee[1], Bryn A. Martin[1], Nimesh Patel[4], Robert Ploutz-Snyder[5], Stuart Sater[6], Michael B. Stenger[7], Brandon Macias[1]

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(Original Research)

INTRODUCTION: The spaceflight associated neuro-ocular syndrome (SANS) is characterized by multiple ocular structural changes during long-duration spaceflight including optic disc edema, hyperopic shifts, and choroidal folds. The purpose of this study was to quantify morphologic changes of the eye and optic nerve that are hypothesized to be associated with the development of SANS during long-duration International Space Station (ISS) missions. **METHODS:** The Ocular Health study included 11 long-duration (170 ± 19 days) ISS crewmembers with measurements taken before, during (on flight days 10, 30, 90, and 150), and after spaceflight (10, 30, 90, 180, and 365 days after landing). Measurements included global total retinal thickness (from Bruch's membrane opening to 250 µm) and peripapillary choroid thickness from optical coherence tomography (OCT) images, optic disc edema calls from fundoscopy, and ocular globe flattening from 3D reconstructed magnetic resonance imaging (MRI). A linear mixed-effects regression model was used to test for significant differences from preflight. **RESULTS:** OCT-derived total retinal thickness increased from preflight by flight day 10 (mean: +11.9 µm, 95% CI: 6.6-17.3 µm, $P < 0.001$) with a maximum increase by flight day 150 (mean: +27.6 µm, 95% CI: 22.7–32.6 µm, $P < 0.001$). Similarly, peripapillary choroidal thickness also increased by flight day 10 (mean: +24 µm, 95% CI: 15-33 µm, $P < 0.001$), with a maximum increase by flight day 150 (mean: +43 µm, 95% CI 35-46 µm, $P < 0.001$). However, only 2 of 11 subjects demonstrated Frisèn grade 1 optic disc edema in flight. In addition, flattening of the posterior ocular globe was found immediately postflight (mean: -9.9 mm^3, 95% CI: -4.6 to -15.2 mm^3, $P < 0.0001$). **DISCUSSION:** The results from this study demonstrate that ocular structural changes are not limited to the ~15% of astronauts diagnosed with optic disc edema identified by fundoscopy, but rather develop in the majority of crewmembers. Quantitative OCT-based metrics of choroid and optic nerve head morphology during long-duration spaceflight may provide an early monitoring tool of optic disc edema and further characterize the complexity of SANS.

Learning Objective

1. The audience will learn about recent quantitative ocular structural changes associated with Spaceflight Associated Neuro-ocular Syndrome (SANS).

[417] CHOROIDAL THICKENING: OCULAR RISKS DURING LONG-DURATION SPACEFLIGHT AND IMPLICATIONS FOR SPACEFLIGHT ASSOCIATED NEURO-OCULAR SYNDROME (SANS)

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[3]*Coastal Eye Associates, Webster, TX, USA*

(Original Research)

INTRODUCTION: Changes to visual performance and ocular anatomy have been linked to short-duration and long-duration spaceflight, and together these signs and symptoms have been termed Spaceflight Associated Neuro-ocular Syndrome (SANS). Choroidal thickening is detected in virtually all long-duration astronauts and represents one of the unique signs of SANS. This project aimed to explore existing theories for terrestrial choroidal thickening, along with their associated ocular risks, that could be extrapolated to SANS. **METHODS:** The PubMed National Library of Medicine database was searched to identify known terrestrial pathologies that demonstrate choroidal thickening, and further searches were performed to investigate mechanisms for their choroidal thickening. The details of these proposed mechanisms were compiled into ideas for the potential etiology, evaluation, and associated risks of choroidal thickening in astronauts. **RESULTS:** Central serous retinopathy, age-related macular degeneration, and polypoidal choroidal vasculopathy are associated with choroidal thickening in terrestrial patients. Hypothesized mechanisms for choroidal thickening with these pathologies include choroidal dilation, hyperpermeability, neovascularization, and ischemia – all of which are theorized to lead to retinal pigment epithelium detachment with possible subretinal fluid accumulation, causing poor retinal perfusion and eventual photoreceptor death. Risk factors include exercise, causing decreased subfoveal blood flow leading to choroidal ischemia; physiologic stress, causing choroidal vessel engorgement via catecholamine cortisol effects; and hypertension, causing choroidal dilation leading to compression of the small choroidal vessels nearest the retina. **DISCUSSION:** The choroid is a highly active component of the eye, and its spaceflight-associated thickening has a wide range of potential implications for SANS. Astronauts should be monitored for altered visual acuity, color vision, and contrast sensitivity. This surveillance is important during space missions but also after astronauts have returned to Earth, and years down the road. Future suggested work includes correlating choroidal thickening and folds to astronaut cortisol levels, exercise activity, blood pressure, and subretinal fluid accumulation, and determining if relationships exist as theorized. These efforts may help elucidate some of the pathophysiology of SANS and guide the development of SANS countermeasures.

Learning Objective

1. Recognize the pathologic changes described in choroidal disease and extrapolate these changes to a possible mechanism for the choroidal thickening observed in Spaceflight Associated Neuro-ocular Syndrome (SANS).

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Centennial IV

[S-78]: PANEL: GARRISON COMPREHENSIVE MEDICAL READINESS PROGRAM FOR FLIGHT SURGEONS

Chair: Douglas Files

Co-Chair: Bryant Martin

PANEL OVERVIEW: Aerospace medicine professionals face many threats to their aircrew and other patients and workers. Some of this occurs in deployed settings and some is in garrison at their regular base back home. Through shop visits, sanitation assessments, human factors briefings and fatigue countermeasures, flight surgeons defend aircrew from these health risks. This panel will engage participants with hands-on interactive experiences addressing a single unit's experiences. Participants will consider a scenario which will involve food and workplace safety as well as briefings and measures combatting fatigue. The session format will include updated didactic material addressing each step in the sequence, but attendees will engage directly in the deployment sequence by splitting into groups (as appropriate) and working through each of the four sections using pictorial examples of findings on the inspections and site visits. At the conclusion, attendees will have improved their ability to defend against various contingencies in a garrison setting.

[418] GARRISON SANITATION AND FOOD SAFETY

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[1]*U.S. AIR FORCE SCHOOL OF AEROSPACE MEDICINE, Wright-Patterson AFB, OH, USA*

(Education - Program / Process Review Proposal)

BACKGROUND: Aerospace medicine professionals oversee public health and preventive medicine operations at their worksites. Food and water vulnerability assessments are often assigned tasks. However, some flight surgeons struggle to perform enough assessments. This presentation will assist aerospace medicine professionals to maintain currency by participating in a prototypical virtual food/water vulnerability inspection. **OVERVIEW:** The safety and health of their patient populations is part of the duty of flight medicine providers in garrison. These experts perform sanitation and food/water vulnerability assessments in order to ensure maximal mission completion and safety in the air. This program will update aeromedical and allied professionals on sanitation and food/water vulnerability inspection issues through individuals participating in a virtual inspection regarding a water safety case. **DISCUSSION:** Food and water vulnerability inspections should be performed regularly at airfields and other workplaces. Failure to do so can affect flying safety and other goals. This session offers preventive medicine and occupational health personnel an opportunity to learn the latest techniques to perform water and food inspections. International colleagues will gain insight into USA food and water standards and how performing these inspections might positively affect airfield safety and health in their own countries. Thus, professionals from all services and all nations can benefit from food and water inspection cases.

Learning Objective

1. Participants will be able to state the factors involved with conducting a water inspection in conjunction with bioenvironmental engineers.

[419] GARRISON SHOP VISITS

Douglas Files[1], Cady Blasser[1]
[1]*U.S. AIR FORCE SCHOOL OF AEROSPACE MEDICINE, Wright-Patterson AFB, OH, USA*

(Education - Program / Process Review Proposal)

BACKGROUND: Health hazards are common around flight line worksites including toxins, ergonomic hazards, infectious agents and threats of injury. Aerospace medicine professionals often serve in an occupational medicine capacity with a focus on preventing workplace injuries and illnesses. **OVERVIEW:** Many industrial hazards occur on a flight line, and investigating physical and chemical hazards can prevent illness and injury. Professionals in occupational medicine should not overlook common threats such as hygienic conditions, airborne dust, and worksite smoking. Participants in the current exercise will discuss potential hazards in aviation and maintenance environments and what might be done to mitigate those hazards. **DISCUSSION:** Performing a worksite visit can link physical manifestations with environmental hazards. Aerospace medicine professionals from multiple disciplines and countries can benefit in obtaining comprehensive medical readiness skills delivered during this session.

Learning Objective

1. Participants will be able to conduct worksite shop visits in garrison aviation workplaces.

[420] HUMAN FACTORS BRIEFINGS IN GARRISON

Jeffrey Lawson[1], Douglas Files[2], Cady Blasser[3]
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(Education - Program / Process Review Proposal)

BACKGROUND: Providers in aerospace medicine clinics present briefings regarding safety, human factors, etc. to aircrew and other staff. This presentation will assist professionals to maintain currency by participating in a human factors briefing. **OVERVIEW:** Aerospace medicine professionals often present medical topics to aviators. This can occur during instrument refresher training, during safety briefings, HUD (Head-up Display) tape reviews, etc. This program will reinforce techniques to aid flight surgeons in presenting human factors topics by providing an opportunity for individuals to participate in a human factors briefing regarding spatial disorientation risks. **DISCUSSION:** Aerospace medicine professionals' role in the aviation community involves promoting health and safety in the communities we serve. As such we present medical topics to aviators. The U.S. Air Force has determined that currency in human factors briefings should be performed on a recurring basis. Attendees will discuss factors regarding how to improve one's briefing style, for example about spatial disorientation.

Learning Objective

1. Participants will be able to present a spatial disorientation scenario to laypeople using risk communication skills.

[421] FATIGUE COUNTERMEASURES IN GARRISON

Cady Blasser[1], Douglas Files[1]
[1]*U.S. AIR FORCE SCHOOL OF AEROSPACE MEDICINE, Wright-Patterson AFB, OH, USA*

(Education - Program / Process Review Proposal)

BACKGROUND: Aerospace medicine professionals sustain maximal aviator performance in various ways. One potential way to achieve this involves the use of medications. Flight surgeons prescribe hypnotics to help aviators sleep prior to some operational missions and in some circumstances prescribe stimulants to improve performance during critical phases of flight. This presentation will instruct aerospace medicine professionals in the operational usage of performance-enhancing medications for aviators. **OVERVIEW:** Aerospace medicine professionals study the physiologic effects and risks of flight. In order to ensure mission completion, flying safety, and health flight surgeons sometimes prescribe medication for use. At times, hypnotics assist aircrew to sleep prior to a mission while other medications improve pilot alertness during critical phases of flight. This program will update flight surgeons on medical and other fatigue countermeasures. **DISCUSSION:** The U. S. Air Force requires annual training regarding the use of performance enhancing medication. Many other military services also use performance-enhancing medication. This program will model techniques and will aid all AsMA attendees participating in the session.

Learning Objective

1. Participants will model how to safely use performance-enhancing medications in an operational setting.

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Regency 6

[S-79]: SLIDE: INFECTIOUS DISEASE IMPLICATIONS IN GLOBAL TRAVEL

Chair: J. Klingenberger

Co-Chair: Kathleen Flarity

[422] THE EXPERIENCE OF NOROVIRUS IN THE CRUISE INDUSTRY

Mel Skipp[1]
[1]*Salford University, Salford, Manchester, United Kingdom*

(Education - Case Study: Clinical / Human Performance)

Norovirus is the most common cause of viral gastroenteritis with an estimated 699 million cases a year worldwide. The illness can spread very rapidly from person to person, especially in closed and semi close environments such as cruise ships and aircraft. While the illness is generally mild and self limiting it can have a significant impact on ship operations and guests vacation experience. This presentation will include a brief introduction to norovirus, its characteristics, spread and the history of outbreaks on cruise ships. This will include examples of where passengers travelling on aircraft have also been affected. Details of overall ship outbreak prevention and management strategies including key control measures will be provided, including early identification, isolation, education, hand washing and eradication. Additionally a review of recent research into effective cleaning and disinfection methods will be discussed, along with the use of hand sanitizers. Finally a summary of current norovirus developments and new technology will be included.

Learning Objectives

1. Understand the background and history of norovirus outbreaks.
2. Understand the experience of the cruise industry with norovirus, including incidents then related to air travel, and recent research and developments.
3. Understand overall management including prevention and control of norvirus on cruise ships.

[423] AIRCRAFTS AND INFECTION: COMMON MICROBES ENCOUNTERED, RISK OF INFECTION, AND HOW TO MITIGATE INFECTION RISK WHILE FLYING

Isaac Bogoch[1]
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(Education - Tutorial Proposal)

INTRODUCTION: Aircrafts have the potential to be a major nidus of bacterial and viral infections given the wide range in aircraft sanitation and disinfection practice worldwide. With over 4 billion passengers flying per year, individuals may be at risk for infection due to the close congregation of large volumes of passengers, often for many hours at a time. **TOPIC:** This presentation will focus on common bacterial and viral infections that may be encountered on commercial aircrafts. **APPLICATION:** We will evaluate factors associated with infection transmission and the potential risk of infection. This will include common clinical syndromes such as respiratory, gastrointestinal, and skin and soft tissue infections that passengers may contact and potentially acquire with while travelling. Lastly, we will explore ways to mitigate infection transmission at the individual and aircraft levels.

Learning Objectives

1. Describe common infectious organisms encountered on commercial aircrafts.
2. Explore potential risks of infection and colonization with organisms encountered on commercial aircrafts.
3. Explore mechanisms to prevent infection from organisms encountered on commercial aircrafts at an individual and population level.

[424] STUDY ON MICROBIAL DISTRIBUTION CHARACTERISTICS AND DIVERSITY ON THE SURFACE OF AIRCRAFT CABIN

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(Original Research)

OBJECTIVE: To investigate the microbial contamination and explore the diversity of materials surfaces on passenger aircraft. **METHODS:** The sample which carried by highly touched objects surfaces in cabins was preserved in a sterile falcon tube and transported to the microbiology lab for bacteriological examination. Petri dishes, incubated at 36℃ for 48h, were used to quantify colony forming units in the samples(CFU).Isolated strains were confirmed by mass spectrometry and 16SrRNA sequencing. Using PCR(polymerase chain reaction)

conducted amplification and Illumina Miseq sequencing platform, two-terminal sequencing of V4 areas of 16S rRNA was carried Date analyzed using SPSS version 21.0; diversity of community structure was analyzed using the software such as Mothur. **RESULTS:** A total of 1035 sample of high touched surfaces were collected and analysed.55 strains of clinical or opportunistic pathogenic were isolated,93.8% of them were primarily from surface of toilet seat. 812 samples of cabin objects surface and 195 samples of toilet objects surface were monitored, the percentage of > 10cfu/cm^{2}or cfu/item was 2.6% and 32.8% respectively. The pathogen positive rates of long distance flights and short distance flights were 70.6% and 65.2% respectively (c^2=65.049, P<0.05) In total,2889879measured sequences, and 1493 genus were found in 18 samples, belonging to 625 family. Simpson index 7.92±0.89 in trap tables, 8.35±1.04 in armrest group and 8.87±0.95 in toilet seat group. All of them had no statistical difference(P>0.05). **CONCLUSION:** This study demonstrates that the frequently touched aircraft inanimate objects surfaces are relatively common polluted by pathogen or opportunistic pathogen. The surfaces of long-haul flights and lavatory areas could pose higher health risks by causing infections due to their relatively high microbial contamination compared with other surfaces. We present a quantified study of aircraft-surfaces microbial contamination. We suggest that regular microbial monitor and standardized disinfection on high touch surfaces of aeroplane.

Learning Objective

1. The audience will learn about the microbial contamination status of the high-touch surfaces on aircrafts and It is main factors.

[425] REVIEW OF AEROMEDICAL EVACUATION OF HIGH CONSEQUENCE INFECTIOUS DISEASE PATIENTS: LESSONS LEARNT AND FUTURE DEVELOPMENTS

Robert Lindfield[1]
[1]*Royal Air Force, High Wycombe, United Kingdom*

(Education - Program / Process Review Proposal)

BACKGROUND: High consequence infectious diseases (HCID), such as Ebola, pandemic flu or 'Disease X' – the next pandemic, have the capacity to cause significant global disruption. Early identification and treatment, including public health measures, are critical if the disease is to be contained. A key part of this response is the safe movement by Air of patients with HCID so that they can receive appropriate treatment. Nations deploy different capabilities to aeromedically evacuate (AE) a HCID patient however there has been no overview of each system to determine an optimal method to move a patient from the point of infection (POI) to a receiving hospital. **OVERVIEW:** The Royal Air Force (RAF) has extensive experience using an air transportable isolator, a self-contained, mobile, negative pressure chamber, to move HCID patients over long distances. A review of HCID AE modalities globally was undertaken to understand different capabilities and how these deliver care to the patient as well as the limitations of each system. This work has been developed to support the UK national response to HCID AE delivered by the RAF. The study utilised mixed methods to explore each capability, included both military and civilian organisations and was augmented by visiting different capabilities to better understand their roles. The study revealed that several nations have AE HCID capabilities but these vary in size, duration that the patient can remain isolated, and ability to deliver clinical inteventions. Most are designed for short moves on rotary or fixed wing aircraft and those designed for strategic moves are frequently large, labour intensive and costly. There is limited experience of moving HCID patients and few nations utilise both tactical and strategic capabilities meaning that movement across the whole patient pathway has not been fully developed. **DISCUSSION:** The capability to safely aeromedical evacuate a patient with HCID is critical in the management of any HCID outbreak. Several nations utilise a range of different tools predominantly designed for short, tactical moves. There are limited options for strategic moves and, frequently, these offer suboptimal clinical care. There is a need to develop a more robust capability that can efficiently move patients across both tactical and strategic spaces, provide optimal clinical care, and keep care-givers safe.

Learning Objectives

1. The audience will hear the range of options available globally to aeromedically evacuate a patient with a high consequence infectious disease.
2. The audience will understand the limitations of the existing systems used to aeromedically evacuate a patient with a high consequence infectious disease.
3. The audience will learn about the features of a potential future capability that meets specific requirements across both tactical and strategic spaces to move a patient with a high consequence infectious disease.

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Regency 8

[S-80]: SLIDE: HEADS UP NEUROLOGY

Chair: Cheryl Lowry

Co-Chair: Dana Windhorst

[426] "DOCTOR, I THINK IT'S NO BIG DEAL" - IS 'RESOLVED' NEUROLOGICAL PROBLEM DURING AIRCREW/ATCO SELECTION NEGLIGIBLE? (SERIES OF 4 CASES)

Steven Chin-chiu HO[1], Robert Anthony Cocks[1]
[1]*The Chinese University of Hong Kong, Hong Kong, Hong Kong*

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: During civilian aircrew/ATCO initial licensing medical examinations, candidates are required to report all of their past medical history. Sometimes candidates may think certain history is "no big deal" since they thought that it happened a long time ago or they are told by non-aviation medical personnel that there is no concern. Such 'resolved' medical history, however, from the aeromedical risk assessment point of view, may not be classified as trivial. **BACKGROUND:** A series of 4 cases of declared past neurological problem during initial licensing medical examinations were selected. There were arguable factors that candidates believe their conditions are waivable, yet from aeromedical risk assessment point of view, the impact to safety could be substantial. **CASE PRESENTATION:** The first case is a candidate with history of syncopal attack presenting with seizure like symptoms, who required a risk analysis of the chance of epileptic seizure. In the second case, a candidate had a remote history of isolated status epilepticus. The challenge of analysis from limited old records in determining the aetiology is enormous yet essential, otherwise the future risk of epilepsy cannot be estimated. The third case is a candidate with the incidental finding of an arachnoid cyst of significant size. It did not carry zero risk as the candidate was told by his physician that it was 'just a water bubble'. The fourth case is a candidate with operated spinal ependymoma. The debate of whether ependymoma is benign or malignant can change the aeromedical risk assessment significantly. **DISCUSSION:** Complete reporting of past medical history is essential during selection of aircrew and Air Traffic Controllers. The aeromedical significance of such history should be ascertained by trained aviation medical examiners/assessors. Where necessary, full records of the past event should be retrieved despite their remoteness in time. The so-called 'no big deal' issues from point of view of layman or non-aviation medically trained personnel could carry substantial aeromedical risk. Aviation medical examiners should be aware of such issues and be stringent in obtaining details of full past medical history to assist in a robust aeromedical risk assessment.

Learning Objectives

1. Understand the need of a comprehensive aeromedical risk assessment of past history during initial aircrew/ATCO selection.
2. Understand the aeromedical risk assessment rationale of various neurological conditions.

[427] REVERSIBLE CEREBRAL VASOCONSTRICTION SYNDROME AND INTRACRANIAL HEMORRHAGE ASSOCIATED WITH AIR TRAVEL IN A 53-YEAR-OLD WOMAN

Laurel Charlesworth[1], Christopher Skinner[1]
[1]*University of Ottawa, Ottawa, Ontario, Canada*

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This report describes a 53-year-old woman presenting with intracranial hemorrhage secondary to reversible

cerebral vasoconstriction syndrome (RCVS), with no clear precipitants aside from recent air travel. **BACKGROUND:** RCVS is a non-inflammatory arteriopathy secondary to reversible vasospasm of intracranial vessels. It is known to be triggered by medications including sympathomimetic agents and some illicit drugs; however, up to 30% of cases have no identifiable trigger. High altitude climbing is an identified trigger and hypobaric hypoxia has been postulated to be a precipitant of RCVS in the literature, though few cases have been described. **CASE PRESENTATION:** The patient is a 53-year-old previously healthy woman with recent flight returning to Canada from south Florida following a cruise vacation. She experienced a thunderclap headache within 1 hour of landing of the aircraft which lasted several hours. Over the following days, she experienced several further headaches culminating in visit to a local emergency department; imaging at the time was reported as normal. Two days later, she presented to the local tertiary care neurological service with acute stroke-like deficits and was found to have a large left sided basal ganglia bleed. Vessel imaging noted diffuse beading of the proximal and distal vessels of the anterior and posterior circulation. She was started on nimodipine and admitted for monitoring. These vessel changes were noted to be reversed on follow-up MRI in 4 months, confirming a diagnosis of RCVS. **DISCUSSION:** The temporal relationship of the initial thunderclap headache shortly after landing as well as absence of other triggers suggest that the flight could have been a trigger for this patient's presentation. In this instance, RCVS could be precipitated by the hypobaric hypoxic environment of the aircraft leading to increased vascular tone. This case demonstrates flight as a potential trigger for RCVS; this could suggest that this falls on the spectrum with the secondary headache syndrome "airplane headaches". It is important for physicians to be aware of this, both for risk stratification and workup of in-flight and post-flight headaches in pilots, aircrew, and passengers.

Learning Objectives

1. The audience will be able to understand the pathophysiology of RCVS and how this may be affected by the hypobaric hypoxic environment of flight.
2. The participant will be able to apply an approach to initial evaluation of post flight headaches.

[428] TUMEFACTIVE DEMYELINATION: AEROMEDICAL APPROACH AND DISPOSITION

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(Education - Case Study: Clinical / Human Performance)

BACKGROUND: Tumefactive Demyelinating (TD) lesions are those measuring more than 2 cm in size with image characteristics unlike that of Multiple Sclerosis thereby posing a diagnostic challenge. Presentation of the disease is different from that of Typical MS as it usually presents with signs & symptoms akin to a Space Occupying Lesion (SOL) like seizures, limb paresis etc. The condition is rare with 1-2 cases per 1000 cases of Multiple Sclerosis. **CASE PRESENTATION:** A 35 years old male commercial pilot initially presented with a one-week history of unexplained tiredness and left upper limb weakness with numbness and paraesthesias in bilateral shoulders and lower limbs in May 19. MRI brain was suggestive of space occupying lesion in the right corona radiata. Imaging characteristics on PET CT & MR Spectroscopy confirmed tumefactive demyelination. He was treated with intra-venous glucocorticoids for a week and thereafter recommended monthly pulsed steroid therapy for the next three months. One month after initiation of treatment the individual demonstrated marked improved in his clinical status and a resolving brain lesion was noted. The individual is under regular clinical follow-up. **DISCUSSION:** TD lesions have a high risk of recurrence with close to two-thirds of cases following a relapsing-remitting course typical of a conventional MS. Therefore, strict vigilance towards occurrence of symptoms by means of regular follow-up is warranted. This case reports aims to bring out the aeromedical challenges associated in such a case and a possible roadmap to reinstate flying duties.

Learning Objective

1. The audience will learn about the presentation, evaluation and aeromedical disposition in a case of Tumefactive Demyelination.

[429] ASSESSING VISUAL MOTION PERCEPTION WITH AND WITHOUT MILD TRAUMATIC BRAIN INJURY: IMPLICATIONS IN HIGH-PERFORMANCE ENVIRONMENTS

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(Original Research)

INTRODUCTION: High-performance environments require individuals to operate under dynamic sensory conditions. Mild traumatic brain injury (mTBI), common among operators, may result in sensitivity to dynamic environments, termed visual motion sensitivity (VMS). The pathophysiology of VMS may involve disruption of brain networks involved in visual and vestibular function. We hypothesize that alterations in cortical multisensory processing are responsible for VMS. We employed a novel task-based fMRI paradigm to define the alterations in cortical activation after subacute mTBI. **METHODS:** Subacute mTBI and healthy controls underwent visual/vestibular testing and resting-state MRI and fMRI. Study was IRB approved. Subjects viewed 30-second videos with variable optic flow. Videos included operationally relevant content, either 'neutral' or 'provocative' (known to provoke VMS). Optic flow was quantitatively estimated. After each video, subjects rated symptoms/intensity. fMRI data analysis included time series regression with group-level analysis of the 'provocative-neutral' condition. Resting-state analysis were region-of-interest (ROI) measures of connectivity. **RESULTS:** mTBI group consisted of 12 subjects aged 29.3 $\pm$ 12.9 years 2-12 weeks post-concussion. Control group consisted of 10 subjects aged 27.5 $\pm$ 4.0 years. Provocative videos had greater mean/max optic flow compared to neutral videos. The mTBI group reported more symptoms. Both groups showed robust mean activation in primary and secondary visual areas, parietal lobe, parieto-insular vestibular cortex (PIVC), and cingulate gyrus. Selective increased activation was noted in the mTBI versus control group for the 'provocative-neutral' contrast including PIVC and inferior frontal gyrus, both putative visual/vestibular sensory processing centers. Resting-state analysis identified several ROI connections correlating with clinical measures of VMS. **DISCUSSION:** Increased activation was observed in visual/vestibular multisensory processing regions in subjects with VMS suggesting increased weighting of visual input into sensory processing networks may underlie VMS after mTBI. Unique ROI connections correlated with response to distinct multisensory (vision/motion) tasks. The observed cortical activation and connectivity differences offer insights into plasticity of dynamic visual perception, pre-injury risk factors relevant to operator selection, and implications in high-performance environments.

Learning Objectives

1. Participants will be able to discuss the cortical networks involved with visual perception and the operational implications of changes to these networks.
2. Participants will be able to discuss risk factors for visual perceptual abnormalities in both normals and after mild TBI and implications for operator selection criteria.

[430] AIRCREW HIV – DEPRESSION CHALLENGES IN SUB-SAHARAN AFRICA

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(Education - Tutorial Proposal)

INTRODUCTION: Mandatory HIV testing can be perceived as a brutal way of carrying out aviation medical examination, but it can be vital to areas of high-HIV prevalence such as Sub-Saharan Africa (SSA). Identified HIV positive airmen should be regularly and properly screened for psychiatric manifestations particularly mood disorders such as depression using appropriate agreed tools. **TOPIC:** Estimates reported by the World Health Organization (WHO) suggested that there were approximately 36.9 million people worldwide living with (HIV/AIDS in 2017, 19.6 million (53%) of them being in sub – Saharan Africa (SSA). Depression, one of the most common psychiatric

disorders, is 2-3 times more prevalent in people living with HIV (PLWHIV) than in the general population in many settings as shown in western countries but remains neglected in SSA WHO and UNAIDS do not support mandatory or compulsory testing of individuals on public health grounds; insisting that HIV testing, no matter how it is delivered, must always respect personal choice and adhere to ethical and human rights principles Several challenges lie ahead of us: how can we identify HIV positive aircrew who are likely to conceal their HIV status or shun from testing as a result of depression and stigma? Are we not closing our eyes to a possible next Germanwings disaster in SSA by simply relying on voluntary HIV testing by our airmen? **APPLICATION:** Mandatory HIV testing should be adopted and supported by ICAO subject to HIV prevalence of the State concerned. Any known HIV positive airman should be evaluated in accordance with HIV protocol accommodating comprehensive depression scale e.g. Hamilton depression scale. **RESOURCES:** 1. World Health Organization. 10 Facts on HIV/AIDS. 2017. 2. Roy KF, Andriote, JM. HIV and Clinical Depression Fact Sheet. *American Psychiatric Association*, www.psychiatry.org/AIDS. 3. Infectious Diseases Guidance Material. *UK Civil Aviation Authority*, 2015. 4. Guide for Aviation Medical Examiners – Federal Aviation Administration. 25 September 2019. 5. Bernard C et al. Prevalence and Factors Associated with Depression in People Living with HIV in sub-Saharan Africa: a Systematic Review and Meta-analysis. *PLOS One*, 12(8): e0181960. https://doi.org/10.1371/journal.pone.0181960. 6. WHO/UNAIDS. HIV Testing Services: New opportunities and Ongoing Challenges. *Joint United Nations Programme on HIV/AIDS*. 2017.

Learning Objectives

1. HIV prevalence can have a significant impact in aviation medical standards in a given geographical area.
2. For high HIV prevalent states, Mandatory HIV testing can greatly assist in determinining and managing aviation safety risks associated with HIV.
3. Management of diagnosed HIV Aircrew/Airmen should follow established HIV protocols that should address mood disoders particulary depression using comprehensive tools such as Halimton depression scale.

[431] THINNING THE BLOOD - MANAGEMENT OF ANTICOAGULATION IN AIRCREW

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(Original Research)

INTRODUCTION: Several clinical conditions require anticoagulation to mitigate the risk of thromboembolism, and in common with the general population pilots are represented among the sufferers of these conditions. In addition to the incapacitation risk of the condition, anticoagulation itself presents a hazard. This presentation covers the management of anticoagulation in aircrew, including monitoring and the special situation of trauma in pilots taking anticoagulants. **METHODS:** Analysis of the case histories of five pilots requiring anticoagulation (two with pulmonary embolism, two with deep vein thrombosis and one with antiphospholipid syndrome and a later mitral valve replacement. A review of the medical literature regarding the utility of traditional anticoagulants such as warfarin compared with newer direct oral anticoagulant drugs (DOACs) is presented. **RESULTS:** Two pilots managed with warfarin over many years were successful in managing their own anticoagulation, including INR-guided dosage adjustments. However, both pilots sustained significant traumatic injury (one to the head and the other to the chest) during a ten-year period of observation. The other pilots were managed for periods of 6-12 months with no injuries during the treatment period. Management of the injuries and aeromedical decision-making for return to duty are covered **DISCUSSION:** Pilots with medical conditions requiring anticoagulation need to be assessed for both the incapacitation threat of the condition and the hazards presented by the therapy. In this study, those pilots on long-term warfarin were trustworthy in managing their own INR and dosage adjustments under periodical medical supervision. Traumatic injury in all pilots treated with warfarin or DOACs requires careful management.

Learning Objectives

1. The participant will be able to understand the clinical indications for anticoagulation and the incapacitation risks presented by both the condition and the therapy.
2. The participant will learn about the management of anticoagulated pilots who suffer traumatic injury.
3. The participant will be able to understand the clinical considerations involved in determining the aeromedical fitness of pilots who experience complications while under treatment with anticoagulants.

Thursday, 05/21/2020 ***1:30 PM***
Exhibit Hall

[S-81]: POSTER: SAFETY & ENVIRONMENTAL MEDICINE

Chair: Ryan Peirson

Co-Chair: Susan Fondy

[432] OPTIMAL PHYSICAL SPACE FOR EN ROUTE CARE: MEDIC POSTURE AND INJURY SURVEY RESULTS

Sandra Conti[1], Laura Kroening[1], Rachel Kinsler[1], Amy Lloyd[1], Jeffrey Molles[1]
[1]*U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL, USA*

(Original Research)

INTRODUCTION: A survey was presented to active duty U.S. Army, Reserve, and National Guard en route care medical providers. The survey examined awkward postures associated with delivering patient care in the confined space of common medical evacuation platforms.
It also related care provider health and efficiency with the postures and resulting injuries. **METHODS:** A survey was created and distributed online using ClassApps LLC SelectSurvey.net. **RESULTS:** Sixty valid surveys, 46 complete and 14 incomplete, were collected. Respondents included Critical Care Flight Paramedics, Ground Medics, Standardization Instructors, Flight Instructors, Flight Surgeons, a medical evacuation Crew Chief, and a Flight Medic. All but one respondent had 68W Military Occupational Specialty experience and 86.7% of respondents had experience as Critical Care Flight Paramedics. Compartment Configurability, Litter System, Cabin Ergonomics, Compartment Size, Patient Loading Capability, and Personal Protective Gear were all indicated by over 60% of respondents as negatively affecting the mission. Loading and unloading litter patients was a top cause of awkward postures such as bending, overextending, kneeling, and squatting. Every type of injury had more counts of being unreported than reported. Lower back injuries related to patient loading and treatment during their career as a caregiver were reported by 87% of respondents. Awkward positions, flight gear, lifting patients, and body armor were leading causes of lower back injuries. Leading sources of neck injuries were night vision goggles and helmets. Fisher's exact analyses identified that care providers of average male height or below were 73% more likely to find the crew sets negatively affected the mission than care providers of at least average height (Gordon, 2014), 84% more likely to find the environmental control system to be a negative feature, 81% more likely to find the oxygen system to be a negative feature, and 86% more likely to find patient loading capability to be a negative feature. No statistically significant differences were found when comparing genders. **DISCUSSION:** Finding a way to minimize the stress placed on the care providers while lifting and loading patients is likely to contribute significantly to reducing the amount of back injuries. Designing cabin areas and litter pan systems with the intention of minimizing these awkward postures could significantly reduce the amount of back and knee injuries.

Learning Objectives

1. The audience will learn the results of each question on the survey, the most frequently cited activities that caused injuries and awkward postures, and possible mitigations.
2. Learning Objective 2: The audience will learn the frequency of reported and unreported injuries along with the reasons for not reporting injuries.

[433] ESTIMATED ACCIDENT RATES FOR BASICMED VS MEDICALLY CERTIFIED PILOTS

William Mills[1]
[1]*Civil Aerospace Medical Institute, Oklahoma City, OK, USA*

(Original Research)

INTRODUCTION: The latest expansion of U.S. flight operations that do not require a current FAA medical certificate was the introduction of BasicMed in May 2017, which included over 50,000 pilots as of August 2019. There is interest in the safety of BasicMed, including a congressionally mandated report due in 2021, but there are currently no provisions to collect the data needed to calculate accident rates. This study uses six-month flight times reported on pilots' last FAA medical application to estimate accident rates for BasicMed pilots compared to pilots holding third-class medical certificates. **METHODS:** The roster of BasicMed pilots as of 5/1/2019 was obtained from the FAA's Airman Registry. Using NTSB records, I identified all accidents since May 2017 for BasicMed pilots and pilots holding a third-class medical certificate. These pilots were matched to the FAA pilot medical database to extract the previous six-month flight time reported on their last exam. I used these flight times to calculate estimated accident rates per 100,000 hrs. for both groups. Adjusted accident odds ratios were calculated using logistic regression. The main analysis was restricted to BasicMed pilots less than 5 years from their last FAA medical exam to reduce temporality issues but excluded groups were also explored. **RESULTS:** The estimated overall (fatal) accident rate per 100,000 flight hours for the BasicMed group was 7.86 (1.7) compared to 6.49 (1.4) for the medically certified pilots. Neither of these differences was statistically significant. Accident rates and adjusted logistic regression models were compared across multiple subgroups and only the 80+ year old BasicMed group showed significantly elevated accident odds ratio of 2.5. (P = 0.020.) **DISCUSSION:** This study did not detect a significant difference in accident risk between the BasicMed pilots and medically certified third-class pilots except for a possible increased risk in the over 80 year old BasicMed pilots. The median time since last FAA exam was two years for the BasicMed pilots, and most of their FAA exams are good for two years. So our findings do not reflect the absence of formal medical certification in the BasicMed rules and repeat studies are needed.

Learning Objectives

1. Understand the challenges to calculating accident rates for the population of BasicMed pilots.
2. Understand one possible technique that can be used to estimate accident rates.

[434] COMPARISON OF AUTOPSY RESULTS FOR THIRD-CLASS MEDICALLY CERTIFIED PILOTS VERSUS BASICMED AND SPORT PILOTS

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(Original Research)

INTRODUCTION: The scope of flight operations that do not require formal aeromedical certification has greatly expanded in the U.S with the introduction of BasicMed in 2017, which as of August 2019 included over 50,000 pilots. Reliable data needed to assess the safety impact of this program is lacking but congress has, nevertheless, mandated a report addressing its safety for 2021. We compared aeromedically hazardous autopsy findings as a surrogate measure of risk in pilots flying with third-class medical certificates, under BasicMed rules, and under the sport pilot rules introduced in 2004. **METHODS:** We identified third-class medically certified pilots, BasicMed pilots, and sport pilots who were fatally injured in aircraft accidents since May 2012 using the FAA autopsy database. Autopsies were classified as to the presence of preexisting progressive disease that should represent a risk of a future incapacitating event. We compared proportions of autopsy hazards between the three groups with adjustment for confounders. **RESULTS:** Autopsy hazards were found in 29% of medically certified pilots, 54% of BasicMed pilots, and 62% of sport pilots. After adjustment for age, there was no statistically significant difference between third-class and BasicMed findings, but sport pilots had a strongly significant difference with a hazard odds ratio of 3.3. **DISCUSSION:** Our study did not detect a significant difference in proportions of hazardous autopsy findings between medically certified third-class pilots and BasicMed pilots. However, autopsy hazards were 230% higher in the sport pilot group even after adjustment for age. The median time since last FAA exam was only 2 years for the BasicMed pilots but was 10 years for those sport pilots who had a previous FAA exam. Most FAA exams in these groups are good for two years. Therefore, our findings do not reflect the effect of medical certification status for the BasicMed pilots, but sport pilots do appear to be at higher medical risk.

Learning Objectives

1. To understand the difficulty comparing safety experience between medically certified, BasicMed, and sport pilot groups.
2. To understand the use and limitations of autopsy results as a surrogate measure of risk.

[435] CULTIVATING HIGH PERFORMANCE AND DESENSITIZATION FROM SKYDIVING FOR FAVORABLE OUTCOMES: A CASE REPORT

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(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: In this case report, we present a circumstance in which a skydiver committed a fatal mistake in judgement, and we highlight an opportunity for harnessing stress-reactivity for a greater cause, rather than a detriment. **BACKGROUND:** Skydivers experience robust idiosyncratic and physiological stress responses. Speculation exists that extensive prior experience with a stressor may shift the activation of emotion-regulation neurocircuitry. Over time, adrenal hyperactivity and memory consolidation in the amygdala, not only leads to neural plasticity, but can result in desensitization and hazardous behavior. **CASE PRESENTATION:** A 49-year-old experienced skydiver, jumped from a Beechcraft King Air at an altitude of 14,000 feet. Freefall was uneventful, followed by deployment of his parachute without incident. Medical history positive only for hypertension. Other relevant information includes: noncloudy weather, 85 degrees Fahrenheit, ground wind speed 4 mph; no new or unfamiliar gear; jumper was licensed by the USA Parachute Association and had over 7000 jumps in 20 years. On approach under canopy, jumper made a series of intentional rapid turns, called "hook turns," including a 180 degree return on final, causing a hard landing on impact. He subsequently suffered innumerable bone fractures, crush injuries, internal hemorrhage and died soon after being airlifted to a Level 1 Trauma Center. The jumper was under a square, steerable and stable canopy and a thorough Federal Aviation Administration investigation concluded no equipment failure or liability, other than human error. **DISCUSSION:** When skydiving becomes mundane, jumpers steadily max out the capabilities of gear, altitude and judgement—often by flying smaller canopies and performing high-speed turns. This case illustrates the point that persons in high performance occupations should be on the lookout for desensitization and neurasthenia. We must remain cognizant of the many barriers to recognize this, to include naivete, unfamiliar beliefs and seemingly top performance that continually pushes the limit. Additionally, we can take cues from this case and seek to advance our knowledge in order to constructively utilize high performance and so-called desensitization. Rather it be destructive, we can identify certain behaviors and exploit them for maximal production and performance in any given field.

Learning Objectives

1. Have a better understanding of the downstream effects of desensitization in high performance professions.
2. Learn from a case in which an experienced skydiver committed a fatal mistake in judgement.
3. Seek out opportunities to utilize high-performance emotional adaptations for positive results.

[436] BIODYNAMIC ASSESSMENT OF NOVEL TWO-PIECE HH-60 SEAT BACK CUSHIONS DURING VERTICAL IMPACT

Daniel Catrambone[1], Chris Perry[2], John Buhrman[2], Joseph Strzelecki[2]
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(Original Research)

INTRODUCTION: It has been determined that human vertebrae can support loads 19.9 times their normal supported weight (19.9 G) with injury potential dependent on factors such as posture and age (Desjardins). Of particular concern, the lumbar region is the location of injury in up to 61% of vertebral fractures resulting from military helicopter crashes (Stemper, et al.). The purpose of this study was to investigate a novel seat back cushion of varying heights designed for the HH-60 rotary wing aircraft that could potentially modify lumbar spine mechanics and biodynamics, compared to a traditional HH-60 back cushion or no cushion conditions, while wearing a body armor vest. **METHODS:** A rigid seat was mounted at a 5° recline (appropriate for HH-60 crew seat) in a +z-axis impact orientation on the front vertical surface of the Vertical Deceleration Tower (VDT) drop carriage. The seat back cushions that were investigated consisted of several configurations of a two-piece, HH-60 seat back cushion designed by Survival Innovations and its commercial partners. The lower segment of the two-piece back cushion was tested in 6, 7, 8 and 9 inch height variations, observing load support and spine biodynamics during vertical crash simulations of an Anthropomorphic Test Device (ATD) wearing a size large armored vest with appropriate Kevlar plate inserts. The ATD that was used for this effort was the Large Anthropomorphic Research Device (LARD) manikin dressed in a standard USAF flight suit, and with a test weight of approximately 245lbs. The ATD was centered in the seat on a standard HH-60 seat-pan cushion, and restrained using a five point restraint harness with rotary buckle. The VDT was configured to provide a vertical input acceleration (Z-axis) of approximately 11 G measured on the VDT carriage, which provided a peak Z-axis acceleration of approximately 20 G in the chest of the LARD manikin. The achieved 20 G chest acceleration was intentionally targeted based on previous research of stroking seats in the HH-60 aircraft. **RESULTS:** Lower Cushion Only 8" (1203.5 ± 14.9lbs) and Lower Cushion Only 9" (1167.0 ± 1.4lbs) demonstrated statistically significant lower lumbar resultant loads ($P<0.05$) compared with Full Back Cushion (1338.2 ± 27.6lbs), No Back Cushion (1335.5 ± 23.3lbs), and Lower Cushion Only 6" (1342.5 ± 65.8lbs) test conditions respectively. No additional statistically significant differences of lumbar resultant loads were observed. **DISCUSSION:** The 8" and 9" lower back cushions reduced lumbar resultant loads by 10% and 13% respectively compared to the full back cushion test condition while body armor was worn during simulated vertical crash tests and demonstrated strong potential for reducing injuries. Additional tests are warranted to next investigate comfort and performance.

Learning Objective

1. Understand that reducing resultant lumbar load in vertical crash scenarios could reduce potential injury and improve chances for survivability.

[437] COMPARING THE EFFECTS OF USA AIR FORCE HELMETS ON NECK KINEMATICS AND FATIGUE

Molly Wade[1], Emily Mills[2]
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(Original Research)

INTRODUCTION: Joint Helmet Mounted Cuing System (JHMCS) helmets used in high performance aircraft have a mounted display to show mission critical information. This added functionality comes at the cost of increased weight and shifted center of gravity compared to standard HGU-55/P helmets, which may lead to increased neck pain, fatigue, and injury, even at ground level. This study compared changes in cervical neck range of motion (ROM), isometric strength, and subjective discomfort when wearing a JHMCS helmet compared to an HGU-55/P helmet in a 1 G laboratory setting. **METHODS:** Forty subjects volunteered for two days of laboratory testing where one helmet was worn on each day. Subjects were seated in a rigid chair with a back rest reclined to 10 degrees and asked to perform six neck motions: flexion, extension, right rotation, left rotation, right lateral flexion, and left lateral flexion. Maximum joint angles and isometric neck strength were recorded. Subjects also answered a subjective discomfort questionnaire. These testing procedures were repeated three times per day: without a helmet, with a helmet, and after wearing a helmet for one hour. **RESULTS:** Decreases in all ROM measures were found after donning either helmet. Wearing either helmet for one hour did not consistently alter ROM further, except for extension in the HGU-55/P helmet ($p = 0.011$) and right lateral flexion for both helmets (HGU-55/P $p = 0.003$, JHMCS $p = 0.046$). JHMCS helmets caused decreases in neck strength for right ($p = 0.028$) and left ($p = 0.011$) rotations and right lateral flexion ($p = 0.004$) after one hour, while the HGU-55/P caused decreases in neck strength during extension ($p = 0.009$) after one hour. JHMCS helmets had significantly greater discomfort in the head region after one hour compared to HGU-55/P helmets ($p = 0.020$). **DISCUSSION:** Range of motion was significantly reduced when donning either helmet; however, additional changes in ROM were not seen after one hour. in either helmet. Neck strength was not consistently influenced by helmet or time. Reduced ROM and strength have operational significance for high performance aircraft pilots who are turning their heads in the aircraft; however the degree of reduced function that results in operational decrements has not been determined. Larger decrements in neck ROM and possibly neck strength would be expected when wearing the helmets for longer periods of time and under high G forces, which future research may examine.

Learning Objectives

1. The audience will learn about the differences in neck and head discomfort while comparing helmet types in a 1Gz environment.
2. The audience will gain knowledge on changes in neck range of motion when donning different high performance aircraft helmets and after one hour of wearing a helmet.
3. The audience will learn if there are any changes in isometric neck strength after wearing high performance aircraft helmets for one hour, which could be related to neck fatigue.

[438] SHORT-TERM RESPONSE OF TWO SEPARATE EXERCISE REGIMENS ON NECK FUNCTION AMONG F-15E AIRCREW: A PILOT RANDOMIZED TRIAL

Maximilian Lee[1], Robert Briggs[2], Brian Young[3], Gregory Kearby[4], Vanessa Scheirer[5]
[1]U.S. Air Force, Niceville, FL, USA; [2]U.S. Air Force, Fort Sam Houston, TX, USA; [3]University of Baylor, Waco, TX, USA; [4]U.S. Air Force, RAF Lakenheath, United Kingdom; [5]U.S. Air Force, Davis Mothan AFB, AZ, USA

(Original Research)

INTRODUCTION: Neck pain is common among fighter aircrew, yet there is insufficient evidence to guide examination, testing, treatment, and prevention of neck pain in the affected population. The purpose of the study was to collect baseline data for neck function in F-15E aircrews and to determine efficacy and feasibility of two exercise protocols by analyzing objective and subjective functional measurements. **METHODS:** Forty-one F-15E aircrew were enrolled by sample of convenience then randomly assigned to a progressive neck muscle strength and mobility group (PRO) or a generalized strength and mobility group (GEN). Dependent variables were cervical range of motion, joint repositioning error, and neck girth. Data collection occurred at baseline, 3 weeks, and 3 months. **RESULTS:** At baseline, 41.1% reported neck pain and 79.5% has a prior history of neck pain attributed to flying duties yet 12.8% reported being grounded from flight duties for neck pain. Follow ups were recorded in 43% of originally enrolled at week 3 and 34% at 3 months. BMI (p=0.047) was the sole difference between groups. A statistically significant improvement in left cervical sidebend was seen in the GEN group (p = 0.029), but 3.5 degree improvement was within measurement error. Both groups had significant improvement over time in the composite cervical range of motion (ROM) but there were no between group differences. No differences were seen in joint repositioning error or neck

girth. Post-hoc analysis showed that aircrew with current neck pain had higher total flight hours ($p = 0.027$) and higher F-15E hours ($p = 0.006$). Aircrew without neck pain trended towards longer deep neck flexor hold times and higher composite cervical ROM at baseline, but differences weren't statistically significant compared to those with neck pain. **DISCUSSION:** This study supports prior surveys on the prevalence and self-reported neck pain in fighter aircrew. Total flight hours and F-15E flight hours are significantly correlated with neck pain. Left cervical sidebend in the GEN group and composite ROM improvements in both groups over time were significant but clinical implications require further study. Moreover, aircrew lost to follow up limited assessment of deep neck flexor hold times and joint reposition error as screening tools. Finally, future studies should integrate exercise policy and data collection in training units with dedicated resources for long-term follow-ups.

Learning Objectives

1. The audience will learn about the prevalence and reporting practices of high performance jet aircrew.
2. The audience will learn about risk factors correlated with neck pain and objective measurement tools that can be used to study future neck strength, range of motion, and injury prevention strategies.

[439] CURRENT PREVALANCE OF NECK PAIN IN UK MILITARY AIRCREW

Vivienne Lee[1], Jonathan Boyd[1], Ken Puxley[1], Sarah Day[1]
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(Original Research)

INTRODUCTION: Neck pain is known to be a potential consequence of military flying associated with exposure to high G, the use of head mounted equipment and the need to achieve unfavourable postures. There is a need to understand the prevalence of neck pain amongst aircrew and identify associated factors in order to tailor mitigating strategies. The NATO HFM RTG 252 on Aircrew Neck Pain Prevention and Management has recently published recommendations to help quantify and mitigate neck pain. In order to allow comparison across nations of prevalence of neck pain in military aircrew a set of core questions were recommended. The aim of the current work was to establish the prevalence of neck pain in the UK military aircrew population using the NATO recommended core questions. **METHOD:** A questionnaire, based on NATO core questions, was developed and distributed to all UK military aircrew via an e-survey in March 2019. Questions on neck pain experienced over the 12 month period prior to the survey together with exercise and activity undertaken outside of flying, platform flown and head equipment worn were asked. The NATO definition of significant flight related neck pain was used. **RESULTS:** 596 responses were received across all aircraft platform types. Significant flight related neck pain was reported by 51% of fast jet (FJ), 17% of FJ trainer, 41% of rotary wing (RW) and 22% of multi-engine (ME) aircraft aircrew. 22%, 21% and 8% of FJ, RW and ME respondents respectively perceived neck pain to have an impact on safety during a 'worst-case' flight. Significant associated factors ($p < 0.05$) included Night Vision Goggle (NVG) use in the past 12 months (FJ and ME) and time spent wearing NVGs (RW). Time sitting at work, excluding flying, was also a significant factor associated with neck pain for FJ aircrew ($p=0.01$). **DISCUSSION:** Neck pain continues to be reported by UK military aircrew. For the first time in the UK, duration spent sitting at work (excluding flying) has been identified as an associated factor suggesting workspace ergonomics is an important factor. This may have potential to be modified to add to the suite of interventions to help address aircrew neck pain.

Learning Objective

1. The audience will be able to understand the current prevalence of neck pain in UK military aircrew and understand current factors that are associated with neck pain.

[440] PREVALENCE OF HEARING LOSS IN ITALIAN AIR FORCE PILOTS

Claudia Milella[1], Daniela Sarandria[1], Federico Piccoli[1], Angelica D'Angelo[1], Marco Lucertini[1]
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(Original Research)

OBJECTIVE: The aim of this study is to estimate the prevalence of hearing loss among Italian military pilots. Military aviators are potentially at risk for developing noise-induced hearing loss, for this reason they are examined using pure tone audiometry and tympanometry test every 12 months in our Institute. **METHODS:** we examined the reports of the visits performed by pilots belonging to the Italian Air Force throughout 2018. Reviewing the final report of the visits, we collected data about the prevalence of hearing loss. According to ITAF rules, normoacusia is a threshold ≤ 20 dB on each frequency tested (250, 500, 1000, 2000, 3000, 4000, 6000 and 8000 Hz). An increase of the threshold in any frequency leads to the diagnosis of hearing loss. **RESULTS:** the study includes 993 pilots, 967 male (97,4%) and 26 female (2,6%) examined during 2018. Mean age was 41 years. Of these, 269 (27%) had a diagnosis of hearing loss: 176 (17,7%) bilateral sensorineural hearing loss, 26 (2,6%) right sensorineural hearing loss, 61 (6,1%) left sensorineural hearing loss, 6 (0,6%) bilateral mixed hearing loss. No pure conductive hearing loss was found. **DISCUSSION:** Further studies are needed to examine whether different hearing deficits are due to total flight hours or different ambient aircraft noise exposure.

Learning Objective

1. The audience will learn about the prevalence of hearing defects among pilots.

[441] EFFECTS OF LOW LEVEL NITROUS OXIDE (N2O) EXPOSURE ON PILOT COGNITION AND PERFORMANCE

Frank Golich[1], Tatana Olson[1], Leslie Drummond[2], Adam Biggs[3], Dain Horning[1], Matthew Doubrava[1], Megan Gallo[1], Matthew Funke[1], Brian Sharits[1], Richard James[1], Karen Mumy[1]
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(Original Research)

INTRODUCTION: Physiological Episodes (PEs) often include symptoms indicative of having a Central Nervous System (CNS) origin. Chemical contaminants had been a suspected cause of PEs, and although a number of chemical compounds have been identified in and around US Navy aircraft, all appear to be within regulatory limits. Surprisingly, Nitrous Oxide or "Laughing Gas" was detected in the vicinity of F-18 and T-45 aircraft at concentrations up to 17 parts per million. It is currently unknown whether low level nitrous oxide exposures present an operational hazard to aircrew cognition. The aim of this study was to test this hypothesis by exposing human participants to representative nitrous oxide exposure levels to evaluate resultant performance or cognitive effects. **METHODS:** NAMRU-Dayton has the capability of conducting benchtop, animal and human research as well as our own Institutional Review Board (IRB) to monitor our human research protocols. Participants (3 females and 12 males) were exposed for two hours to a nitrogen / oxygen control gas mixture as well as to nitrous oxide at 500 ppm in the same mixture. Continuous physiologic measurements were conducted including blood oxygenation (SpO_2) using a transcutaneous oximeter, and heart and breathing rates using a Zephyr™ Bioharness monitor. Cognitive assessments including a Go / No-Go task, a Color Continuum task, and a Flight Simulator task with time estimations were conducted, and symptoms were documented. **RESULTS:** Manifested effects included a significant increase in breathing rate ($p = 0.019$) and a near significant increase in heart rate ($p = 0.12$). A significant increase in Time Estimation Error (TE_{ERR}) ($p = 0.0045$) was identified between conditions during the first of three testing cycles in the exposures. An analysis of reported symptoms did not reveal any differences between conditions ($p = .79$). **DISCUSSION:** The results imply a slight effect due to nitrous oxide exposures as manifested by an increase in breathing rate and slight increase in heart rate along with an increase in TE_{ERR} in the test condition vs. the control condition. These results do not entirely rule out low level exposures to nitrous oxide in terms of causing slight physiological and cognitive changes; however, the results would make it difficult say with absolute certainty the presence of this contaminant is causal of reported PE symptoms.

Learning Objective

1. To understand the cognitive, physiologic, and symptomatic effects of Nitrous Oxide exposures with respect to its role as a possible cause(s) of Physiological Episodes.

[442] ALUMINIUM CONTENT IN CREW-MEALS

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(Original Research)

INTRODUCTION: The aluminum contents in crew meals have been measured and compared with existing data to estimate and evaluate the uptake of aluminum by crew members. Results were also compared to existing official data on common aluminum contents of typical foods in Germany. **METHODS:** Lufthansa Crew Meals are produced by the Lufthansa Service Company. The Meals are packed hot into sealed aluminum boxes right after been cooked and subsequently cooled to at least 39 degrees F, the so called `Cook&Chill´ Process. The food packages are then handled entirely in a cold chain until the food trays are reheated in the stove on board the plane. All meals tested were heated to 338 degree F for 25 minutes after the above mentioned `Cook & Chill´ process. Values reported represent total aluminum content composed of the natural content in the food plus the potential migration from the aluminum trays. **RESULTS:** Extensive tests at an accredited food safety laboratory reported total aluminum contents of between 2 and 5 mg/kg in most meals. The calculated incorporation of aluminum per person per week is about 9 mg based of a typical crew meal of 500 g and a typical 3,5 days per week on board a plane. **DISCUSSION:** In 2013, the European Council recommended a maximum of 5 mg/kg of aluminum in food based on the principal that this should be reasonable achievable (ALARA-Principle). However, so far no medical reasons have been established for such a limit. The tolerable weekly ingestion (TWI) recommended by the European Food Authority (EFSA) is 1 mg per kg body weight. Crew meals contribute on average approximately only 13% of the tolerable dose of aluminum ingestion per week as recommended by EFSA (Tolerable maximum 70 mg for a person of 70 kg weight per week). The migration of aluminum from the trays into the food during the `Cook & Chill´ process is estimated to be fairly low based on standard food science. During chilled distribution virtually no aluminum migration from the trays into the food is expected. Limiting the re-heating process and avoiding longer warm holding periods is expected to further reduce aluminum migration into the food. However, the extent of aluminum migration into the food can differ by food types. In particular, foods high in natural acids seem to leach out more aluminum during the heating process. Bioavailability of aluminum is very low due to the fact that less than 1 percent of aluminum passing the gut is absorbed into the body.

Learning Objectives

1. The Aluminum Content of meals produced in Germany is low. It varies with the natural acids in the food.
2. The `Cook & Chill´ process does not cause a significant migration of aluminum from the tray into the food.
3. Heating of crew meals in the stove on board for 30 minutes is save.

[443] ENVIRONMENTAL HEALTH RISKS DURING EXPEDITIONARY MEDICAL OPERATIONS IN A BARE MILITARY BASE IN SOUTHWEST ASIA: A CASE REPORT

Carolyn Prill[1]
[1]*Nellis AFB, Las Vegas, NV, USA*

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: This case report describes challenging issues encountered during an initial three months of joint military medical operations in Southwest Asia. **BACKGROUND:** A team of medical service members was tasked to support a contingency by setting up an Expeditionary Medical Support (EMEDS) clinic at a bare base. **CASE PRESENTATION:** Upon arriving to the base, a clinic was set up to support a population of 800 military personnel at the end of three months. EMEDS consists of preventive medicine [Bioenvironmental Engineering (BE), Public Health, and Independent Duty Medical Technician], primary care, and ground surgical teams. The factors that threatened the health of the force were suboptimal sanitation conditions, heavy dust, and machine noise. The latrines evolved from Cadillac to Harvest Falcon and SEA BOX expandable tents. Compared to residential toilets, latrines used in the AOR are all vulnerable to clogging by toilet paper and especially baby wipes. These clogs can damage pumps, forcing Civil Engineering to shut down latrines. E. coli was also detected in the non-potable water system used for showers, personal sanitation, and dish washing. Chlorine took several weeks to acquire, but was eventually added to the system to combat the contamination. The source of the E. coli was identified as trucks that delivered water from a nearby water plant. The primary care team did not see a spike in DNBI cases such as diarrhea due to this contamination. However, dry-coughing and congestion cases were more prevalent, which may be related to high levels of dust in the air. In addition, there is a risk of chronic disease related to crystalline silica exposure from the dust. BE sampled for airborne PM2.5 and silica for further analysis. Much of the dust arose from the nearly constant construction of a base course from granite gravel. In addition to creating dust, noise levels similar to heavy construction sites were often present 24-hours per day near living tents. This noise interrupted sleep, though no noise dosimetry could be conducted to determine 8-hour Time Weighted Average decibel exposure due to lack of equipment. **DISCUSSION:** The case highlighted the operational medicine challenge during the first base set up outside the US in the past 20 plus years. The environmental and occupational health hazards such as sanitation, dust, and noise should be aggressively addressed early on to mitigate their negative impact on troops' health and mission.

Learning Objective

1. Understand the challenges faced by Expeditionary Medical Operational Support in an austere environment while deployed; the risk factors such as sanitation, dust, and noise that threaten force health; and mitigation measures.

[444] MEDIATORS OF THE RELATIONSHIP OF VIDEO GAME AND FLIGHT SIMULATION EXPERIENCE WITH FLIGHT PERFORMANCE

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(Original Research)

INTRODUCTION: The Aviation Selection Test Battery (ASTB) is used by the Navy, Marine Corps, and Coast Guard to select candidates eligible for naval aviation training. A subtest of the ASTB, the Performance-Based Measurement (PBM), includes tasks assessing spatial rotation, dichotic listening, and physical tracking skills. Consistent with previous research indicating video game playing enhances these skills, self-reported video game experience and self-reported experience with hands on stick and throttle (HOTAS) flight simulation were correlated to scores on PBM tasks. Additionally, HOTAS flight simulation experience was also correlated to student flight performance during training. The purpose of this study was to evaluate whether the PBM mediated the relationships of video game and HOTAS experience with primary flight grades. **METHOD:** Archival data was from 1,132 student naval aviators (94.4% male, 87.0% Caucasian). PBM task scores were regressed onto video gaming experience and HOTAS flight simulation experience and residualized. Primary flight training grades was then regressed onto the PBM residuals and PBM variables. **RESULTS:** Comparison between results of these regressions indicated more variance accounted for by the PBM task scores ($R^2 = 0.08$) than for the residualized PBM scores ($R^2 = 0.05$). **DISCUSSION:** The results suggests mixed evidence of mediation by PBM task scores of the relationships between gaming and HOTAS experience with flight grades.

Learning Objectives

1. The audience will learn about the importance of the performance-based measurement in the selection of aviators.
2. The audience will learn about skill development related to video game playing and its relation to successful operation of an aircraft.

[445] FLIGHT SYSTEM EVALUATION: USING ELECTROENCEPHALOGRAPHY TO MINIMIZE TRAINING TIME

Jim Chiaramonte[1], Kyle Bernhardt[1], Katie Feltman[1]
[1]*U.S. Army Aeromedical Research Laboratory, Ft. Rucker, AL, USA*

(Original Research)

INTRODUCTION: The involvement of Army rotary-winged aviators in desert areas like Iraq and Afghanistan has ramped-up efforts to combat flight in degraded visual environments (DVEs). The Army's DVE Mitigation

program seeks to develop technologies-primarily in the areas of advanced flight control laws, pilot cueing, and environmental sensors-to assist pilots when flying in DVEs. A logistical consideration with DVE mitigation is how to minimize training time for pilots transitioning to new DVE technologies. One potential avenue to shorten training time is to leverage psychophysiological measures to estimate pilot workload during initial system development to make design decisions. The purpose of this study was to demonstrate the use of electroencephalography (EEG) to assess pilot workload during the evaluation process of a new integrated cueing environment designed for flight in DVE. **METHOD:** Eight rated UH-60 Blackhawk pilots tested two versions of a visual symbology set displayed on a panel mounted and helmet mounted display. One symbol set (Symbol Set A) incorporated more cueing information and the other set (Symbol Set B) incorporated less. Participants performed eight DVE flights in a full-motion UH-60 Black Hawk simulator. EEG indices of workload were recorded from participants via a wireless EEG unit during the flights. Flight performance metrics were also collected. **RESULTS:** Flight performance metrics indicated a clear advantage of Symbol Set A over Symbol Set B during enroute and landing phases of flight. Symbol Set A resulted in better lateral, vertical, and speed control enroute and more accurate touchdowns at landing. EEG workload metrics suggested a similar pattern. However, these data indicated that pilot workload, when measured at the level of cortical activity, depended on if the particular symbol set was presented on either a helmet- or panel-mounted display. Specifically, display type modulated EEG workload only when Symbol Set B was used, further supporting the choice of Symbol Set A. **DISCUSSION:** This study demonstrated the use of a physiological measure to make recommendations for minimizing pilot workload with a new DVE flight system. The use of EEG in this study allowed for a more fine-grained analysis of pilot workload not readily observable with overt flight performance. Using psychophysiological measures to quantify pilot workload may be a viable option for making design decisions that can reduce workload and thus pilot training time.

Learning Objective

1. Understand using psychophysiological measures to reduce new flight system training time through informed system testing.

[446] THE COGSCREEN LRPV SCORE: AN INDICATOR OF COGNITIVE FUNCTIONING?

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(Original Research)

INTRODUCTION: The CogScreen AE, a computerized cognitive screening test used extensively by the FAA to assess pilot's cognitive functioning is well validated and has been in use for over 20 years. The CogScreen consists of 13 subtests designed to assess multiple cognitive domains. A score call the LRPV is a calculated score which is said to indicate the likelihood of cognitive impairment. The purpose of this study is to examine the relationship between the LRPV and other neuropsychologic tests. Specifically, to find the which neuropsychological tests account for the largest degree of variance in LRPV scores. It is hypothesized that LRPV scores will correlate highly with other tests in the "core" battery if the CogScreen proves to be a good indicator of overall cognitive functioning in the aviation environment. **METHODS:** The subjects were 38 pilots seeking a medical certificate who were seen for ADHD, SSRI, Neurological disorders and HIMS evaluations. The sample included airmen seeking 1st through 3rd class medicals. Data was analyzed using SPSS v. 25 to perform Pearson correlations on the CogScreen LRPV raw score and demographically adjusted t-scores on 6 other measures of neuropsychological performance (i.e., TOVA visual omission and commission scores, CVLT learning total, Trails B, BCT, and PASAT total). **RESULTS:** Data from Neuropsychological evaluations of 38 adult pilots (40±17 years old, 90% male, 15±2 years education) were analyzed. Performance on the LRPV was moderately related to CVLT learning total ($r = -.38$; $p = .02$; 14% shared variance) and BCT ($r = -.40$; $p = .02$; 16% shared variance). LRPV performance was not related to TOVA visual omission ($r = .02$; $p = .93$) and commission scores ($r = .22$; $p = .18$), Trails B ($r = .01$; $p = .96$), or PASAT total ($r = -.29$; $p = .15$). **DISCUSSION:** Based on the results of our analyses, it appears that the CogScreen LRPV is greatly influenced by learning and concept formation factors. There is likely a large impact of executive functioning on the tests which constitute the LRPV. The implication of this finding is that there may be many areas of strength or deficit which are untapped by the LRPV score. Therefore, using the LRPV to make decisions about an airman's overall level of cognitive functioning is likely to lead to erroneous conclusions and a full battery of neuropsychological tests should be performed in call cases of aeromedical significance.

Learning Objectives

1. The audience will learn about Neurocognitive factors in pilot selection.
2. The audience will learn about the assessment of various cognitive domains.
3. The audience will learn about the use of testing in pilot selection.

[447] REAL-TIME COGNITIVE WORKLOAD ESTIMATION USING EEG DATA IN VIRTUAL ENVIRONMENT

Yuko Aiba[1], Yasutaka Wachi[2], Koichiro Hada[2], Masashi Arake[3]
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(Original Research)

INTRODUCTION: Military personnel who use advanced intelligence systems such as unmanned aerial vehicles have to build optimal situation awareness and make an effective decision from complicated information. Human machine interface of the intelligence systems should be designed to maintain acceptable level of their cognitive workload for preventing human errors. In this study, we research about the method for real-time estimation of cognitive workload using EEG and apply it to complicated cognitive tasks under virtual simulation environment for confirming the validity. **METHODS:** Experiment1: Nine military personnel executed N-back tasks which can control the level of cognitive load by adjusting the number of load factor 'N'. The experiment was consisted of three types of tasks: 1-back, 2-back and 3-back tasks. We analyzed EEG signals during the tasks and built two types of models which could classify EEG data according to 'N' using regression analysis technique (Partial Least Squares (PLS) regression) and deep learning method (Stacked auto encoders(SAEs)). We compared the classification accuracy between two types of models. Experiment2: Six military personnel executed simulated military mission tasks (high and low cognitive load tasks) under virtual simulation environment. EEG signals, subjective measure and performance measure were recorded. EEG data were classified according to 'N' every one second by the classification model. The classified values as estimated cognitive workload were compared with subjective measure and performance measure to confirm the validity. **RESULTS:** Experiment1: SAEs (95.4%) could classify more accurately than PLS regression (86.7%). Experiment2: Estimated cognitive workload was consistent with the results of subjective measure and performance measure during the simulated mission tasks in the virtual simulation environment. **DISCUSSION:** SAEs were more accurate method than PLS for classification of EEG signals according to the cognitive load. SAEs could convert multidimensional EEG data into more abstract expressions through a simple non-linear model and fuses features by optimization algorithms. In addition, estimated cognitive workload using EEG signals were related subjective measure and performance measure. From these results, it might be confirmed about concurrent validity. We would like to apply our method which could estimate cognitive workload in real time to the educational method such as flight simulator training.

Learning Objective

1. The participant will be able to obtain knowledge about the method of estimating cognitive workload using machine learning methods.

[448] A HANDS-FREE, VISUAL SEARCH TASK WITH SCALABLE DIFFICULTY BASED UPON THE TRAIL MAKING TEST: A PLATFORM FOR ASSESSING COGNITIVE WORKLOAD

Christopher Aura[1], Ellis Akins[1], Leonard Temme[1], Joseph Bleiberg[2], Paul St. Onge[1]
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(Original Research)

INTRODUCTION: The Trail Making Test was initially developed as part of the U.S. Army Individual Test Battery (1944) to measure central

executive functioning. More recently, electronic versions have been developed using touch-screen technologies to optimize delivery and configurability (Fellows et. al., 2017). U.S. Army Aeromedical Research Laboratory (Ft. Rucker, AL) has created a new method using eye-tracking to provide a hands-free capability with expanded task-cuing to increase cognitive demands and reduce interaction time through streamlining test administration. **METHODS:** Stimuli were presented on a screen in conjunction with IR-based video eye-tracking to allow gaze-based user input. Volunteers visually locate and briefly fixate sequential individual numbers as quickly as possible. Two sets of numbers are presented, each set with a unique characteristic, with the correct number having the characteristic-matching cue presented on one side of the screen. Further, an interrupt cue present at another side of the screen indicates when the subject is to break sequence and fixate on an interrupt target located amongst the numbers. Difficulty is controlled by the frequency of the characteristic and interrupt cues occurring within the counting sequence. Eye position and pupil area were collected continuously for oculometric analysis of task workload and fatigue. **RESULTS:** Time to completion scaled with task difficulty, demonstrating that the visual trail making task was effective at reliably manipulating cognitive workload. Oculometrics, including saccade dynamics, blink rate, and pupillary dilation, were of sufficient to allow the application of various mental workload metrics, further demonstrating the effectiveness of the scalable difficulty of the task. Data were collected with this paradigm from individuals in several operationally relevant environments (including a UAV simulator and BlackHawk simulator) using multiple camera-based eye tracking solutions. Stimulus code will be made available upon request. **DISCUSSION:** This task generated controlled levels of mental workload without manual or verbal responses from the participant. Further, it provides oculometric data in conditions more akin to a naturalistic viewing environment, where the point of gaze seldom remains fixed to a single point in space. The automatic execution and widely reconfigurable nature of this paradigm allow rapid administration and simplified data collection.

Learning Objective

1. To introduce and detail a hands-free visual search task based upon the Trail Making Task used to induce graded levels of cognitive workload for oculometric studies.

[449] PUPIL DIAMETER AS AN INDEX OF COGNITIVE WORKLOAD

Kevin Baugher[1], Leonard Temme[1], Christopher Aura[2], Paul StOnge[1], Amanda Hayes[1], Bobby Bowers[1]
[1]U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL, USA; [2]Goldbelt Frontier, LLC, U.S. Army Aeromedical Research Laboratory; Fort Rucker, AL, USA

(Original Research)

INTRODUCTION: Effects of light on pupil diameter (PD) are dramatic and well known. Less well known and dramatic are the effects psychophysiological states have on PD. Recent literature describes characteristic pupillary behavior as a promising objective biomarker of mental workload. One challenge is to differentiate the pupil's workload response from its light response. The findings reported here describe the pupil's response to three mental workload levels under three well-defined lighting conditions. **METHODS:** A commercial, off-the-shelf eye tracker recorded PD binocularly at 500 Hz (EyeLink 1000+ SR Research) in 22 volunteers as they performed a commonly used cognitive task involving short-term numeric memory and recall, the Delayed Digit Recall Task (N-Back). Each volunteer performed an easy, moderate, and difficult N-Back task configuration for 30 seconds under three levels of calibrated lighting—low (0.1 cd/m2), moderate (8.0 cd/m2), and high (80.0 cd/m2) photopic luminance. These stimulus conditions were randomized across volunteers as a balanced Latin-square. **RESULTS:** Average (standard error) PD was ≈ 6.5 (0.21) mm for low luminance, ≈ 4.9 (0.21) mm for moderate luminance and ≈ 3.4 (0.12) mm for high luminance. Preliminary analysis shows N-Back difficulty significantly affected PD at each luminance such that, in general, the more difficult the task the larger the PD. Notably, the increase in PD with increasing workload, averaged between eyes over subjects, was about 0.236 mm whereas the change in PD in response to luminance averaged about 1.539 mm. Thus, the size of the PD workload response is about 15% that of the PD light response. While PD systematically increased with increased work load for each luminance for each eye, most of these differences were not statistically significant. **DISCUSSION:** These results confirm that the PD reflects both luminance as well as cognitive workload. The two responses are combined in PD with the workload response a fraction of the light response. These are encouraging results. A stable lighting condition allows the separation of the two types of responses. Subsequent analyses of additional data will describe the separation of the PD workload response from PD light response in the presence of well-defined, well-controlled sinusoidally modulated light.

Learning Objective

1. Understand the differential effects on pupil diameter of cognitive workload vs. level of ambient luminance.

Thursday, 05/21/2020 ***3:30 PM***
Centennial I

[S-82]: PANEL: CAREER OPTIONS AFTER RESIDENCY IN AEROSPACE MEDICINE

Chair: Kazuhito Shimada

Co-Chair: Terrance Taddeo

PANEL OVERVIEW: Not all of beginner in Aerospace Medicine have a clear idea in selecting life after residency. Especially if you are a civilian, job openings are only a few per an institute each year. Still, as there are so many types of aerospace medicine jobs, if you look beyond popular institutes, there are abundant openings in the wide market. In this session, each panelist will share their actual professional life story: what happened after graduating from the medical school. We hope the information from this session help audiences to find more opportunities. Panelists with vast spectrum of specialties, space agency, aviation authority, academia, industry entities, are selected to give their view in aerospace medicine career development. One of the panelists will also provide foreign medical graduate view in addition. Panelists from today's session were all trained at the Aerospace Medicine Program at Wright State University. Unfortunately, this program at Wright State University no longer accepts any new resident. NASA used to fund the scholarship for two residents per year at the time of panelists' era. Many NASA scholarship graduates from Aerospace Medicine program led by late Dr. Mohler were selected to work at NASA, which was the result sponsor aimed for. Other than NASA, about dozen more graduates went to work at non-US space agencies. The largest group of aerospace physician resides in FAA. As you all know, FAA assists Aviation Medicine Examiners and keeps the system active. Within FAA, the clinical section is not the only section hires medical specialist. Many other aviation medical science sections also hire medical specialists. FAA's aerospace physicians group locates in Oklahoma, but many other branches exists in US, which means many more career opportunities. Please also note that FAA's operation as the federal authority is spreading to the commercial human space flight. In academic field, teaching positions in aerospace medicine is not a big entity, but their position is very fulfilling as they generate new colleagues of AsMA. There is always a chance of new institute establishing. Recent trend in the growing aviation industry is that traditional aviation business seeks not only clinical and occupational, but also other disciplines. Last of all, we would like to see more Foreign Medical Graduates trained internationally. Receiving aerospace medicine training in US is not easy, but there are some succeeded cases.

[450] INTERNATIONAL VIEW OF U.S. RESIDENCY IN AEROSPACE MEDICINE

Kazuhito Shimada[1]
[1]Tsukuba Koken, Tsukuba, Japan

(Education - Tutorial Proposal)

INTRODUCTION: Aerospace Medicine attracts not only those in the US, but also others in the world. When you look into the demography of our customers, US has ca. 600,000 pilots, in addition to cabin and ground personnel who are at roughly the same number. Extrapolating this to the world population of 7,000,000,000, we

wonder why there are very few Residents in Aerospace Medicine outside US. Especially when customer number is growing with exploding population of drone operators, which we did not even included in our count here. **TOPIC:** How can the world educate necessary number of Aerospace Medicine personnel, specially Residents in Aerospace Medicine? We should look around the audience at AsMA to find hints. One of the keys is international activities. In many countries, the core role in Aerospace Medicine is assumed by Aviation Medical Examiners. FAA goes out of US and educate foreign AME's. Although only a small number of Foreign Medical Graduates are found among RAM programs, roles of those graduates are important in fulfilling the need of Aerospace Medicine leaders in countries outside US. In reality, every government authority is not familiar with why pilot medical certification is technically hard. Therefore, each government authorities need personnel who received formal education in Aerospace Medicine even more. **APPLICATION:** There are some obstacles to achieve mutual international collaboration. In USs' case, passing USMLE can be overcome by individual's effort, however, VISA requirement is tough with the additional financial burden. In the past, there were some cases that FMG RAM was denied access to medical facilities on a US base. However, now US bases are closed to all civilian foreigners. Therefore, abundant medical infrastructure for RAM education are unavailable to FMG. At present, it is not practical for an FMG to enter a RAM program and eventually become board-certified in Aerospace Medicine without governments support. US Air Force has a high need for RAM graduates, and they also provide "Advanced Aerospace Medicine for International Medical Officers", a 23-weeks course to foreign military physicians. It may not be easy to run such program by civilians, but considering the successful results from the past data, it is worth considering it. Education institutes should review AAMIMO program, and providing feedbacks for the future civilian program.

Learning Objective

1. The audience will learn about roles, issues, and possible improvements of USA RAM programs, seen from an international standpoint.

[451] CAREER OPPORTUNITIES AT THE FAA CIVIL AEROSPACE MEDICAL INSTITUTE (CAMI)

Melchor Antunano[1]
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(Education - Program / Process Review Proposal)

The FAA Civil Aerospace Medical Institute (CAMI) is one of the premier civil aerospace medicine organizations in the world and it's mission is to promote civil aerospace safety through excellence in medical certification, research and education programs. CAMI's programs focus on the safety of pilots (air & space), flight attendants, air traffic controllers, passengers, and the entire human support system that embraces civil aerospace operations. The goals of our certification, research and education programs include: 1) The prevention of aerospace incidents and accidents due to human causes, 2) Making aerospace vehicles and all support systems safer for occupants (crews and passengers), 3) Optimizing human performance of safety-sensitive personnel in all aerospace operations, 4) Promoting the health and well-being of aerospace personnel and passengers, and 5) Preparing aerospace flight personnel and other occupants for post-accident survival. CAMI personnel are pioneering new technologies, procedures and scientific developments that will lead to new global safety standards as innovations are translated into operations. CAMI personnel address the medical and human factors implications of operational hazards in aerospace transportation including: adverse weather (storms, lightning, hail, icing, clear air turbulence, microbursts, etc.), runway incursions, ground incidents (taxiing, ramp operations, etc.), wildlife strikes, geological events (volcanic eruptions, tsunamis, etc.), wake turbulence, inflight traffic incidents, cockpit automation, laser strikes, inflight medical emergencies, operational fatigue in aviation (pilots, flight attendants, air traffic controllers, maintenance personnel, etc.), disruptive/unruly passengers, emergency evacuations (precautionary or real), aircraft maintenance, physiological incapacitation or impairment of pilots (hypoxia, inflight spatial disorientation, acceleration exposure, fatigue, medications and drugs, unreported medical conditions, etc.), primary training in technically-advanced aircraft, etc. The types of job opportunities available at CAMI include: aerospace physiologists, biochemists, engineers (biomedical, electrical, mechanical), epidemiologists, geneticists, information technology specialists (software and hardware), mathematicians, nurses, pharmacologists, physicians, physician assistants, psychologists (aerospace, organizational, industrial), radiobiologists, statisticians, and toxicologists.

Learning Objective

1. The audience will learn about the types and scope of programs as well as available careers at the FAA Civil Aerospace Medical Institute.

[452] AEROSPACE MEDICINE ACADEMIC CAREERS

William Powers[1]
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(Education - Tutorial Proposal)

INTRODUCTION: Aerospace medicine is a small field of specialized medicine. Only five residency training programs exist in the US with very few graduates each year. Academic aerospace medicine has its own set of unique rewards and challenges distinct from focused clinical practice. Many factors contribute to the success or failure of a training program. **TOPIC:** One of the greatest challenges faced by academic programs is securing the funding for the program to pay for course tuition and salaries for the students. Contrary to most other residency training, the practice of aerospace medicine does not usually include patients who are insured by Medicare or Medicaid. Therefore, these training programs are often dependent on military budgets, grant money or substantial contributions from the academic institution. Funding from these sources can be inconsistent from year to year. Another challenge is assuring that the program is in compliance with requirements determined by the accreditation organizations. In the case of an aerospace medicine residency program, the required master's degree in public health is accrdited by the Council on Education for Public Health (CEPH) and the residency program is accredited by the Accreditation Council or Graduate Medial Education (ACGME). There are often conflicts when scheduling all of the associated requirements for both entities into a two-year program. Ultimately, it is imperative for the program to meet requirements to assure eligibility for board certification by the American Board of Preventive Medicine (ABPM). Attracting qualified faculty for an academic program can be difficult as the number of board certified specialists is few and providing a competetive salary requires support from the training institution. Also, supplying the type of training desired for future employers requires a broad network of connections and a good relationship with other professionals in the field. **APPLICATION:** The benefit of a strong aerospace medicine residency program inlcudes providing a well trained work force for the future. A broad range of training experiences assures that graduates will be adaptable to the opportunities that become available. As commercial space activity increases, a higher demand for qualified aerospace medicine specialists will follow.

Learning Objective

1. The participant will be able to obtain an understanding of the challenges facing a career in academic aerospace medicine.

[453] AEROSPACE MEDICINE IN THE AEROSPACE INDUSTRY

Eduard Ricaurte[1]
[1]*The Boeing Company, Oklahoma City, OK, USA*

(Education - Program / Process Review Proposal)

BACKGROUND: Aerospace medicine is the preventive medicine specialty that promotes the health and performance of crew members and well-being of passengers traveling in aircrafts and space vehicles. A challenging aspect of the aerospace environment is the body's physiological responses associated with aviation and space flights. Historically, the field of aerospace medicine has been essential in improving aviation safety by monitoring the aeromedical certification process of aerospace crewmembers, the medical standards and physical/mental fitness of aerospace flight applicants to obtain a medical certificate. In addition, supporting aerospace accident investigations and aerospace human factors, including the determination of the mechanisms of injury in crewmembers and occupants in aircraft and space accidents have

improved the safety of aerospace transportation. **OVERVIEW AND DISCUSSION:** With current fast growing and challenges in the aerospace industry, it is expected that more professionals with a combined experience in aerospace medicine, aeromedical research, human factors and system safety engineering are going to be needed. The role and contribution of aerospace medicine and human factors/system safety professionals in the complex environment of advanced design and technology, safety, quality and productivity improvement will be discussed during this presentation.

Learning Objective

1. The participant will learn the increased role of aerospace medicine professionals in the current aerospace industry.

[454] AEROSPACE MEDICINE CAREERS AT NASA

Terrance Taddeo[1]
[1]*NASA/Johnson Space Center, Houston, TX, USA*

(Education - Tutorial Proposal)

INTRODUCTION: NASA's human spaceflight programs and mission operations require the substantial involvement of physicians with Aerospace Medicine expertise. These physicians, almost all of whom are graduates of Aerospace Medicine residency programs, encounter diverse challenges and opportunities in their practices. **TOPIC:** NASA currently operates the International Space Station and maintains a constant human presence in orbit. NASA physicians provide medical support before, during and after the orbital mission, and ensure that real time health and performance requirements are implemented. These physicians also participate in launch and recovery operations of crews from Kazakhstan, and plan for medical contingencies for all phases of the mission. NASA is nearing the end of the development phase of the Orion, SpaceX and Boeing spacecraft. In work are the Gateway vehicle, lunar landers and planned lunar surface operations. NASA physicians have been intimately involved with the development of health and performance requirements for these vehicles, as well as requirements for pre-flight health stabilization, launch pad emergency escape, emergency medical services for launch, and recovery operations.Physicians at NASA support dive operations at the Neutral Buoyancy Laboratory and extravehicular excursions on-orbit, both of which involve prolonged suited activities and alternobaric environments. NASA physicians provide ongoing medical care of the astronaut corps as well as annual medical certification for flight assignability. They also provide medical certification for NASA's pilots and aircrews. A select few aerospace-trained physicians participate in NASA's human spaceflight programs as physician astronauts. **APPLICATION:** The nature of NASA's operations in air, space and under water provide unique and challenging opportunities for the practitioner of Aerospace Medicine.

Learning Objective

1. The participant will learn about the career opportunities at NASA for a graduate of an Aerospace Medicine residency program.

Thursday, 05/21/2020 ***3:30 PM***
Centennial II

[S-83]: SLIDE: HUMAN SYSTEMS INTEGRATION & PERFORMANCE

Chair: Kevin Heacock

Co-Chair: Eric Friedman

[455] AUTOMATION ON THE RAMPAGE: THE BOEING 737MAX CASE STUDY

Carlos Salicrup[1], Diego García[2], Dwight Holland[3]
[1]*Aeromexico, Mexico City, Mexico;* [2]*Embry-Riddle Aeronautical University, Daytona Beach, FL, USA;* [3]*Principal, Human Systems Integration Associates, Roanoke, VA, USA*

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: There is nothing more terrifying than trying to take manual control of an airplane during a critical situation with a non-responsive automated system over-ruling commands. It took 2 accidents, 346 dead, and enormous consequences to ground B737MAX. Civil aviation authorities banned the MAX shortly after the second accident, when preliminary investigations appointed to a B737MAX native system: The Maneuvering Characteristics Augmentation System (MCAS). This review covers different Human Systems Integration (HSI) perspectives: Level of Automation (LoA), Training, Human Cognitive Performance and Situation Awareness (SA). **BACKGROUND:** The aerospace industry promotes more automation as one of the solutions for overcoming more complex digital jet systems as part of the answer to enhanced operational capacity. Automation helps to shed workload in complex systems saving cognitive resources, to enhance peak-performance. LoA is defined by the amount of human involvement to complete such tasks. The conundrum of automation lies in choosing the right amount of LoA depending on the task, but also in collateral, deleterious effects on human skills, SA, and decision making. Even so, pilots must be trained in detail about how the various LoA assist the tasks at hand, and all the intervention protocols in various failure modes. **CASE PRESENTATION:** The initial Boeing 737 (1967) model transitioned through 3 generations of modifications. The B737MAX introduced MCAS: an augmented protection for excessive angle of attack (AoA) stalls, which compensates for the pitch-up momentum resulting from the thrust of new engine configuration, especially during high-power and low-speed situations (take-off and initial climb). This case presentation addressees operative details of the MCAS system, the applied automation philosophy, and the training process for pilots. **DISCUSSION:** Human-centered automation should allow pilots to regain full control of the airplane in manual mode at any moment, avoiding deterrent process for overriding system's control. Automation has solved many human performance limitations linked to all types of mishaps. Indeed, safety numbers are at their best today in great part due to technology. But it has also taken the burden of costly events related to reduced situational awareness, automation overreliance, and impaired psychomotor skills related to automated processes. Automation should always be a tool to enhance human performance, not to reduce it.

Learning Objective

1. The attendee will learn about the human systems automation and it risks.

[456] A FAILURE TO COMMUNICATE: TITANIC'S RADIO ROOM AND ITS HUMAN SYSTEMS INTEGRATION (HSI) LESSONS FOR TIME-CRITICAL, REMOTE-TEAM OPERATIONS

David Kazdan[1]
[1]*Case Western Reserve University, Cleveland, OH, USA*

(Education - Case Study: Clinical / Human Performance)

INTRODUCTION: RMS *Titanic* sank in 1912 after a chain of safety lapses resulted in an iceberg strike. At the end of the chain was information handling: *Titanic* carried a state-of-the-art radio room with excellent operators, and they received notices of the icefield from another ship. The radiotelegraphers were busy with a backlog of passengers' radiograms and did not take the warning messages to their captain. **BACKGROUND:** The problems of radio communications, whether from a shore station or from a ship at sea, had been solved remarkably by *Titanic's* sailing. The transmitter could run from the ship's electrical system or from backup batteries. The main receiver used a windup clockwork and was independent of all electrical power. The vertical antenna with its ship-length capacitance hat was as efficient as the wavelength and structures allowed. The International Morse Code was information-dense with its early form of data compression. However, basic human factors problems regarding communications and prioritization were poorly understood: What primary purpose did the radio station serve, under whose command were the radio operators, and how were they to work with the ship's officers? **CASE PRESENTATION:** *Titanic's* radio room was owned by the Marconi Company and existed to exchange radiograms in revenue service. During the day 14 April 2012, the radio failed and the two radio operators, graduates of Marconi's radio school, spent the day repairing the transmitter. By evening, they had a backlog of radiograms to send and were exhausted. Famously, the last and most dire of six warning messages received was from *Californian's* captain to *Titanic's* to indicate her halting for the night in ice. The response: "DDD ["stop sending"]" *Californian's* only radio operator shut down, only fifteen minutes before *Titanic's* collision. *Californian's* officers saw *Titanic's* flares but ignored them. Radio code and language incompat-

ibilities (U.S. Navy operators used American Morse; German ships' operators knew no English)**. CONCLUSIONS:** A priority structure for communications could have changed history. Marconi speculated during the Senate hearings of automated emergency radio alerts, which were implemented. Language-independent telegraph codes were standardized and extended into aviation. Every engineered solution inherently contains HSI and communications issues. If we continue to ignore them, we do so at our peril.

Learning Objectives

1. The audience will learn about the evolution of command structures in low-bandwidth emergency communications systems.
2. The audience will learn about the history of mobile radio systems and the continued development of their regulatory systems.

[457] OPPORTUNITIES AND RISKS OF ARTIFICIAL INTELLIGENCE: A JOURNEY THROUGH WHAT COULD BE AND WHAT SHOULDN'T BE

Dave Prakash[1]
[1]*Stanford, Johns Hopkins, SUNY Syracuse, Palo Alto, CA, USA*

(Education - Tutorial Proposal)

INTRODUCTION: Artificial intelligence and machine learning are poised to become a significant part of the third offset in military strategy. This tutorial will explain artificial intelligence/machine learning, and the applications of the technology in aerospace medicine. There will be a specific focus on potential to select for better suited candidates for high-cost, high-risk missions by using broader feature sets than conceivable in traditional analytics. The discussion will also address the risks and unintended consequences of this technology in candidate selection. **TOPIC:** The ability to analyze enormous and diverse data sets, draw correlations beyond human discernment, and deliver self-improving predictive models will provide a distinct strategic advantage. AI will not simply automate and replicate human performance, it will deliver entirely new levels of insight, precision and prediction. This technology, however, is rapidly advancing beyond our understanding of the operational, medical, legal, and ethical implications. And we are just starting to understand the unintended consequences and risks of AI. **APPLICATION:** Currently, organizations like the Food & Drug Administration, National Institute of Standards and Technology and the DoD are turning to the private sector to better understand how this technology can be employed, misused and regulated. As with prior leaps in technology, we can start by apply existing frameworks to understand the theoretical and practical implications. But we must be cognizant of where existing frameworks fall short. In this presentation, we will apply current frameworks of human systems integration like human response to automation in aviation, legal guidelines and ethical considerations. We will identify points of departure from existing frameworks to explore emerging consequences in human-machine collaboration with AI, such as the black box conundrum and operator complacency. In medicine, the black box conundrum, or lack of explainability is a significant regulatory hurdle. In aviation, automation, system complexity and operator complacency have repeatedly proven deadly. Unexplainable AI will exponentially amplify these risks in medicine and in combat operations. Ethical frameworks will also be reviewed in light of new concerns of fairness, bias and where historical implicit biases in candidate selection will propagated and possibly amplified.

Learning Objectives

1. Understand the importance of explainability of Artificial Intelligence in candidate selection.
2. Understand the mechanism for propagating bias in machine learning.

[458] INNOVATIONS FOR ENHANCING HUMAN SYSTEMS INTEGRATION WHILE EXPLORING... UNDERWATER. IN A CAVE. 90 METER BELOW SURFACE

Karoly Schlosser[1]
[1]*Goldsmiths, University of London, Budapest, Hungary*

(Education - Program / Process Review Proposal)

Aquanauta is a series of manned mission simulations that is to study the adverse effects of isolation, confinement, darkness on cave divers in thermal caves. Our rationale to organize such high fidelity mission simulations is that astronauts regularly train as divers in large artificial pools, where they can explore the effects of microgravity and practice specific protocols and skills later carried out or used on the International Space Station. Further, astronauts often train together in caves in order to get used to confined and isolated contexts and preparing for missions in the Moon's lava tubes. Despite significant efforts to understand, human factors in extreme contexts remain understudied and are usually mitigated with meticulous sampling and training processes. In the not too far future, human space exploration will impose new needs were the human factors may not be "factored out" so easily. Crews of six cave divers, or 'aquanautas' will live in a habitat underground that is connected to a natural thermal cave with a diverse tunnel system completely under water, reaching out nearly 10kilometers in length to 90 meters deep. Our current dive equipment is capable of carrying out approximately seven-hour long dive hikes, similar in length to actual space walks performed by astronauts. Our purpose is to research the effects isolation, confinement, darkness and microgravity on humans, and to understand how human factors and the systems we can design can benefit teams in conducting work and/or living in these extreme environments.

Learning Objectives

1. Discuss the importance of human factors in space exploration.
2. Discuss the importance of high fidelity missions to understand human behavior in extreme contexts.
3. Evaluate the utility of conducting mission simulations in thermal caves.

[459] A REAL-TIME ACHIEVABILITY LIMIT DISPLAY FOR A PROPELLENT-CONSTRAINED, PILOTED, PLANETARY LANDER

Carlos Pinedo[1], Joshua Seedorf[1], Torin Clark[1]
[1]*University of Colorado Boulder, Boulder, CO, USA*

(Original Research)

INTRODUCTION: Providing real-time achievability limit information to the pilot has been proposed as a means to reduce their workload, improve situation awareness, and increase safety during lunar landings. The piloted lunar landing task requires determination of a suitable LS (landing site) while maintaining vehicle attitude control. Suitable LS selection includes proximity to points of scientific interest, vehicle performance, and hazard avoidance. During Apollo LM landings most of the LS selection decisions were made in a 2-minute window. In this time-constrained environment, determining landing point achievability is critical for safe LS selection. Thus an achievability limit algorithm was developed that combines a behavioral model of the pilot and physical models of the vehicle and environmental dynamics to predict the propellant required to reach any potential LS. **METHODS:** A human-subject study was conducted on a ground-based flight simulator to evaluate the impact of the real-time display of achievability limit information on LS selection performance. Subjects completed simulated lunar landing trials where they were asked to maintain manual control of the vehicle's pitch and roll through joystick inputs. Half the subjects were provided an initial static landing footprint the other half received real-time achievability limit information. In each trial the subject was tasked to select the optimum landing site that was 1) achievable 2) minimized hazards and 3) was closest to three points of scientific interest. LS selection information was provided on an ego-centric top-down horizontal situation display. **RESULTS:** Initial results from LS selection without real-time achievability limit information indicate that subjects prioritize safe (minimize hazards) over optimum (nearest points of scientific interest) LS points. Subjects at times display anchoring bias, where they rarely change their initial decision even in the presence of updated information, deciding to focus instead on the piloting tracking task. **DISCUSSION:** The factors that define LS achievability often behave and interact in a non-intuitive manner such that even experienced pilots may struggle to accurately estimate the achievable limits. When this information becomes critical for LS selection subjects display common decision making biases. Providing a real-time display of the achievability limit can help mitigate these decision biases and result in more optimum LS selection decisions.

Learning Objective

1. The audience will learn about the potential benefits of providing real-time achievability limit information on landing site selection decision making.

[460] HABITABILITY AND SLEEP HYGIENE FOR USCG ALERT DUTY PILOTS

Brendan Blain[1], Nita Shattuck[1], Brennan Cox[1], Heather Clifton[1], Imani Murph[2], Katherine Mortimore[3]
[1]Naval Postgraduate School, Monterey, CA, USA; [2]Embry-Riddle Aeronautical University, Daytona Beach, FL, USA; [3]University of Washington, Seattle, WA, USA

(Original Research)

INTRODUCTION: U.S. Coast Guard (USCG) alert duty pilots maintain a 24-hour readiness status known as Bravo-Zero (B-0), which requires them to become airborne within 30 minutes of an immediate alert (e.g., search and rescue call). These pilots are permitted to sleep during their rotation; consequently, there are occasions when they are awoken unexpectedly and required to perform complex tasking while in a state of sleep inertia (i.e., post-awakening grogginess associated with physical and cognitive impairment). This study investigated the prevalence and severity of sleep inertia among USCG pilots, to include environmental contributors to sleep inertia and mitigation strategies for countering its effects. **METHODS:** A two-part study was conducted. Part 1 involved a survey of all USCG B-0 pilots (N = 607). Respondents rated their experiences with sleep inertia on- and off-duty, and compared their on- and off-duty sleep in terms of comfort and quality, as well as the noise, light, and temperature quality. Part 2 involved an environmental assessment at two USCG air stations. Light, noise, and temperature data were captured in multiple sleeping quarters and common spaces, and then compared to ASTM international standards to evaluate the habitability features of these environments. **RESULTS:** 169 USCG B-0 pilots completed the survey (27.8% response rate). Respondents indicated experiencing a greater prevalence, intensity, and duration of sleep inertia on-duty versus off-duty ($p < .05$ for all items). Compared to their on-duty sleep, respondents rated their off-duty sleep as closer to their ideal in terms of sleep comfort, sleep quality, noise levels, lighting quality, and temperature quality ($p < .001$ for all items). Data from the environmental assessment corroborated these findings, as evidenced by considerable variation in light, noise, and temperature data across sleeping spaces, and multiple violations of ASTM standards for optimal sleeping environments. **DISCUSSION:** Results and recommendations were delivered to the USCG Human Systems Integration office. Findings may inform efforts to improve the habitability and sleep hygiene experiences of B-0 pilots, to include the development of training on sleep inertia and associated mitigation strategies. Future research should employ objective sleep and performance measures to quantify these experiences and evaluate overall impact.

Learning Objectives

1. The audience will be able to describe subjective and objective methods for assessing habitability conditions.
2. The audience will be able to describe factors associated with sleep inertia.

Thursday, 05/21/2020 ***3:30 PM***
Centennial III

[S-84]: PANEL: RECENT SPACEFLIGHT LIFE SUPPORT RESEARCH UPDATES FROM THE AIAA LIFE SCIENCES AND SYSTEMS TECHNICAL COMMITTEE

Sponsored by Communications Committee

Chair: Daniel Buckland

PANEL OVERVIEW: The American Institute of Aeronautics and Astronautics (AIAA) Life Sciences and Systems Technical Committee represents the AIAA's official interface with the space medicine community. This panel presents a range of recent research and engineering developments that the Technical Committee feels are important to present and discuss with clinicians and space medicine operations researchers. It will focus on Life Support Engineering topics such as; sampling of air quality in the ISS, the results of international workshops on changes in planetary microbial protection policies necessary for crewed-flights to Mars, material sciences advances that could improve CO2 absorption in the ISS, and recent findings that can impact radiation risk mitigation profiles in exploration spaceflight. These presentations will be followed by an open discussion that will hopefully enhance and produce AIAA and AsMA member collaborations and knowledge exchange.

[461] TOOLS AND TECHNIQUES FOR RADIATION RISK MITIGATION IN AN ERA OF EXPLORATION

Ronald Turner[1]
[1]Analytic Services Inc, Falls Church, VA, USA

(Education - Program / Process Review Proposal)

INTRODUCTION: Radiation poses a significant risk to astronauts. The natural radiation threat to exploration missions beyond the Earth's geosphere comes in two varieties: the steady and highly penetrating Galactic Cosmic Radiation (GCR) and the intense but more moderately energetic Solar Particle Events (SPE). In keeping with the theme of this panel, this presentation focuses on the tools and techniques available to NASA to help mitigate the risk from radiation exposure. It provides an update on the state of the art in dosimetry and particle detectors; shielding materials useful to moderate the radiation environment inside a vehicle or habitat; and instruments and models used to forecast SPEs and GCR intensity. The common theme to these diverse technologies is they each contribute to an overarching radiation risk mitigation strategy, whether the exploration context is short duration lunar missions or long duration missions to Mars. **RESULTS:** Modern tools and capabilities to monitor and reduce the risk of space radiation are built on over fifty years of evolving operational experience at NASA. Observations of the particle environment is grounded by heritage instruments on GOES, but supplemented with sensors on science and operational platforms such as DSCOVR, SOHO, and SDO. These observations provide near real time characterization of the particle flux from tens to hundreds of MeV/nucleon. Dosimetry has advanced from passive film detectors to active, real-time readout personal dosimeters distributed throughout a spacecraft and habitat. NASA recognizes that to reduce the neutron flux within spacecraft and habitats, that synergistic, not parasitic, composite low Z materials should be used where they are reasonable. Finally, while GCR characterization is generally adequate for forecasting months or years in advance, GCR forecasting will be improved as experience is accrued in currently historically low solar activity. However, forecasts of SPEs have not improved and still limit NASA operational flexibility. **DISCUSSION:** The presentation shows that elements are in place to provide a solid risk mitigation strategy for human exploration, wherever it goes. However, the strategy is fragile and each element must continue to get the attention it deserves, or the risk to astronauts will increase. Further, elements must be combined using a solid systems engineering approach that considers astronaut operational plans and constraints, or again, risk will increase.

Learning Objective

1. The audience will learn what techniques and processes are in place to mitigate radiation exposure in deep space exploration.

[462] AIR QUALITY - AEROSOLS IN THE SPACECRAFT CABIN

Marit Meyer[1]
[1]NASA Glenn Research Center, Cleveland, OH, USA

(Education - Program / Process Review Proposal)

INTRODUCTION: The International Space Station (ISS) is a unique indoor environment that has been both home and workplace to a crew of six people since 2009. While gaseous pollutants have been continuously monitored, particles have only recently been investigated. The first aerosol experiment captured airborne particles and brought them back to Earth for analysis. **METHODS:** Two types of samplers were deployed on ISS. Passive Samplers were placed on the edges of air intakes of the ventilation system to capture large particles from air entering the cabin filters. Active Samplers (commercial samplers) captured particles as small as 10 nm. **RESULTS:** Particles were analyzed by computer-controlled scanning electron microscopy with energy dispersive x-ray spectroscopy. A database of 80,000 metal particles gives the ability to search and plot ISS aerosol results by elemental composition, size, abundance by location, roundness, aspect ratio, and by proportion of all particles sampled (weight or number %). The smallest particles collected with the Active Sampler (300 nm and below) were relatively sparse. Two notable particle types in this size

range include titanium dioxide and agglomerated metal fume particles, with primary particle sizes ranging from 3 to 20 nm. The storage area of ISS was the cleanest, while the exercise and hygiene area was the dirtiest. Crew members exercise for two hours per day, which produces three particle types that dominated the samples: lint (clothing fibers), human skin flakes and antiperspirant particles. **DISCUSSION:** Human presence and activities dictate the quantities of particles in different areas. Laundry does not exist due to the scarcity of water, so the crew must wear their clothing multiple days before discarding them. This results in repeated clothing changes and antiperspirant applications each day. When the particle-laden clothing is agitated during changing and exercising, the lint, skin flakes and Al-Cl-Zr particles are emitted in quantity. The samples contained 27 different metals, many not typically found in indoor environments on Earth. This can be attributed to the many experiment payloads, which are the chief activities of astronauts in their waking hours. Sources of certain unique metals have not been identified, however, many stainless steel and aluminum wear particles are recognizable and are more abundant near exercise equipment.

Learning Objectives

1. Understand the unique behavior of aerosols in the microgravity environment.
2. Understand aerosol emissions from human occupants of spacecraft.
3. Understand the consequences of no laundry capability on space missions.

[463] NOVEL SORBENTS FOR CO2 REMOVAL FROM SPACECRAFT CABIN ATMOSPHERES

James Nabity[1], Daniel Buckland[2]
[1]University of Colorado, Boulder, CO, USA; [2]Duke University, Gaithersburg, MD, USA

(Education - Program / Process Review Proposal)

INTRODUCTION: Human spaceflight poses many challenges to regenerable environmental control and life support (ECLS) and *In Situ* Resource Utilization (ISRU). In particular, robust systems for atmosphere revitalization are still being sought. Elevated levels of CO_2 onboard the International Space Station have been hypothesized to adversely affect crew cognitive performance, and cause headaches and lethargy. While the findings are not conclusive, NASA has established a goal to reduce the partial pressure of CO_2 to below 2 mmHg; a level that cannot be met by the zeolite sorbent used in the Carbon Dioxide Removal Assembly (CDRA). To meet this need, solid amines and room temperature ionic liquids (RTILs) are being researched as regenerable sorbents for CO_2 removal as well as for humidity control of cabin atmospheres. Both have promise, although the ionic liquids have unique properties that make them attractive for human spaceflight, which are negligible vapor pressure, thermal and chemical stability, and little or no risk of toxicity to the crew. These novel sorbents have the potential to control CO2 to levels below 2 mmHg. **METHODS:** The engineering implementation of these sorbents along with results from engineering design, analyses from first principles and experiments will be presented. A solid amine has been tested onboard the International Space Station (ISS). Supported Ionic Liquid Membranes have been tested in the laboratory. **RESULTS:** A CAMRAS demonstrator, a CO2 And Moisture Removal Amine Swing-bed systems, has been on-orbit since 2013. There are plans to launch the Carbon Dioxide Removal by Ionic Liquid Sorbent (CDRILS) System to the ISS within the next two years. Results and lessons learned from laboratory and flight experiments will be presented. **DISCUSSION:** Experimental results show that both solid amine and RTIL sorbents are quite promising. In this panel discussion, I will relate the results to the atmosphere quality needed in support of crew health.

Learning Objectives

1. Identify and describe state-of-the-art and novel CO2 removal technologies for spacecraft cabin atmosphere revitalization. Discuss their principal attributes and performance characteristics.
2. Appreciate the current understanding of effects of elevated levels of CO2 on crew health and performance.

[464] MICROBIAL MONITORING ASPECTS OF PLANETARY PROTECTION FOR CREWED MISSIONS TO MARS

J Andy Spry[1]
[1]SETI Institute, Mountain View, CA, USA

(Education - Program / Process Review Proposal)

INTRODUCTION: In current exploration planning, NASA has committed to "push the boundaries of human exploration forward to the Moon and on to Mars". While the Moon is not of great concern from the point of view of harmful contamination as a result of exploration, or the threat of adverse changes to the Earth resulting from introduction of returned extraterrestrial materials, Mars is. Mars may have had, or still have, an indigenous biosphere. First, this drives efforts to ensure that Mars is not exposed to uncontrolled levels of contaminating terrestrial bioorganic materials, before we understand it. Second, until we understand the martian environment better than at present, consensus scientific opinion is that we need to ensure that martian materials returned by sample return mission(s) are contained to a high level of stringency, preventing their uncontrolled release into the terrestrial environment. This two-fold control of interplanetary transfer is the discipline called planetary protection. **METHODS:** While approaches for these are manageable and affordable for robotic missions, it is widely agreed that once humans travel from Earth to the surface of the red planet, such partitioning of the two planetary environments becomes impracticable. NASA, and more recently COSPAR (Committee on Space Research, the organization charged by the United Nations with maintaining planetary protection policy), have over the last several years, held a series of workshops to develop a transition pathway from current robotic mission planetary protection approaches, to a new planetary protection paradigm for crewed missions. **RESULTS:** The workshop series generated a set of knowledge gaps associated with planetary protection; refined and prioritized them; identified destinations and opportunities for addressing them; and in the latest two meetings, described the instruments and measurements necessary to close the knowledge gaps. These findings are documented in a report series, and a timeline for addressing the knowledge gaps before the first "boots on the ground" in the mid-2030s is described. **DISCUSSION:** During the workshop discussions, the knowledge gaps were grouped into three areas: Microbial and human health monitoring; Natural transport of contamination on Mars; and, Technology and operations for contamination control, linking strongly to ongoing microbial monitoring technology developments and activities in the space medicine and life support systems communities.

Learning Objectives

1. The audience will learn about plans and approaches to protect Mars and astronauts from microbial cross-contamination, the discipline of planetary protection.
2. The audience will learn about opportunities for integrating/aligning their own space medicine research interests with the ongoing planetary protection planning.

Thursday, 05/21/2020 ***3:30 PM***
Centennial IV

[S-85]: PANEL: GLOBAL REACH COMPREHENSIVE MEDICAL READNIESS PROGRAM FOR FLIGHT SURGEONS

Chair: Catherine Blasser

Co-Chair: Paul DeFlorio

PANEL OVERVIEW: Expedient response to a physiologic event or a mishap with mass causalities is of paramount importance to flight surgeons and it is an essential function aiding our ability to maintain global reach. Moreover, proportional and appropriate actions must be taken at a moment's notice. This panel will immerse participants in a hands–on mishap sequence, beginning with an inflight emergency due to a physiologic event. Participants will assess scene safety and respond to casualties to determine if they require aeromedical evacuation. They will then address the environmental considerations for their personnel remaining in the deployed location. At the conclusion, participants will have reinforced preparedness for maintaining global reach.

[465] GLOBAL REACH AEROMEDICAL EVACUATION

Bryant Martin[1], Catherine Blasser[1], Douglas Files[1]
[1]U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH, USA

(Education - Program / Process Review Proposal)

BACKGROUND: Flight surgeons are responsible for certifying patients with medical needs that exceed capabilities in deployed locations. This interactive scenario will simulate evacuation clearance cases to maintain and improve comprehensive medical readiness skills. **OVERVIEW:** Following a mass casualty event or aircraft mishap a number of patients may require aeromedical evacuation. In this session participants will make complex medical decisions clearing patients for aeromedical evacuation using a tracking system like the US Transportation Command Regulating and Command & Control Evaluation System from the deployed environment. **DISCUSSION:** Medical clearance and patient movement certification are important functions both in the deployed location and in garrison. The training is applicable beyond the Air Force to all aeromedical evacuation including the Tri-service interface with the American inter-theater military casualty evacuation system.

Learning Objective

1. The participant will prepare patients for aeromedical evacuation.

[466] GLOBAL REACH MASS CASUALTY RESPONSE

Russ Turner[1], Catherine Blasser[1]
[1]*U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH, USA*

(Education - Program / Process Review Proposal)

BACKGROUND: Mishap and mass casualty response are important capabilities for flight surgeons and can often involve inherent hazards. This session will involve a simulated mass casualty event with multiple casualties and injured aircrew following an aircraft mishap. **OVERVIEW:** medical first responders must be equipped with a wide range of skills to include advanced trauma life support, triage and procedural skills. Aerospace medicine physicians often manage mass casualties at a higher level, requiring more specific knowledge of the mishap response plan and their role within the National Incident Management System. To complicate matters, aircraft contain many hazardous materials that make ensuring scene safety particularly important. **DISCUSSION:** Given the relatively low frequency of a mass casualty events and aircraft mishaps, maintaining the necessary skillset to ensure rapid and appropriate response in an emergency situation can be difficult. Insight into the National Incident Management System while working through a simulated mass casualty and aircraft mishap will provide bolstered disaster response capabilities.

Learning Objective

1. Attendees will participate in the strategic implementation of mishap response in a complex mass casualty situation.

[467] GLOBAL REACH TRAVEL MEDICINE UPDATE

Catherine Blasser[1]
[1]*U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH, USA*

(Education - Program / Process Review Proposal)

BACKGROUND: Often our operational airfields are in locations that may pose unique environmental hazards due to endemic and vector borne diseases. Aerospace medicine professionals must be prepared to provide support for worldwide deployments. This presentation will help aerospace medicine professional maintain currency with participation in travel medicine briefings. **OVERVIEW:** Medical expertise in travel health is an essential capability for flight surgeons and medical travel guidelines are always changing. This program will allow aeromedical professionals to participate in travel medicine briefings for deployment to Niger. **DISCUSSION:** This program offers flight surgeons the opportunity to use the latest travel medicine guidelines to plan and present a briefing on the unique risks associated with a deployment to Niger. Special attention will be paid to malaria prophylaxis as well as Ebola activity in the region.

Learning Objective

1. Participants will prepare and present relevant medical guidance for an upcoming deployment to Niger.

[468] GLOBAL REACH INFLIGHT- PHYSIOLOGIC EMERGENCY RESPONSE

Douglas Files[1], catherine Blasser[1]
[1]*U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH, USA*

(Education - Program / Process Review Proposal)

BACKGROUND: Acute physiologic emergencies such as decompression sickness, spatial disorientation and hypoxia can have catastrophic consequences when occurring during flight. These causes are often preventable, so preparation is imperative. **OVERVIEW:** Physiologic events require medical evaluation to determine any contributing factors such as flight equipment, environmental conditions, and how these could be prevented. Some physiologic events require a medical workup for diagnosis of an underlying condition that may cause a predisposition to future events. Attendees will work through a scenario involving a physiologic event. **DISCUSSION:** Physiologic events resulting in injury are not common in aircrew, making maintaining currency as an aerospace medicine physician challenging. Attendees will perform a case-based analysis of a mishap sequence that results in an injury to demonstrate the potentially serious consequences of these events. Following the training, the attendees will have improved comprehensive medical readiness skills.

Learning Objective

1. Attendees will be able to respond to an in-flight physiologic event in which an aircrew member has been injured.

Thursday, 05/21/2020 ***3:30 PM***
Regency 8

[S-86]: SLIDE: GREENLIGHTING COLOR VISION

Chair: Arthur Formanek

Co-Chair: Tovy Kamine

[469] COLOR VISION DEFICIENT DIGITAL OBSERVERS: RELATING OBSERVER DEFICIENCIES TO MEANINGFUL AVIATION STANDARDS

Thomas Harding[1], Jon Vogl[1], Kharananda Sharma[1]
[1]*U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL, USA*

(Original Research)

INTRODUCTION: Color vision deficiency effects about six to eight percent of males and only about one-half percent of females. The majority of those with a color vision deficiency are anomalous trichromats with defective long or medium wavelength cone function. Due to the limited number of color vision deficient observers needed to evaluate color vision requirements or characterize digital display imagery for aviation and other visual demanding skillsets, the use of digital observers with well-defined color vision deficits may provide a needed solution. **METHODS:** RGB values needed for single cone excitation charts of increasing contrast, like those produced by Rabin et al.,[1] were developed using a non-linear evolutionary solver. The solver identified the RGB population mean, for a given contrast, that would only stimulate the long, medium, or short wavelength cone populations. Charts were developed for both computer and visual assessment. Machado's matrix coefficients[2,3] for protanomalous, deuteranomalous, and tritanomalous observers, were used to filter the aforementioned charts. Chart cone contrasts were calculated and attenuation coefficients determined for the full range of CVD severities (from normal to dichromat) and these results were then related to Cone Contrast Test (CCT) scores. **RESULTS:** RGB matrix coefficients were developed for a series of CCT scores covering the range of anomalous trichromats expected in the general population. Computer results were largely confirmed by visual inspection of processed charts. **DISCUSSION:** Having the capability to process computer imagery associated with aviation display systems or ambient scenes based on known color vision deficits and standard clinical scoring metrics, allows objective analysis of visual tasks that may not be generally possible given the rarity of some color vision deficiencies. **REFERENCES:** 1. J. Rabin, J.M. Gooch, D.J. Ivan, Rapid quantification of color vision: the cone contrast test. Investigative Ophthalmology & Visual

Science, 1167, 10-6283 (2011). 2. G. M. Machado, M. M. Oliveira, and L. A. Fernandes, "A physiologically-based model for simulation of color vision deficiency," IEEE Transactions on Visualization and Computer Graphics 15(6), 1291–1298 (2009). 3. G. M. Machado, "A model for simulation of color vision deficiency and a color contrast enhancement technique for dichromats," Master's Thesis, Instituto De Informatica, Universidade Federal Do Rio Grande Do Sul (2010).

Learning Objective

1. Due to the low availability of some color vision deficient observers, having digital color vision deficient observers, that are readily available with known color vision test scores, provides a remedy for the evaluation of test imagery.

[470] A COLOR VISION ANALYSIS OF AN UNMANNED AIRCRAFT SYSTEM'S WARNING SIGNALS

Jon Vogl[1], Juan Colon-Cruz[1], Thomas Harding[1]
[1]U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL, USA

(Original Research)

INTRODUCTION: In order to assist in the determination of the need for U.S. Army color vision requirements for unmanned aircraft system (UAS) operators, representative cockpit display images from the Shadow and Gray Eagle Universal Mission Simulator (UMS) were collected and analyzed. The UMS computer monitors, graphics engines, display characteristics, and especially caution/warning imagery are identical to those used in Shadow and Gray Eagle tactical cockpits. Of particular interest, were warning or cautionary signals consisting of text overlaid over colored backgrounds. Three background colors were used in order of priority: red for warning, yellow-orange for caution, and blue for an advisory. **METHODS:** Machado's matrix coefficients for protanomalous, deuteranomalous, and tritanomalous observers with color vision deficiency (CVD) severity indices of 0 to 1.0 (normal to dichromat), were applied to the RGB values for each of the three cautionary alert background colors. Twenty-one swatches representing 21 severity scores were created for the 3 color deficiencies. Swatch RGB colors were converted to CIELAB color space in order to calculate distances between swatches which have previously been used to correlate with perceptual color confusion metrics. **RESULTS:** Using a CIELAB criterion separation distance of thirteen, only the red-yellow swatch distances for the more severe deuteranomalous observer fell below the criterion. Using a two times criterion distance, which may be better suited for establishing color vision requirements, resulted in some of the protanomalous separations falling below the raised criteria as well. Results affirm that only red-green color deficient observers could have difficulty discriminating between the red and yellow warning colors. **DISCUSSION:** Using additional analyses that correlated Machado's model of CVD deficits with Cone Contrast Test (CCT) scores, CCT scores were established for one and two times the color confusion threshold. CCT scores determined in this fashion relate well to current tri-service requirements for admission to flight school. The use of computer-based, color-blind simulations may offer significant advantages when assessing color imagery discrimination with a ready population of digital CVD observers.

Learning Objective

1. Understanding of color vision issues for U.S. Army UAS operators.

[471] SCREENING FOR COLOR VISION DEFICIENCY IN PILOTS: EXPERIENCE FROM THE UK CAA AEROMEDICAL CENTRE 2009-2015

Stuart Mitchell[1]
[1]UK Civil Aviation Authority, London, United Kingdom

(Original Research)

INTRODUCTION: Color vision deficiency (CVD) remains a hazard to safe flight operations in commercial aviation. The Color Assessment and Diagnosis (CAD) Test was developed by City University, London for the UK Civil Aviation Authority as a secondary test to diagnose the type (protan/deutan/tritan) of color deficiency and its severity against a standard of operational performance identification of PAPI lights equivalent to normal trichromats. The test was introduced as the advanced color test to follow a failed Ishihara screening in the Aeromedical Centre of the UK CAA in 2009, replacing a protocol using the Ishihara Plate screening followed by Beyne and Holmes-Wright Colored lanterns if one error or more plates were incorrectly identified. **METHODS:** A retrospective audit was conducted of the records of medical certificate applicants undergoing color vision testing at the UK CAA Aeromedical Centre at Gatwick between 2009 and 2015. The first audit identified the CAD test results from 2009 in those applicants who attended for CAD testing who had previously failed the previous lantern protocol ("lantern failures"). The second part of the audit reviewed the results of all the applicants between 2009 and 2015 who underwent full CAD testing. **RESULTS:** For the 51 previous "lantern failure" applicants tested in 2009, 50% of the protan individuals and 25% of the deutans passed as 'color-safe'. Of the 679 full CAD tests performed (from an estimate of approximately 12,000 total applicants), 37 were normal, 144 and 85 were color-safe deutans and protans respectively, and 290 and 118 were color-unsafe deutans and protans respectively. There was poor correlation between the number of Ishihara errors and the CAD thresholds. If a limit of 6 errors were to have been set instead of 0, all 37 normals would have been passed without CAD testing, but 20 and 2 color-unsafe deutans and protans respectively would have been passed by Ishihara alone. **DISCUSSION:** Pilots with CVD who were previously failed by lantern testing were able to pass and become pilots. In addition to the methodological weaknesses, the number of failed Ishihara plates cannot be relied upon to diagnose the type or severity of CVD, nor determine whether applicants are color-safe for aviation.

Learning Objectives

1. The audience will learn about how the UK's new color assessment test was implemented in the UK in 2009 and what effect it had on applicants passing or failing their color vision testing at the initial medical.
2. The limitations of the Ishihara color test for screening initial applicants for aircrew licenses.

[472] NORMATIVE VALUES, REPEATABILITY AND EFFECTS OF AGE ON THE CCT-HD

Jeff Rabin[1], Julie Lovell[1]
[1]University of the Incarnate Word, San Antonio, TX, USA

(Original Research)

INTRODUCTION: The Cone Contrast Test High-Definition (CCT HD®, Konan Medical) selectively stimulates red (R), green (G) and blue (B) cones at progressively lower contrasts to determine the lowest cone contrast visible (contrast sensitivity, CS) for diagnosis of hereditary and acquired color vision deficiency. It utilizes a well-established, response-driven, staircase method (psi) to determine not only CS but added parameters such as the slope of the function between stimuli and responses and impact of factors not directly related to threshold. Our purpose was to establish normative data for the CCT HD®, repeatability and potential effects of age. **METHODS:** The CCT HD® presents a Landolt C in one of four orientations and the subject uses an arrow keypad to input the perceived direction of the gap in the C: up, down, right, left. The program determines R, G and B cone CS in 2-3 minutes per eye. 90 healthy adults (64 < 40 years old [young: Y], 26 > 40 years old [old: O]) with normal color vision on anomaloscope, Ishihara and Innova Cone Contrast Tests were assessed after providing written informed consent. **RESULTS:** Two-way repeated-measures ANOVA across eye tested and cone type showed a significant difference between cone type CS ($F = 2132$, $P < .0001$) but no difference between right and left eyes ($P > 0.17$). Post-hoc paired t-tests (Bonferroni correction) showed no difference between R cone mean log CS (2.03) and G cone CS (2.02, $P > 0.7$), but both R and G cone CS were significantly higher than B cone CS (0.92, $P < .0001$) consistent with the lower number of B cones. The coefficient of repeatability (95% confidence interval for change) was 0.3 log CS; hence a decrease in a patient with acquired color deficiency exceeding 0.3 log CS is significant. There was a significant effect of age on R cone log CS (Y: 2.06, O: 1.88, $P < .001$), G cone CS (Y: 2.08, O: 1.94, $P < .0001$), and S cone CS (Y: 0.97, O: 0.79, $P < .0001$). Linear regression showed a significant decrease in the sum of R, G & B log CS with increasing age ($F = 43.63$, $R^2 = 0.33$; $P < .0001$). The CCT HD® accurately diagnosed ten subjects confirmed to be color deficient on a battery of tests. **DISCUSSION:** The CCT HD® provides an exacting measure of R, G and B cone sensitivity in only 2-3 minutes. The findings reported herein establish normative values for each cone type, repeatability, as well as significant effects of age on color vision performance.

Learning Objectives

1. To understand that the CCT-HD can quantify type and severity of color vision deficiency.

2. To understand the relation between CCT-HD scores and cone type being stimulated.
3. To understand how the CCT-HD scores change with increasing age.

[473] COMPARISON OF THE CONE CONTRAST TEST HIGH-DEFINITION FULL AND ADAPTIVE METHODS

Julie Lovell[1], Jeff Rabin[1]
[1]*University of the Incarnate Word, San Antonio, TX, USA*

(Original Research)

INTRODUCTION: The Cone Contrast Test High-Definition (CCT HD®, Konan Medical) selectively stimulates red (R), green (G) and blue (B) cones at progressively lower contrasts to determine the lowest contrast visible (contrast sensitivity, CS) for diagnosis of hereditary and acquired color deficiency. It uses a response-driven, staircase method (psi) in "full threshold" as well as an "adaptive" mode with half as many trials. Most data collected thus far are based on full threshold. Our purpose was to compare full threshold and adaptive modes for color vision testing. **METHODS:** The CCT HD® presents a Landolt C in one of four orientations. The subject uses an arrow keyboard to input perceived direction of the gap in the C: up, down, right, left. Full threshold uses 30 trials per cone type while adaptative uses 12-15 trials. After written informed consent 90 healthy adults (mean age 33, 59 females, 31 males) with normal color vision, confirmed by Ishihara and Innova Systems CCT, were tested with the full threshold in one eye, and adaptive in the fellow eye with order counter-balanced across methods and eyes. **RESULTS:** Two-way repeated-measures ANOVA showed no difference between cone CS for the full threshold vs. adaptive threshold methods ($F = 1.82$, $P > 0.17$) and no significant interaction ($F = 0.09$, $P > 0.91$) indicating that the lack of difference between methods applied equally to red, green and blue cones. A small sample of subjects (n=10) confirmed to be color deficient on a battery of tests were correctly diagnosed in terms of type and severity of color deficiency on both the full threshold and adaptive methods. **DISCUSSION:** The CCT HD® is a highly efficacious test of color vision. The test is effective in identifying hereditary color vision deficiency with vast potential for detection of disease-related acquired deficiency. The full-threshold test, requiring 2-3 minutes per eye, yielded comparable results to the shorter adaptive protocol requiring 1-1.5 minutes per eye. However, it is recommended that additional evaluation of repeatability and test sensitivity be conducted before implementation of the adaptive threshold as a standard in occupationally based settings.

Learning Objectives

1. To understand how the Cone Contrast Test High-Definition Test (CCT HD®, Konan Medical) measures red, green, and blue cone sensitivity.
2. To understand the different methods available to administer the CCT HD.
3. To understand whether different methods for administering the CCT HD yield comparable results.

[474] FOXTROT - Forward Operating Base EXpert Telemedicine Resource Utilizing MObile Application for Trauma

Jennifer Stowe[1], William Gensheimer[2]
[1]*U.S. Army Aviation Research Lab, Enterprise, AL, USA;* [2]*455th Expeditionary Medical Group, Craig Joint Theater Hospital, Bagram Airfield, Bagram, Afghanistan*

(Education - Program / Process Review Proposal)

During Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF), 10-15% of combat-related trauma injuries involved the eye. There were 170 ocular trauma cases reported in 2018 occurring in deployed locations. The military ophthalmologist's primary mission is to be prepared to manage ocular trauma, especially in an austere environment; however with deployments across the globe, access to ophthalmic care is not easily accessible. The primary purpose of our research is the development of an operationally secure, Health Insurance Portability and Accountability Act (HIPPA) compliant, mobile application (mApp) to provide ophthalmic care to any remote deployed location through a teleophthalmology called **FOXTROT** - **F**orward **O**perating Base E**X**pert **T**elemedicine **R**esource Utilizing M**O**bile Application for **T**rauma. The development of this application will effect the Aerospace Medical community by reducing the number of MEDEVACs needed in theater operations. In addition, future buildout of this application will involve developing a platform for aviation flight physicals. Currently in the military, we have one primary method for teleophthalmology involving pagers and non-secure phones. FOXTROT is currently being fielded in Afganistan field hospitals. Based on an independent assessment, FOXTROT could potentially save the Military $2.4M by preventing costly medical evacuations out of theater. There is currently limited access to ophthalmic care at forward-operating bases, especially with ocular trauma. FOXTROT teleophthalmology mApp will improve and extend ophthalmic trauma care in remote deployed environments. In addition to field hospitals, it could be utilized for ocular trauma in any remote or austere environment, including ships at sea, disaster areas, and humanitarian missions. It could also be integrated into any medical treatment facility (MTF) or emergency department without an in-house ophthalmologist. Military providers could use the App for ophthalmic consultations during outpatient visits or inpatient encounters, providing a more convenient, comprehensive, and economical solution for managing ophthalmic disease and trauma. FOXTROT would enhance the safety and quality of patient care and lower costs by avoiding some referrals. The transition plan for the FOXTROT platform will include other surgical and medical specialties, including a platform for aviation medicine.

Learning Objectives

1. Understand the importance telehealth can play in austere environments.
2. Realize the return on investment (ROI) for virtual health in reduction of aviation evacuations.
3. Understand the requirements of virtual health with regards to protection of patient's personal information.

Friday, 05/22/2020 ***8:00 AM***

[S-87]: WORKSHOP: INTRODUCTION TO DIVING AND MARINE MEDICINE

Chair: Brian Pinkston

Co-Chair: Cheryl Lowry

[475] INTRODUCTION TO DIVING AND MARINE MEDICINE

Brian Pinkston[1]
[1]*Kinetic Adventure Medical Education, Galveston, TX, USA*

(Education - Tutorial Proposal)

WORKSHOP OVERVIEW: INTRODUCTION: This is intended to be an introductory workshop focused on diving medicine, treatment and prevention of common aquatic disease and injuries, ocean survival, and providing expedition support in a marine environment. **TOPIC:** Lectures will describe common illnesses and injuries in an aquatic environment. Lectures will be reinforced by veiwing marine organisms most likely t injure humans. Lectures will discuss injury prevention and survival at sea, followed by hands-on familiarization and use of marine safety and life-saving equipment. Workshop lectures will review diving physiology, common diving injuries and medical concerns, as well as expedition participant screening and support considerations. Participants will have hands-on familiarization with common diving equipment and medical kit contents. Additionally, AsMA members may either support or participate in research expeditions and adventure travel. Wilderness Medical Society (US) and World Extreme (UK) are the primary providers of this sort of CME. Our members would benefit from an opportunity for adventure/expedition CME provided by AsMA at this conference. **APPLICATION:** The need for medical professionals to understand and support diving and aquatic activities is rapidly expanding. NASA and commerical space entities are exploring landing space vehicles and recovering crew in the ocean. NASA uses the aquatic environment as an analog for space adaptation. Military operations and mishap investigations may occur in or near water, and adventure travel is becoming increasingly popular.

Learning Objectives

1. Describe the role of the medical officer in supporting marine and diving operations and initial decompression illness first aid procedures.
2. Practice rescue and survival skills in a marine environment.
3. Discuss the treatment of marine envenomations including currently used antivenins.