

[294] U.S. AIR FORCE TEST PILOT SCHOOL "HAVE BREATHLESS" STUDY – WORK OF BREATHINGR.S. Mayes¹, D. Burch¹, D. Schmitt², D. Koeniguer³, J. Elliott⁴, J. McDonald⁵ and J.C. McEachen¹¹Department of Aeromedical Research, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; ²411 FLTS, Edwards AFB, CA; ³413 FLTS, Edwards AFB, CA; ⁴40 FLTS, Edwards AFB, CA; ⁵419 FLTS, Edwards AFB, CA

Recent United States Air Force (USAF) investigations into unexplained in-flight physiologic incidents have found high work of breathing (WOB) due to restrictions from aircrew flight equipment (AFE) to be major contributing factors to the incidents. To better understand the etiology and effects of elevated WOB in high-performance flight, the 711th Human Performance Wing (711 HPW) USAF School of Aerospace Medicine and the USAF Test Pilot School (TPS) collaborated on the "Have Breathless" (HB) study examining the effects of restricted breathing in flight. Each TPS student test subject performed one pair of centrifuge runs and one pair of F-16 sorties; each pair consisted one "unrestricted" run and one "restricted" run, with identical Gz profiles. The "unrestricted" condition consisted of properly fit AFE gear, while the "restricted" configuration consisted of (1) an increased resistive WOB from an inline nozzle, and (2) an increased elastic WOB from tightly fit AFE. After each maneuver, pilots performed a Trail-Making B cognitive task while WOB was measured by mask sensors, followed by three forced vital capacity tests. Pilots also reported subjective fatigue and air hunger. Data were processed in Matlab to calculate WOB and forced vital capacity metrics. This study was determined to be Non-Human Use by the 711 HPW Institutional Review Board and was accepted by a TPS Safety Review Board. All centrifuge runs and sorties were performed by each subject (n=5). One centrifuge run was not completed, leading to nine matched pairs of data. WOB was higher in the restricted condition for 6/9 pairs; overall WOB was twice as high in the restricted condition. Subjective air hunger was significantly higher in the restricted condition, but self-reported fatigue was not statistically different between conditions. Cognitive performance was not statistically different between conditions. HB represented an important step in gaining aeromedical understanding of WOB in flight. The cognitive and performance impacts of elevated WOB are as yet unknown; cognitive testing results in HB were unreliable due to confounding. HB demonstrated the capability to collect respiratory data in flight and began a process to define boundaries for WOB.

Learning Objectives:

1. Understand the impact on work of breathing from high-performance flight.

[295] U.S. AIR FORCE TEST PILOT SCHOOL "HAVE BREATHLESS" STUDY – INCIDENTAL FINDINGSR.S. Mayes¹, D. Burch¹, D. Schmitt², D. Koeniguer³, J. Elliott⁴, J. McDonald⁵ and J.C. McEachen¹¹Department of Aeromedical Research, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; ²411 FLTS, Edwards AFB, CA; ³Det 1, 413 FLTS, Nellis AFB, NV; ⁴40 FLTS, Edwards AFB, CA; ⁵419 FLTS, Edwards AFB, CA

Recent United States Air Force (USAF) investigations into unexplained in-flight physiologic incidents have found high work of breathing (WOB) due to restrictions from aircrew flight equipment (AFE) to be major contributing factors to the incidents. To better understand the etiology and effects of elevated WOB in high-performance flight, the 711th Human Performance Wing (711 HPW) USAF School of Aerospace Medicine and the USAF Test Pilot School (TPS) collaborated on the "Have Breathless" study examining the effects of restricted breathing in flight. Each TPS student test subject (N = 5) performed paired centrifuge runs and F-16 sorties; each pair consisted of an "unrestricted" run and a "restricted" run with identical Gz profiles. The "unrestricted" condition consisted of properly fit AFE gear, while the "restricted" configuration consisted of: 1) an increased resistive WOB from an inline nozzle; and 2) an increased elastic WOB from tightly fit AFE. After each maneuver, pilots performed a cognitive task while WOB was measured by mask sensors, followed by three forced vital capacity (FVC) tests. Data were processed in Matlab to calculate WOB and FVC metrics. This study was determined to be

Non-Human Use by the 711 HPW Institutional Review Board and was accepted by a TPS Safety Review Board. One centrifuge run was not completed, leading to nine matched pairs of data (four centrifuge, five in-flight). Unexpectedly, WOB was lower in the restricted condition for 3/9 pairs; for each of these, the subject had unusual physical exertion prior to the unrestricted sortie. FVC results were consistent across subjects; the first measurement on the ground was higher than all subsequent measurements. Finally, one subject experienced symptoms (cough, decreased lung capacity) for 24 h after an unrestricted sortie. The degree to which pre-sortie exercise affected respiration in flight was surprising to investigators. If not due to sensor error, FVC findings may suggest a new understanding of lung function at altitude. Finally, the unusual symptoms reported by one subject were similar to those commonly associated with a different airframe; it may be that AFE and restriction may play a role in those symptoms. Future study is planned.

Learning Objectives:

1. Understand the effects of external human factors on high-performance flight physiology.

[296] A PORTABLE, PILOT PHYSIOLOGIC PERFORMANCE MONITORING DEVICE FOR USE IN OPERATIONAL AND HIGH-FIDELITY LABORATORY ENVIRONMENTSD. Burch², R.S. Mayes², M.T. White², D.M. Pohlman², M. Cowgill³, M. Taylor³, S.A. Warner¹ and J.B. Phillips¹¹Biomedical Sciences, Naval Medical Research Unit-Dayton, Wright-Patterson AFB, OH; ²Department of Aeromedical Research, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; ³USAF School of Aerospace Medicine, Wright-Patterson AFB, OH

INTRODUCTION: The United States Air Force vision of operational agility emphasizes strengthening performance-optimization within its working teams. Yet, the hallmark Air Force relationship, that between pilot and fighter aircraft, there are countless sensors monitor every aspect of aircraft performance, but none that monitor the pilot. Continued aircraft mishaps have highlighted this dearth of understanding to how this highly unique environment of hypobarism, high g-forces, and physiologic stressors impact a pilot's ability to continue to fly, fight, and win. In response to the limited data on the physiologic state of the pilot, the primary goal of this research is to develop a suite of sensors to measure pilot physiologic performance during flight with the future intent to advise pilots of their real-time physiologic state and provide warning of performance degradation. These efforts demonstrate the current capabilities of the Aircrew Mounted Physiologic Sensor Suite (AMPSS) system as a versatile aerospace research tool. **METHODS:** A collaborative group between the 711th Human Performance Wing at Wright-Patterson AFB and the Navy Medical Research Unit, Dayton has provided evaluation of the latest AMPSS in high-fidelity laboratories. The function of AMPSS has been verified to standard diagnostic equipment (e.g., Metabolic Cart, mass-spectrometer) in both unmanned and manned conditions in simulated operational environments. Additional Safe-to-Fly evaluation was conducted to verify airworthiness of the AMPSS system. **DISCUSSION:** The current AMPSS system provides the operational community with the cutting edge capabilities to collect physiologic evidence on pilots during flight in high-performance aircraft. Ongoing investigations at the 711th Human Performance Wing are using the AMPSS system to address the impact of the aircrew flight equipment on respiratory performance and the metabolic cost of simulated aerial combat maneuvers in a centrifuge. Subsequent research using AMPSS will determine the respiratory efficiency of the L-1 Anti-G Straining Maneuver under conditions of low and high lung elasticity, which will provide evidence-based training recommendations to improve the g-tolerance of the operational community.

Learning Objectives:

1. Participants will learn about the present state of technology development for in-flight monitoring of pilot physiology.
2. Participants will learn about how this technology is being validated in both high-fidelity laboratory testing and in the operational environment.
3. Participants will learn about how this technology helps expand the capabilities for conducting aerospace physiologic research in challenging environments.

Wednesday, April 27
Avalon 7-9

8:30 AM

S-51: SLIDE: AIRCREW HEALTH CONCERNS

Chair: Eric Fine
Kettering, OH

Chair: Jane Risdall
Cambridge, United Kingdom

[297] RISK OF FEMUR FRACTURES ON EJECTION

M.E. Lewis

AIHF, RAF, Baldock, United Kingdom

INTRODUCTION: Evidence from Tucano ejections demonstrated that detonation cord canopy fracturing is variable and aircrew's limbs may strike the canopy causing injury. System ejection tests had previously identified that a force of 2892N could be generated in a canopy knee strike. To assess this risk of injury acceleration testing was carried out on a Vertical Deceleration Test Rig (VDTR). **METHOD:** 5th, 50th and 95th percentile Hybrid III Anthropomorphic Test Devices (ATD) were subjected to a 15Gz impact (simulating the Tucano ejection thrust). The lower limb of the ATD was pre-loaded with a 20 Kg mass to replicate a 2892N canopy strike. Femur load cells and accelerometers measured the bending moment (My), linear forces in the Fx and Fz direction, and lower spine and seat Gz accelerations. The ATDs were securely strapped in to the seat of the VDTR and the seat-pan was configured to replicate the seat-pan depth of the Tucano ejection seat, which provided the appropriate overhang of the seat-pan to simulate the femur bending moment for each size of ATD. **RESULTS:** For 5th, 50th, and 95th percentile ATD the transmitted linear forces were 247N, 1406N, and 2214N and the bending moments were 91Nm, 240Nm, and 340Nm, respectively. These results were compared to cadaveric injury threshold limits derived from the published scientific literature and the F-35 Femur Injury Criterion (FIC). Cadaveric data demonstrated there was an approximate 1% chance of sustaining a femur fracture from the canopy strike, and was higher when the FIC was applied, but was not quantifiable. **DISCUSSION:** The probability of injury from a canopy strike was then utilized to generate an overall risk of injury during an ejection using a BOW TIE methodology and this indicated that overall risk to be 2.5x 10⁻⁹ which is considered to be As Low As Reasonably Practicable.

Learning Objectives:

1. Identifies and examines a possible injury mechanism on ejection from aircraft.

[298] RETURNING PILOTS WITH CHRONIC HEPATITIS B BACK TO FLYING WHILE ON NUCLEOS(T)IDE ANALOGUES: A CASE SERIES

D. Tan and W. Gan

Air Force Medical Service, Republic of Singapore Air Force, Singapore

PROBLEM STATEMENT: Current published waiver guidelines advise against allowing aviators with chronic Hepatitis B (CHB) on nucleos(t)ide analogues (NUCs) to resume flying duties. This case series presents 7 military aviators who were returned to flying duties while on varying combinations of NUCs. **BACKGROUND / LITERATURE REVIEW:** Hepatitis B infection remains a major threat in the world, and is associated with liver diseases such as cirrhosis and hepatocellular carcinoma. Pilots are at a similar risk of becoming infected with CHB, which can have a significant impact on their organizations and flying careers due to flying restrictions. The treatment often entails an extended duration of NUCs, which disqualifies pilots from flying based on current published waiver guidelines. **CASE PRESENTATION:** The 7 pilots in this case series were aged 36 to 42 years old at the point of treatment initiation. Of the 7 pilots, 4 were rotary wing pilots, 2 were transport aircraft pilots and 1 was a UAV pilot. Varying drug combinations were used and these included: (a) Adefovir and Lamivudine; (b) Adefovir and Entecavir; (c) Entecavir; and (d) Adefovir. Prior to resumption of flying duties, all pilots attained normal liver function tests, and 2 pilots had detectable levels of Hepatitis B Virus (HBV) DNA. A board of Aviation Medicine specialists and their Gastroenterologist had also reviewed them. **OPERATIONAL / CLINICAL RELEVANCE:**

This case series highlights the potential for pilots with CHB to continue flying duties while on NUCs. While there have been limited studies evaluating the use of NUCs in pilots performing flight duties, literature review in the general population has shown that NUCs are generally well tolerated, and have a good safety profile. Current waiver guidelines consider chronic hepatitis to be disqualifying, unless pilots demonstrate normal hepatic function and are not on disqualifying medications, including NUCs. However, managing pilots with CHB in consultation with their Gastroenterologist provides a holistic approach to their medical management, addressing all aspects of the biological, psychological and social model of medical management.

Learning Objectives:

1. This case series aims to illustrate the potential for pilots on NUCs to be returned to flying duties, when managed by Aviation Medicine specialists, in conjunction with their Gastroenterologist.

[299] A CASE REPORT OF A FATAL ACCIDENT DUE TO CORONARY ARTERY DISEASE AND SUDDEN IN-FLIGHT INCAPACITATION

A.L. Ciales³, E.M. Ricaurte¹ and C.A. DeJohn²

¹Aerospace Medical Research Division, FAA Civil Aerospace Medical Institute/CND, Edmond, OK; ²Medical Research Division, FAA Civil Aerospace Medical Institute, Oklahoma City, OK; ³National University of Colombia, Bogota, Colombia

INTRODUCTION: Cardiovascular disease remains the most common cause of loss of a pilot's medical certificate. Coronary Artery Disease (CAD) is the leading cause of death, premature permanent disability, and significant cause of sudden in-flight incapacitation (SII). It has been reported that in two-thirds of sudden cardiac death, the underlying cardiac rhythm is ventricular fibrillation, and in 80% of these cases, the underlying condition is CAD. **CASE REPORT:** A 67-year-old male pilot with a history of heart disease and a coronary episode had a stent implanted (Cypher® Drug-eluting stent) on March 2008 and was treated with Clopidogrel, Acetylsalicylic acid, Amlodipine, and Simvastatin. He had a Special Issuance limited 2nd-class medical certificate. In April 2009, he suffered an SII while piloting an aircraft. The airplane's owner, not a rated pilot, was in the co-pilot's seat and declared an emergency, describing the pilot's incapacitation. An air traffic controller guided the owner through the process of disengaging the autopilot, descending, and heading changes; the airplane landed uneventfully. During resuscitation efforts, the pilot was found to be in ventricular fibrillation that progressed to pulseless electrical activity, then to asystole, and subsequent death. The autopsy reported mild in-stent stenosis at the transected end, with 25% luminal narrowing by neointimal proliferation and two separate atherosclerotic lesions in the left anterior descending coronary artery, with a maximum estimated obstruction of 50% without evidence of acute myocardial ischemia. No evidence of sudden clot formation was found. Postmortem toxicology revealed the absence of Amlodipine in the pilot's blood. The cause of death was determined to be "Hypertensive and atherosclerotic cardiovascular disease," although the exact cause of his fatal arrhythmia could not be determined. **DISCUSSION:** Cardiovascular events causing in-flight incapacitation are very rare. Non-compliance with the medication Amlodipine could have increased the risk of angina due to vasospasm and also increased the risk of arrhythmias due to ischemia from vasospasm.

Learning Objectives:

1. The attendees will be able to understand the importance of performing autopsies and toxicological tests in fatally injured pilots.
2. The attendees will be able to learn the evolution and outcomes of severe cardiovascular disease in pilots.
3. The attendees will be able to understand the evaluation of risk factors from an aviation safety perspective in pilots with severe cardiovascular disease.

[300] MORTALITY FROM UROGENITAL CANCER IN FIGHTER AIRCREW

V.M. Pearson

Residency in Aerospace Medicine, USAF School of Aerospace Medicine, Fairborn, OH

INTRODUCTION: This was a case-control database review of the Air Force Mortality Registry (AFMR) to evaluate the mortality rates from

urogenital cancers and determine if a difference exists between crew from fighter airframes versus non-fighter airframes. A difference, or lack thereof, in mortality rates can help determine whether increased screening would be indicated if there is indeed an increased incidence of urogenital cancers in fighter aircrew. **METHODS:** The case group consisted of all male subjects from the AFMR database with urogenital cancers from 1976 through 2014. The control group consisted of subjects with non-cancer renal disease that were 1:1 matched to age at death, gender, and ethnicity to case subjects. The Air Force Personnel Center was used to obtain data parameters on the subjects not available in AFMR. A two-tailed chi-square statistic was used to test the case and control group for a statistically significant difference in mortality rates between fighter and non-fighter aircrew. Stratification of the data by total flight hours (i.e., >500 h, >1,000 h, >2,000 h) was done to determine if there is a threshold of exposure time in fighter airframes as suggested by a previous study. **RESULTS:** Two-tailed chi square statistic showed there is no significant difference between mortality rates from urogenital cancer in fighter aircrew and non-fighter aircrew. Stratification of total flight hours did not demonstrate a statistically significant increase in mortality in fighter aircrew with >2,000 h. There was no significant difference in the mortality rates in the >500 h and >1,000 h groups either. **DISCUSSION:** Although previous studies have provided evidence that there are significantly more cases of urogenital cancers in fighter aircrew than non-fighter aircrew, this study demonstrates the mortality rates are similar in both groups. This suggests that either the cancers developing in fighter aircrew are low grade and/or are very slow growing. Those with a greater history of exposure (higher number of total flight hours) are at no higher risk of mortality. This is evidence that, despite the fact that more urogenital cancers may be forming in fighter aircrew, increasing surveillance and screenings is not indicated as there would be no improvement in end-point mortality.

Learning Objectives:

1. Increasing surveillance and screenings for prostate cancer may not lead to improvement in end-point mortality.
2. Fighter pilots have significantly different exposures than non-fighter pilots. This may play a role in future flight physicals and clearances.

[301] GLAUCOMA IN U.S. PILOTS WITH THIRD-CLASS MEDICAL CERTIFICATES

C.A. DeJohn¹ and W.D. Mills²

¹Medical Research Division, FAA Civil Aerospace Medical Institute, Oklahoma City, OK; ²Aerospace Medicine Division, FAA Civil Aerospace Medical Institute, Oklahoma City, OK

INTRODUCTION: Glaucoma can be a hazard to flight safety due primarily to its potential effects on peripheral vision. In the U.S., glaucoma has required a waiver for medical certification until 2013, when aeromedical examiners were authorized to evaluate glaucoma and issue medical certificates without a waiver under the specific conditions provided in the FAA AME Guide. **METHODS:** The FAA's medical database, the Document Imaging Workflow System, was searched for pilots with a current pathology code for glaucoma. The National Transportation Safety Board (NTSB) Accident Database was then searched to determine which glaucoma pilots also had aircraft accidents during the same period. The accident rate for pilots with glaucoma was determined using self-reported six-month flight times on their FAA medical certificate applications. **RESULTS:** Between January 1, 2005, and December 31, 2014, 5,269 pilots reported on their FAA aviation physical examinations that they had been diagnosed with glaucoma. Seventy-eight of the 5,269 were involved in aircraft accidents. The accident rate for pilots with glaucoma who held a 3rd-class medical certificate was 7.4 per 100,000 flight hours and their fatal accident rate was 1.8 per 100,000 flight hours. **DISCUSSION:** Although the total accident rate of 7.4 per 100,000 hours and the fatal accident rate of 1.8 per 100,000 hours for pilots with glaucoma holding a 3rd class medical certificates were slightly higher than the general aviation total and fatal rates of 6.72 per 100,000 hours and 1.24 per 100,000 respectively, these differences were not statistically significant ($p = 0.9$, z -score = 0.005 and $p = 0.99$, z -score = 0.004). This finding suggests that pilots with glaucoma holding 3rd-class FAA medical certificates are not at significantly greater risk for accidents than the U.S. general aviation community. It also indicates that the FAA certification protocols for certifying pilots with glaucoma provide an adequate level of flight safety.

Learning Objectives:

1. Become familiar with the clinical aspects of glaucoma, how it affects aviation safety and treatments that are acceptable to FAA aviation certification.
2. Become familiar with FAA certification requirements for U.S. pilots with glaucoma, acceptable treatments, and causes for denial.
3. Become familiar with the relative safety record for pilots with glaucoma compared to that of U.S. general aviation pilots.

Wednesday, April 27

Avalon 10-12

8:30 AM

S-52: PANEL: RESIDENT GRAND ROUNDS, I

Sponsored by ASAMS

Chair: Patrick Storms

Dayton, OH

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

[302] VASCULAR THORACIC OUTLET SYNDROME IN A MILITARY HELICOPTER PILOT: A CASE REPORT

T. Bozung and P. DeFlorio

USAF School of Aerospace Medicine, Wright-Patterson AFB, OH

PROBLEM STATEMENT: Vascular thoracic outlet syndrome (VTOS) is a rare but potentially incapacitating condition most commonly seen in the young, healthy, and physically active. While incomplete vascular obstructions can have an indolent course making diagnosis difficult, acute vascular occlusions could compromise flight safety in a demographic that includes many pilots. **BACKGROUND/LITERATURE REVIEW:** The underlying pathology of most VTOS is a congenital or acquired musculoligamentous abnormality. In Paget-Schroetter syndrome, a subtype of VTOS, subclavian vein thrombosis develops due to compression between either the clavicle and first rib or the clavicle and the subclavius muscle. Recurrent overhead activities or shoulder motion can precipitate chronic microvascular pathology and lead to VTOS. Optimal outcome is driven by rapid diagnosis and treatment with thrombolysis and/or surgical decompression of the thoracic outlet. **CASE PRESENTATION:** A 35-yr-old male military helicopter pilot presented with 1 week of left upper extremity swelling, paresthesias, and arm weakness, causing difficulty lifting the helicopter's collective. He had no significant past medical history, no surgeries, and no prior shoulder injuries. While he had no risk factors for deep vein thrombosis, the swelling triggered an ultrasound that showed thrombosis of the subclavian vein. Further evaluation demonstrated concurrent pulmonary embolism. He was treated with an oral anticoagulant for 12 months but, after discontinuing anticoagulation, developed a recurrent left subclavian clot. After successful surgical decompression, he returned to flying with a waiver. **OPERATIONAL/CLINICAL RELEVANCE:** This case highlights the uncommon but important condition of VTOS. Having an increased index of suspicion for patients with recurrent shoulder pain, upper extremity paresthesias, weakness, or swelling could shorten the time to correct diagnosis and reduce unnecessary work-up and treatments. Aircraft mechanics are also at risk of VTOS because of their recurrent overhead activities.

Learning Objectives:

1. Participants will be able to recognize the prevalence, risk factors, clinical presentation, and treatment options of Vascular Thoracic Outlet Syndrome.

[303] UNUSUAL DIAGNOSIS IN A PILOT PRESENTING WITH PHARYNGITIS

M.R. Milner

USAF School of Aerospace Medicine, USAF, Dayton, OH

PROBLEM STATEMENT: This case report describes an Air Force helicopter pilot with pharyngitis as the presenting symptom for an infected branchial cleft cyst. **BACKGROUND/LITERATURE REVIEW:** During fiscal year 2015, 54,000 cases of pharyngitis were seen in Air Force family health clinics. Flight medicine saw only one-sixth of that number, giving flight surgeons far less exposure, and therefore experience, with treating pharyngitis on a regular basis. **CASE PRESENTATION:** The subject pilot was a 26-year old Air Force helicopter pilot with recurrent pharyngitis treated by different physicians in his flight medicine clinic. While treatments were essentially clinically appropriate, his symptoms failed to completely resolve. Finally, what had been previously thought to be an anterior chain cervical lymph node declared itself as an infected branchial cleft cyst and was ultimately surgically removed with excellent outcome. **OPERATIONAL/CLINICAL RELEVANCE:** This case highlights the importance of knowing staple clinical practice guidelines in order to avoid confusing a clinical picture when a patient's symptoms diverge from the expected. It also emphasizes the need for continuity of care allowing for subtle changes to be appreciated as well as a sense of ownership for a patient's symptoms and well-being, especially when the patient is not improving as expected. Finally, this case reminds all providers that not all hoof-beats outside the cockpit are horses; some actually are zebras.

Learning Objectives:

1. The audience will be able to demonstrate an understanding of basic clinical medicine including generating a differential diagnosis for apparent simple presentations.
2. The audience will be able to apply current clinical practice guidelines to a real case and recognize symptoms that lie outside the realm of the guideline's intended symptomatology as well as the importance of continuity in order to recognize these deviations at the earliest opportunity.

Wednesday, April 27
Avalon 13-14

8:30 AM**S-53: SLIDE: PREVENTION & CARE OF MEDICAL PROBLEMS FOR PASSENGERS OF COMMERCIAL AIRLINES**

Chair: Carolyn Jarrett
Longview, TX

Chair: Nora Johnson
Austin, TX

[304] QUALITY OF ECGS OBTAINED IN-FLIGHT BY FLIGHT ATTENDANTSP.M. Alves¹ and N. Nerwich²¹MedAire Inc., Tempe, AZ; ²International SOS, Sydney, Australia

INTRODUCTION: The addition of telemedical devices into the medical kit of some airlines provided a major contribution to refining the ability of assessing medical events occurring in-flight. In particular the ability of obtaining electrocardiograms (ECG) allows for better evaluation of cases of chest pain, just like other out of hospital environments. To maximize its utilization a diagnostic quality tracing should be obtained by the flight attendant who usually receives limited training and use the device infrequently. **OBJECTIVE:** Study the quality of ECG tracings obtained in-flight by flight attendant and transmitted to a medical response center in the ground. **METHODS:** All cases were obtained from 2 airlines using a commercially available multi-parameter telemedical device (Tempus IC – Remote Diagnostic Technologies). ECG tracings were scored according to their quality. Grade 5 were tracings were considered to be flawless Grade 4 were tracings were some minor issue was found, but the tracing was considered adequate for analysis. In grade 3 some information could be extracted, but the overall quality was not good. Ratings below 2 were considered unreadable. If multiple ECGs obtained from the same

case, the best tracing was selected. ECGs obtained from the same patient/flight were accepted as 2 tracings if more than one hour apart. **RESULTS:** A total 120 ECGs were initially available for analysis. Tracings were scored as 5 in 25 cases (21%), 4 in 63 (52.5%), 3 in 17 (14%), 2 in 6%. Only 8 (6.7%) cases were considered unreadable. In six cases no tracing was obtained. Four cases of STEMI (ST elevation myocardial infarct) were identified. In two cases the inferior wall was affected and in two there was infero-apical involvement. A STEMI was ruled-out in 104 cases. Out of the readable cases, an unstable baseline was the most common problem present in 43% of cases, followed by some noise in 18%. Missing or unreadable tracings occurred in 10% and switched cables (R and L) in 5%. **CONCLUSION:** ECGs obtained in-flight by airline flight attendants are mostly of diagnostic quality allowing to confirm or rule-out STEMI, as well as detect arrhythmias of clinical significance in case management. Minor issues identified are also common in ECGs obtained by technicians on the ground and didn't prevent obtaining useful information.

Learning Objectives:

1. Understand the quality of ECGs obtained by flight attendants in flight.

[305] MEDICAL EMERGENCY EQUIPMENT ONBOARD EUROPEAN AIRLINES - SURVEY RESULTS

J. Hinkelbein and S. Kalina

University Hospital of Cologne, Cologne, Germany

INTRODUCTION: Medical emergencies often occur on commercial airline flights, but valid data on their causes and consequences are rare. Although a minimum standard for medical equipment is defined in EASA regulations for Europe, additional material is not standardized and may vary significantly between different airlines. **METHODS:** Based on a previous study for Germany by the same group [1], European airlines operating aircraft with more than 50 seats were selected in December 2014 and interviewed with a 5-page written questionnaire between January and March, 2015. Besides pre-packed and required emergency medical material, drugs, medical devices, and equipment lists were queried. If no reply was received, airlines were contacted another three times by e-mail and/or phone. Descriptive analysis was used for data presentation and interpretation. **RESULTS:** From a total of 50 European airlines, which were contacted, 21 responded and provided information (response rate 21/50; 42%). A first aid kit was available on all airlines. Most responses were from Germany (n=6) followed by Austria (n=2), UK (n=2), and Belgium (n=2). Ireland, Greece, Czech Republic, Finland, Poland, Luxembourg, Switzerland, Italy, and Norway (each n=1) also responded. **CONCLUSIONS:** Although the minimal material required according to European aviation regulations is provided by all airlines for medical emergencies, there are significant differences in the provision of additional material. **REFERENCES:** [1] Hinkelbein J et al. Emergency medical equipment on-board of German Airlines. J Travel Med 2014;21(5):318-323.

Learning Objectives:

1. What type and quantity of emergency medical equipment is available onboard European aircraft.

[306] ACCESS TO AIRLINE MEDICAL INFORMATION FOR FLIGHT CLEARANCESL. Clapham^{1,3}, H. Cliffe^{1,2} and D. Gradwell¹¹King's College, London, St. Helier, Jersey; ²Queen Elizabeth Hospital, Birmingham, United Kingdom; ³Jersey General Hospital, St. Helier, Jersey

INTRODUCTION: A study reported one in 604 flights sampled had a notified medical event of which 7.3% required diversion.¹ The International Air Transport Association (IATA) publish guidelines for Medical Clearance with the aim of reducing such incidents.² This pilot study examined how accessible this information was for passengers. **METHODS:** Data from 89 European airlines were examined. Exclusions included cargo and bankrupt companies, websites not in English or third party booking. Airlines were categorized as low cost carriers (LCC) or a privatized/governmental (PG) airline (defined by the ICAO). Further, it was determined whether the airline offered long haul (LH) (greater than four hours) or only short haul (SH) flights. An algorithm was built to standardize the methodology. Search terms used were "medical", "health", "MEDIF" and "fit to fly". The study examined ease of website navigation for the search terms, information about 'fitness to fly', whether a MEDIF was

offered and if a self-declaration or physician's signature were required.

RESULTS: Results indicated how accessible passenger information about flying with medical conditions was and if a physician's medical history was required. Correlations were calculated for the relationship between our searches in each group. No significant differences in information accessibility, likelihood of offering a MEDIF or requiring a physician's signature were found between LH (total 60) and SH (total 29) carriers. There was a significant difference (p value = 0.0065) in the percentage of LCC (total 28) who required a MEDIF compared to PG (total 61) airlines (11% and 39%, respectively). Among these airlines, physician-signed MEDIFs were more common in LCC (100%) than PG (75%). There was no significant difference in information accessibility between LCC and PG.

DISCUSSION: Results indicate, despite IATA's guidelines, some passengers may experience difficulties accessing appropriate information and guidance from a proportion of the websites sampled. Passengers may benefit from airlines making the information more easily available on their websites. **REFERENCES:** 1. Pearson et al. Outcomes of Medical Emergencies on Commercial Airline Flights. *New England Journal of Medicine* 2013;36:2075-2083. 2. International Civil Aviation Authority. *Medical Manual*, 6th Edition. 2013:1-50.

Learning Objectives:

1. To gain an understanding of the challenges passengers with medical conditions may face when seeking to access advice from airline websites.

[307] DEVELOPMENT AND VALIDATION OF AN EDUCATIONAL BROCHURE AIMED AT THE PREVENTION OF GASTROINTESTINAL DISEASES IN TRAVELERS

M. Salamanca¹, I. Villalba², K. Villarreal², K. Torres² and O. Vargas²

¹Aeronautical Authority of Colombia Aerocivil, Bogota, Colombia;

²Corporacion Universitaria Rafael Nuñez, Cartagena, Colombia

INTRODUCTION: Travelers' diarrhea is the most common health impairment in persons visiting developing countries, affecting nearly 60% of tourists. Precautions can be taken to minimize the risk of developing traveler's diarrhea, either through avoidance of potentially contaminated food or drink or through various prophylactic measures, including both non pharmacological and antimicrobial strategies. Currently there is not a valid educational brochure with medical and scientific information but with a simple language accessible anyone traveling to tropical and subtropical areas. **METHODS:** This is a research developed in three phases: 1. Review of medical literature and prepare a brochure for travelers to the prevention of traveler's diarrhea 2. Validation of the contents of the pamphlet by experts in travel medicine public health and health communication through a survey based in validation of the structural and content of a brochure executed on the review of the medical and scientific literature. 3. Review and evaluation of the prospectus by a group of travelers visiting Cartagena. **RESULTS:** A brochure with medical - scientific information aimed at preventing traveler's diarrhea was developed, which was modified according to the evaluation given by five experts in travel medicine in various medical disciplines: aerospace medicine, public health, epidemiology and infectious diseases specialists. To date, the booklet is being evaluated by a group of tourists visiting the city of Cartagena. Once the modifications completed assessment booklet it will be available in English and Spanish version with the motive of making this known to the health authorities to implement widespread use among travelers. **DISCUSSION:** Travelers' diarrhea continues to be a worldwide disease that affects millions of tourists. It was created a booklet that not only is valid from the point of view of medico-scientific information contained but is easy to understand and attractive for travelers, so that health authorities and other organizations and institutions interested in health commuter implement and disseminate it widely.

Learning Objectives:

1. Develop a valid brochure aimed at the prevention of gastrointestinal illness in travelers to tropical and subtropical areas.

[308] IN-FLIGHT MEDICAL EMERGENCIES DURING AIRLINE OPERATIONS - A SURVEY ON INCIDENCE, NATURE, AND TREATMENT OPTIONS

J. Hinkelbein¹, S. Braunecker¹ and C. Neuhaus²

¹University Hospital of Cologne, Cologne, Germany;

²Heidelberg University, Heidelberg, Germany

BACKGROUND: Data on incidence of in-flight medical emergencies on board civil aircraft are rare and published scarcely. However, data on incidence is tremendously important to provide information on required medical equipment on board of aircraft and for setting up realistic training for crewmembers. The aim of the present study was to gather data on incidence, nature, and treatment options. **METHODS:** Using unipark.de (QuestBack GmbH, Cologne, Germany), an online survey was developed and used to gather specific information. All members of the German Society for Aviation and Space Medicine (DGLRM) were invited to participate in the survey during a four weeks period (21.03.2015-20.04.2015). Chi-square test was used for statistical analysis ($p < 0.05$ was considered significant). **RESULTS:** 348 members of the DGLRM were invited to participate (121 started the survey; response rate, 34.8%). The median duration for the survey was 4 minutes and 51 seconds. $N=54$ (44.6%) of the participants (89.9% male and 10.1% female; mean age, 54.1 years) were at least involved in one in-flight medical emergency. The mean duration of the flight was 5.7 hours. Cardiovascular (40.0%) and neurological disorders (17.8%) were the most frequent diagnoses. In 78.7% the medical equipment was sufficient. An emergency diversion was performed in 10.6% of the cases. **CONCLUSIONS:** Although using a different method of data acquisition, this survey confirms previous data on the nature of emergencies. In the future, data on in-flight medical emergencies should be recorded in a standardized data base to obtain valid numbers and to retrieve reliable conclusions.

Learning Objectives:

1. The audience should learn about incidence, nature, and treatment options for in-flight medical emergencies.

Wednesday, April 27

8:30 AM

Avalon 15-16

S-54: PANEL: PROBLEMS, PITFALLS AND POTENTIAL IN WORKING WITH LEGACY DATA SETS - A CASE STUDY

Sponsored by Army Aviation Medicine Association

Chair: James McGhee

Enterprise, AL

Chair: Glenn Paskoff

Patuxent River, MD

PANEL OVERVIEW: The regulatory environment governing the use of humans and animals continues to mature. Governing laws and agencies (e.g., Animal Welfare Act, Institutional Animal Care and Use Committee, Ethical Principles and Guidelines for the Protection of Human Subjects of Research, National Institutes of Health Policy on Required Education in the Protection of Human Research Participants) are becoming increasingly stringent. This atmosphere makes using previously collected data to speak to present day problems more attractive. However, such a strategy is not without its own issues. This panel will use the recovery of the Naval Biodynamics Laboratory data set, presently underway at the USAARL, as an illustrative case study. The material is in many forms and formats, including unprocessed experimental data, program files, protocols, minutes of meetings, subject records, films, histology slides, and paraffin blocks to mention a few. The challenges of organizing this material into a coherent, searchable form are considerable. Featured presentations will include considerations for the development of a recovery strategy and development of the vision the final form the recovered information should take to maximize its value for future research. The challenges of working with legacy data will also be discussed both in terms of processing old data and the regulatory issues of dealing with material collected under legacy protocols. Finally, an example of a paper illustrating the utility of recovering this material will be presented.

[309] THE LIFE AND TIMES OF THE NAVAL BIODYNAMICS LABORATORY (NBDL)

J.S. McGhee

Injury Biomechanics Division, U.S. Army Aeromedical Research Laboratory, Enterprise, AL

PROBLEM STATEMENT: In order to understand the issues surrounding the use of legacy data sets, the history of one is detailed. **TOPIC:** In the late 1960s, Commander Channing Ewing, noticed that sometimes jets landed hard on carrier decks, missed the arresting cables, and slid into the ocean. No head injury was apparent on aircraft recovery, yet the pilot failed to make any effort to escape. Commander Ewing suspected this was because the pilot had become unconscious upon landing. This suspicion eventually resulted in the establishment of the NBDL in 1971 with (then) Captain Ewing as its first OIC at NASA's Michoud Assembly Facility New Orleans, LA. The lab had three overarching goals: 1) Develop a mathematical model of acceleration injury, 2) Develop a crash test dummy, and 3) Develop an injury model that could not only predict the probability of injuries due to a failed protective system, but also indicate the changes required to make it a success. The NBDL used non-human primates (NHP), human research volunteers (HRV), and anthropomorphic test dummies (ATD) along with several unique devices to do its work. Included among these was a 700 foot horizontal accelerator capable of accelerating a payload of 5000 pounds and a 42 foot vertical accelerator capable of accelerating a 1500 pound payload. The laboratory evolved from a detachment of the Naval Aerospace Medical Research Laboratory (NAMRL) to an independent command. It collaborated with many government, academic, and commercial laboratories and achieved world-class stature. The NBDL was identified for closure under the 1995 BRAC. In 1996 management of the facility was transferred to the University of New Orleans with movement of most of the original data to NAMRL. NAMRL was closed by the 2005 BRAC and the data were moved to USAARL in two 18 wheel trailers and two pick-up trucks. A plan to organize the 40 tons of material and make it useful to future researchers was undertaken and continues to present. **APPLICATIONS:** Understanding of the history of this laboratory and the work it did sets the stage for understanding the problems associated with developing a strategy for making these data useful today.

Learning Objectives:

1. Awareness of the contributions of a world class laboratory focused on acceleration injury and its place in the history of aerospace medicine.
2. Awareness of the magnitude of the effort required to recover the material generated by this Naval Biodynamics Laboratory.

[310] DEVELOPING THE VISION FOR A BIODYNAMICS DATA REPOSITORY

C. Chancey³, B.S. Shender¹ and K.B. Vasquez²

¹Human Systems, NAVAIR, Patuxent River, MD; ²Injury Biomechanics Division, U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL; ³U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL

PROBLEM STATEMENT: With the advent of recent computing advances, the opportunity has become available and realistic to consider the creation of large digital data repositories for ongoing and future research purposes. With the sheer amount of physical assets (more than 40 tons) and the diversity of data types collected during impact acceleration studies at the Naval Biodynamics Laboratory (NBDL), the typical models for relational databases and data repositories were insufficient for the Biodynamics Data Resource (BDR). **TOPIC:** Prior efforts to preserve the massive amount of NBDL data were only able to address a portion of collected data (e.g., sensor, physiology, and select digitized kinematics) through an electronic database. The majority of the data remained as physical materials (e.g., strip charts, high speed films, x-rays, glass slides, and paraffin blocks). Because BDR was established to allow new research with previously collected biodynamics data, the creation and management of a comprehensive and flexible biodynamics research database and repository was required. Massive prioritization of effort was necessary to begin this undertaking. Research and development use and access scenarios were defined and became critical to establish the need to reassemble and associate all data and documentation in non-proprietary formats. Further exploration of use scenarios resulted in the definition of user roles and needs, as well as an outline for data workflow, both during and after repository development. Based on media condition and uniqueness of the data, a priority order for material processing was established along with archival and security requirements for preservation and safeguarding of physical and electronic materials. **APPLICATIONS:** By exploring and developing vision for BDR early in the development process, the research team was able to evaluate implementation

decisions within the larger context of future use the complex data repository. The lessons learned during the development of the BDR provide an outline of critical considerations that should be addressed early in the development of future data repositories.

Learning Objectives:

1. Even with technological advances, research data use scenarios are critical to the development of requirements for research data repositories.

[311] ORGANIZING LEGACY MATERIAL AND DIGITIZING FOR THE MODERN AGE

K.B. Vasquez², C.M. Beltran^{2,3}, A.V. Olszko^{2,3}, J.S. McGhee², B.S. Shender¹ and C. Chancey²

¹Human Systems, NAVAIR, Patuxent River, MD; ²Injury Biomechanics Division, U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL; ³Laulima Government Solutions, LLC, Orlando, FL

PROBLEM STATEMENT: Legacy data and material collections from the Naval Biodynamics Laboratory (NBDL) provide unique and complicated challenges for future research. The NBDL collection consists of multiple formats/media including engineering and physiology data, high speed film, medical images, Human Research Volunteer (HRV) records with extensive medical qualification exams, and administrative paperwork. The Biodynamics Data Resource (BDR) was established to physically organize and store the material, archive in digital formats, and create a relational database for researchers. **TOPIC:** A project such as the one BDR envisioned had never been undertaken before, and no overarching documentation existed to complete this mission. BDR personnel conducted an extensive literature review into industry standards necessary for the organizing and archiving of the NBDL data. The best practices of each industry were implemented or modified to create the BDR Best Practices and Metadata Dictionary. The BDR Best Practices establishes archival-quality digitizing methods for each material type with guidelines on resolution, file format, etc., while the Metadata Dictionary defines the file naming convention and the elements required for each item to create connections among data items. To organize and store the items while maintaining long-term functionality and accessibility, an electronic structure was developed and a relational database was created. The relational database allows researchers a simple and accurate search mechanism and relates the diverse collection datatypes using the defined metadata elements. The BDR is currently entering metadata into this relational database and beginning to work through the issues of security, user access permissions, maintaining data integrity, and opening the database to the biomechanics research community. **APPLICATIONS:** The BDR has defined methods and documentation to assist researchers in organizing a diverse engineering and medical research data, such as found in the NBDL collection. This approach can be applied to organize, digitize, and archive previously collected datasets or to establish a defined standard for organizing and preserving ongoing data collection.

Learning Objectives:

1. The participant will learn about the challenges in organizing, digitizing, and creating a relational database for legacy material types and apply the same techniques to modern data for standardization and preservation.

[312] CHALLENGES OF WORKING WITH LEGACY DATA FROM PRIOR RESEARCH

A.V. Olszko^{1,2}, C.M. Beltran^{1,2}, K.B. Vasquez¹ and C. Chancey¹

¹Injury Biomechanics Division, U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL; ²Laulima Government Solutions, LLC, Orlando, FL

PROBLEM STATEMENT: The Biodynamics Data Resource (BDR) contains a collection of engineering and medical research data from human and human surrogate impact acceleration studies conducted over a 25 year span at the Naval Biodynamics Laboratory (NBDL). To provide useable, useful data from the legacy collection to current and future researchers, several challenges had to be addressed, including past and present regulatory requirements, ownership, accessibility, and validity. **TOPIC:** After reviewing protocol documentation, including

volunteer consent forms in relation to current and past regulatory requirements, future data use was found to be consistent with guiding research ethical principles. By a similar review of contracts and associated documentation, data ownership was determined. With ownership established and research approval obtained, the research team began work with the numerous data sets: 1) data collected and stored by various acquisition methods based on data type; 2) multiple derived copies of time series data resulting from constantly-improving post-processing methods; and 3) original and derived data items duplicated due to progression of state-of-the-art media. Select hardcopy and analog data were digitized to preserve veracity before additional degradation. Based on data descriptions and structure, select electronic data were extracted from proprietary, inaccessible formats and converted to standardized, archival formats. Version and quality control were implemented to manage dataset origin and evaluate data usability, respectively. Multiple copies of individual data items were compared to determine differences due to post-processing methods; versions of similar data items were identified and categorized. For inclusion into the BDR, appropriate and releasable data items were converted into valid, accessible formats. **APPLICATIONS:** This approach, as applied to the NBDL collection for inclusion in BDR, addresses major challenges of data from legacy research projects. This methodology further benefits researchers conducting analyses of the collection for aeromedical research, as well as those researchers addressing similar challenges of effectively using legacy data.

Learning Objectives:

1. Effective use of legacy data requires consideration of challenges in assuring regulatory compliance, ownership, accessibility, and validity of datasets.

[313] FUTURE RESEARCH WITH THE BIODYNAMICS DATA RESOURCE (BDR)

C. Chancey, A.V. Olszko, D. Dorman, C.M. Beltran, K.B. Vasquez and J.S. McGhee

Injury Biomechanics Division, U.S. Army Aeromedical Research Laboratory, Fort Rucker, AL

PROBLEM STATEMENT: Prior Naval Biodynamics Laboratory (NBDL) research studies were focused on developing a systematic understanding of human head-neck response to non-contract, impact acceleration exposures. During the time period of the research studies, articles were published and conference presentations were made describing methodology, development of research and analysis techniques, and overall research outcomes; however, additional analyses and correlation studies with past, current, and future research are possible and needed to expand the current state of knowledge. **TOPIC:** In addition to pre- and post-medical imaging and assessment data, a variety of data describing the dynamic exposure and responses were collected from human research volunteers (HRVs) and human surrogates during impact exposure runs on unique acceleration devices. A portion of these data describes the kinematic response of the HRVs or surrogates. To ensure high fidelity data, accelerometers and high speed film captured kinematic response. A portion of these kinematic response data have been used to develop biofidelic response corridors that have been and continue to be used to develop and assess anthropomorphic test devices (ATDs). Numerous additional analyses could be performed with the existing data (some of these will be discussed). An illustration using kinematic response data will be provided. Other examples of time series and medical data (including anthropometric measurements) will be provided to demonstrate the breadth of data available for comparison to more recent research efforts. **APPLICATIONS:** Legacy data from human research volunteers and human surrogate impact acceleration studies can expand knowledge related to neurological, spinal, and physiological insults experienced during and following impact accelerations. Through associated sets of data, paired comparisons and correlations can be explored between human and human surrogate responses to address aeromedical research questions related to ejection, take-off, controlled descent, aerospace recovery, and accidents.

Learning Objectives:

1. Legacy data can be analyzed with modern analysis techniques.

Wednesday, April 27
Avalon 17

8:30 AM

S-55: PANEL: THERAPEUTICS IN AVIATION MEDICINE (PANEL OF THE FRENCH SOCIETY OF AEROSPACE MEDICINE, IN ENGLISH)

Chair: Olivier Manen
Clamart, France

Chair: Henri Marotte
Paris, France

PANEL OVERVIEW: The progress of therapeutics leads to new indications, protocols, molecules, instrumental or surgical treatment with an impact on symptoms and the natural course of pathologies. In aviation medicine, the ratio benefits/risks is important to assess, particularly in case of a new drug or strategy, for the decision-making process. The first author will present the recent policy for the anti-vitamin K drugs in civilian pilots, with the difficulties to apply the European regulations, the problem posed by direct oral anticoagulants, the role of pathologies requiring anticoagulation and finally the new situations of atrial fibrillation with a very low CHA2DS2-Vasc score. The second author will talk about the immune-modulating drugs, a not so rare therapy in aircrews, with the difficult question of the optimal dose of corticosteroids to authorize a return to flying duties, and also the reality of the infectious complications of the anti-TNF alpha drugs favoured by the travels all around the world. Airline aircrafts take-off with a first-aid kit on board. As far as the third author will present the new version of this kit in a French company, it is interesting to wonder some questions: are there different models depending on flying characteristics? What can be used without a medical doctor on board? Is it adapted to a pilot suffering from a sudden incapacitation, particularly related to a side effect of a treatment? The fourth author will talk about the current place of radiofrequency catheter ablation in preexcitation syndromes, atrial flutter/fibrillation, and premature ventricular beats. Are there so few risks that this treatment may be advised early in the course of these arrhythmias? What are the current efficacy rates? What decision should be taken for a fighter pilot or a monopilot of aerobatics? To conclude this panel, the fifth author will remind the different arguments which should be considered for each aircrew with a well-known or a new treatment. His presentation will be illustrated by many different medical, instrumental and surgical situations, and ethical considerations will be discussed.

[314] PRACTICAL ISSUES OF ANTICOAGULANT ACCEPTANCE IN AVIATION MEDICINE

S. Bisconte⁶, A. Hornez⁴, J. Monin¹, D. Dubourdieu⁵, X. Zirphile³, S. Nguyen³, O. Manen² and E. Perrier⁵

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⁶Robert Picque Military Hospital, Aeromedical Center, Bordeaux, France

PROBLEM STATEMENT: For more than 50 years, vitamin K antagonists (VKAs) were the only available oral anticoagulants and prohibited for flight in France. Since the implementation of European aeronautical standards, it's now possible to fly with VKAs under certain conditions. It's essential to discuss the consequences of this treatment on aeronautical fitness and the problems raised by the use of direct oral anticoagulants (DOACs). **TOPIC:** Professional or private pilots has allowed by the European Aviation Safety Agency (EASA) to fly with VKAs therapy after the agreement of the licensing authority for thromboembolic disorders and after valvular surgery. We don't find this element for the atrial fibrillation, but we think that the evaluation of this therapy should not be different. The efficacy of VKA has been proven, but depends on compliance and multiple drug/diet interactions. Its narrow therapeutic index affects its safety. That's why, EASA proposes a precise protocol to ensure the stability of this therapy. A case report will illustrate the practical difficulties to follow this protocol. The advent of DOACs has increased therapeutic options. The results of clinical trials demonstrate that efficacy and safety are at least as

good, if not better, than VKAs. This treatment has major pharmacological advantages over VKAs including rapid onset of action, few drug interactions, and predictable pharmacokinetics, eliminating the requirement for regular coagulation monitoring but raises new problems including the impossibility to ensure compliance. Fortunately, the stable pharmacokinetic properties and its large therapeutic index allow us not to consider it as a pejorative element. Although this therapy is no longer a cause of unfitness to fly, evaluation of the underlying disease has to stay at remains critical to the fitness determination. **APPLICATIONS:** In conditions of optimal compliance and monitoring, the use of VKAs and mainly DOACs appears possible and safe in pilots, but the assessment of underlying pathology remains paramount.

Learning Objectives:

1. To discuss problems raised by Anticoagulant therapy management in aviation medicine.

[315] IMMUNE-MODULATING DRUGS AND AEROMEDICAL FITNESS

J. Monin¹, S. Bisconte³, A. Hornez¹, G. Guiu¹, N. Huiban¹, D. Dubourdieu¹, O. Manen^{1,2}, J. Deroche¹, P. Bertran¹ and E. Perrier^{1,2}

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INTRODUCTION: Among the population of aircrew members (AM) examined in the Aeromedical Centers, some of them are taking immune-modulating drugs which may jeopardize the flight safety in case of adverse effects. **METHODS:** The aim of this study was to evaluate the short and long-term tolerance in aircrews and the risk of these medications in accordance with the current literature, particularly the reality of infectious complications in the aeronautical environment. All the medical files of the AM taking an immune-modulating treatment were studied in a population of 13,326 AM examined in the Aeromedical Centre of Percy Military Hospital (Clamart) for fitness assessment in 2014. Patients with a cancer were excluded. **RESULTS:** About a hundred of AM examined in our center were treated with an immune-modulating drug including corticosteroids, methotrexate, anti-rejection medicines and anti-tumor necrosis factor alpha. There were various diseases requiring these medications. Some of them were not well tolerated and justified periods of grounding and sometimes a decision of definitive unfitness. **DISCUSSION:** Many prospective cohort studies have been performed worldwide to evaluate the risk of occurrence of infectious complications in case of a treatment with anti-tumor necrosis factor alpha. This risk includes bacteria (especially tuberculosis), virus, fungus, and parasites. To prevent this risk, a medical assessment is necessary before starting the treatment, and a close follow-up is recommended. The use of vaccines needs some precautions. The aeromedical decision with such a treatment should be on an individual basis, considering the following elements: the causal disease (stage, complications, risk of relapse...), the precise protocol (molecule, intake form, dosage, duration...), the initial tolerance, the status (military with overseas deployments, civilian with possible flying limitations) and the flying experience. By supervising the follow-up of these aircrews, the flight surgeon has a role to prevent the onset of complications during a flight or a stopover in a foreign country. He also will assure a close monitoring in case of a return to flying duties of a pilot with an optimal dose of corticosteroids that will be discussed.

Learning Objectives:

1. To evaluate the risks of an immune-modulating treatment in aircrew members.
2. To understand the problem of corticosteroids in aviation medicine, particularly the optimal dose to return to flying duties.

[316] NEW APPROACH FOR IN-FLIGHT MEDICAL CARE

V. Feuillie

Passenger Medical Department, Air France, Roissy Charles de Gaulle Cedex, France

PROBLEM STATEMENT: More than 3 billion passengers traveled last year on commercial airlines, this number is growing annually. In case of medical events on board, Airlines are required to provide first aid kit, universal precaution kits, emergency medical kit, and first aid training for

cabin-crew. The contents of these medical kits are given by the recommendations of IATA, ICAO, FAA, AsMA, and EASA for European airlines. Fortunately, most medical emergencies in-flight are minors with syncope or presyncope. Airlines try to avoid medical diversion most due to cardiac alert or acute stroke. In-flight deaths are very rare but are traumatic events for cabin crew. After a study of all these medical problems on board, we tried to define a new approach for in flight medical care. **TOPIC:** We present new solutions to help cabin-crew and physicians on board with first aid kit, emergency medical kit and a new resuscitation kit to treat a cardiac arrest, we win time. The support of our ground-based medical consultation service (SAMU de Paris) is very important to help to give the good practice and to avoid diversions. For the annually first aid training of all our cabin crew, we are using some movies with real scenario of in-flight medical situations. Cabin crew can also have a look on these movies on intranet system on line. The first aid book is on PC Tablet on board of each Cabin Purser. **APPLICATIONS:** With the last Ebola outbreak in West Africa, we have maintained flights to infected countries. We saw all the interest to have on board all the medical kits, the good training for cabin crew to manage suspected cases on board with the link of a ground based medical support.

Learning Objectives:

1. Knowledge about most important medical events on board.
2. Understanding the need and the regulations for medical kits on board.

[317] THE SPECTACULAR PROGRESS OF RADIOFREQUENCY ABLATION TECHNIQUES AND ITS IMPACT ON AEROMEDICAL FITNESS

A. Hornez³, S. Bisconte⁵, X. Zirphile³, J. Monin¹, S. Nguyen³, D. Dubourdieu⁴, O. Manen² and E. Perrier⁴

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PROBLEM STATEMENT: Radiofrequency ablation (RFA) of cardiac arrhythmias has come to widespread use since it was first performed in the mid-1980s. Together with an increasing understanding of arrhythmia mechanisms, technology has made tremendous progress. What is the current place of this new technique in aviation medicine? **TOPIC:** Arrhythmias are a common cause of disqualification from flying in both civilian and military aircrew. RFA offers a potential definitive cure for some arrhythmias. It has become not only an alternative to drug therapy in the treatment of supra-ventricular arrhythmias, but is nowadays the first therapeutic choice in selected patients, i.e. those without other cardiac pathology and with a low risk profile for procedure complications. Evolution of ablation techniques has allowed to significantly increase the safety and the long-term effectiveness of the procedure. Illustrated by case reports, the three main indications most often encountered in the aircrew population are ablation in Wolff-Parkinson-White syndrome, atrial fibrillation and premature ventricular beats with ventricular tachycardia. Reasonable time post procedure before fly and monitoring are not clearly defined. It's a case by case analysis. Safety and definitive efficiency could allow us to propose to declare fit to fly by waiver a single pilot. The fitness decision is more complicated for fighter and aerobatics pilots because of the pro arrhythmic effects of + G z accelerations. The centrifuge test may help in decision making. **APPLICATIONS:** Technological advances improved the efficiency and safety of the RFA. Its indications in the treatment of cardiac arrhythmias are becoming earlier in the course of arrhythmias. An aeronautical fitness can be considered.

Learning Objectives:

1. To present evolutions of RFA techniques and to determine what is the most appropriate aeromedical decision after RFA for a pilot, especially a fighter or aerobatics pilot.

[318] AEROMEDICAL CONCERNS FOR THERAPEUTICS IN AIRCREWS

O. Manen^{1,2}, J. Monin¹, S. Bisconte³, A. Hornez¹, N. Huiban¹, G. Guiu¹, P. Bertran¹ and E. Perrier^{1,2}

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²French Military Health Service Academy, Paris, France; ³Aeromedical Center - Robert Picqué Military Hospital, Bordeaux, France

PROBLEM STATEMENT: Nowadays, many diseases lead to various methods of treatment, with precise indications and protocols thanks to the results of clinical studies and following recommendations, but also with an important place for the choice of patients. However, all these therapeutics may not lead systematically to a positive decision for flying duties. Some aeromedical concerns should not be forgotten. **TOPIC:** The following therapeutics will illustrate the presentation to explain the decision-making process: medications (in diabetes, migraine, Crohn's disease, multiple sclerosis and restless legs syndrome), endoscopic procedures (for kidney stones and intracranial aneurysm), surgery (for pneumothorax, cavernoma, spine fractures and bicuspid aortic valve) and devices (continuous positive airway pressure and transcutaneous electrical nerve stimulation). **APPLICATIONS:** Aeromedical experts should consider the following elements before the acceptance of some therapeutics: the causal disease; the significance of the treatment as a stage of the disease; the clinical studies about the tolerance and efficiency; the experience of the treatment in the real life of patients; the real effect on the natural course of the disease; the professional constraints of aircrews which may interfere with the intake; the arguments other than anamnesis to prove the good tolerance; the need for a specific follow-up in relation to the treatment; the very specific environmental constraints of some aircrews; the aeromedical justification of some therapeutics and the frequent poor awareness of these implications by the aircrews. Aeromedical experts have not only a role in the final decision but also to give appropriate advices and information to the aircrews before they are treated in case of multiple options. **RESOURCES:** In 2009, a study by questionnaire was carried out in 1,500 pilots of 3 French aeromedical centers (answers 88%, mean age 39.5yo, male 95%/female 5%, civilian 64%/military 36%, mean experience 15y/5,014 flying hours): 12% declared to take a regular treatment (civilian 14%, military 9%); the quasi-exclusive problematic that these pilots seemed to know about the side effects of medications was the potential psychoactive effects.

Learning Objectives:

1. To know all the arguments to consider before taking aeromedical decision in case of a treatment and before a general acceptance of a new therapeutics in aircrews.
2. To understand why all the new therapeutics which are useful in general medicine are not obviously interesting to promote in aviation medicine.

Wednesday, April 27

8:30 AM

Avalon 6

S-56: PANEL: DIABETES AND INSULIN USE BY COMMERCIAL PILOTS

Sponsored by ATM Committee

Chair: Sally Evans

London, United Kingdom

Chair: Stuart Mitchell

London, United Kingdom

PANEL OVERVIEW: Medical certification for pilots using insulin is a topic of utmost interest for aviation safety. The advent of newer insulin delivery methods as well as glucose level monitoring has changed the panorama in recent years.

[319] THE INSULIN TREATED DIABETIC PILOT: CURRENT DIABETES MANAGEMENT

D. Lorber^{1,2}

¹Lang Research Center, New York Presbyterian/Queens, Flushing, NY;

²Medicine, Weill Medical College, Cornell University, Flushing, NY

MOTIVATION: Aerospace medical professionals may be familiar with current treatments of diabetes mellitus. However, regulatory agency concerns about pilot or ATC incapacitation have limited career paths available to insulin treated individuals. The current state of the art in diabetes management has dramatically reduced the risk of pilot incapacitation from hypoglycemia to near zero. This presentation will inform the listener about current management of diabetes mellitus and will provide foundation information that will enhance understanding of the subsequent presentations in this panel. This will enable the listener to make decisions

about appropriate guidelines for credentialing insulin treated pilots and ATCs with diabetes. **OVERVIEW:** This presentation will review current management of diabetes mellitus with particular focus on hypoglycemia risk. Content will include current standards of care for diabetes treatment with insulin and other agents as well as a review of the scientific literature focusing on hypoglycemia risk and its mitigation. **SIGNIFICANCE:** Pilots with insulin treated diabetes mellitus are currently not issued Class one certificates in the United States. This policy has resulted in qualified, experienced pilots being removed from flight responsibilities. Although this restriction may have been appropriate in the early decades of insulin treatment, changes in therapy and monitoring techniques have been shown to markedly reduce the risk of acute incapacitation. It is hoped that recognition of advances in diabetes management will enable regulatory change to allow these individuals the opportunity to resume their chosen career path. This change will allow the United States to join other countries currently allowing insulin treated pilots to achieve Class 1 status, consistent with the FAA's value of global leadership.

Learning Objectives:

1. Participants will understand current insulin treatment of adults with type 1 diabetes.
2. Participants will understand current approaches to mitigating hypoglycemia incidence in diabetes treatment.

[320] COMMERCIAL PILOTS ON INSULIN: WHY NOT?

R. Simons

European Society of Aerospace Medicine, Soesterberg, Netherlands

PROBLEM STATEMENT: Insulin treatment has considerable consequences for the careers of diabetic professionals engaged in safety sensitive jobs, such as airline pilots. Commercial pilots who needed insulin were banned from the flight deck because the hypoglycemia risk was considered incompatible with flight safety. Safe functioning may be affected by complications of diabetes mellitus, such as autonomic neuropathy, cardiovascular disease, retinopathy, and renal disease and by complications of the therapy of which hypoglycemia represents a major threat to flight safety. **TOPIC:** Recent developments, such as diabetes self-management education, self-monitoring of blood glucose, continuous glucose monitoring, and short- and long-acting insulin analogues, may enable more optimal achievement of individual glycemic targets and prevention of hypoglycemia. These developments justify reconsideration of the flight safety risks of insulin treated commercial pilots. **DISCUSSION:** Management of diabetes in airline pilots needs to anticipate adjustments due to time zone crossings, night duties, irregular work, and delays. Professional coaching and self-management of blood glucose in combination with long-acting insulin analogues to control glycemic concentrations between meals and rapid-acting analogues to control postprandial hyperglycemia, not only improves glycemic control and prevention of hypoglycemia, but will also enable coping with above-mentioned operational problems. We conclude that it is possible to keep a selected group of insulin treated pilots on flying status without making concessions to flight safety and optimal prevention of complications. Some national authorities use a protocol that may allow commercial pilots to fly with insulin under strict conditions. According to this protocol, pilots should show evidence of long-term stable glycemic control to be eligible for possible aeromedical certification. However, other national authorities do not allow commercial pilots to fly while using insulin. Civil aviation authorities should pursue harmonization of the medical requirements and consider individual cases of insulin treated pilots for certification.

Learning Objectives:

1. To gain insight in the problems diabetic pilots face when they have to be treated with insulin.
2. Learn how the problems of insulin treated diabetic pilots can be managed in strictly selected cases.

[321] THE INSULIN TREATED DIABETIC PILOT - AIRLINE PILOT UNION PERSPECTIVE

Q. Snyder^{1,2}

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²Air Line Pilots Association, Int'l, Herndon, VA

MOTIVATION: Medical certification of insulin treated diabetic (ITDM) commercial pilots varies by country. Diabetic technology is evolving rapidly.

Factors for determining policy include responsibility for public safety, ability to monitor inflight to prevent subtle and sudden incapacitation, glucose monitoring and insulin infusion technology and the impact of monitoring on flight duty performance. For professional pilots, factors motivating medical certification include the potential consequences of avoiding treatment with insulin, both medical and financial, concerns about privacy of medical information and any operational challenges to maintain/document adequate control according to best medical practices. **OVERVIEW:** Some civil aviation authorities (CAA's) allow certification of ITDM pilots only if they are engaged in non-commercial operations while others allow certification of pilots only in commercial operations, sometimes with operational limitations. Safety of the travelling public is the primary concern of CAA's and any sudden or subtle incapacitation may jeopardize this. Pilots who face medical disqualification for use of insulin will often limit their treatment to non-insulin therapies while sacrificing optimum glycemic control. Education in management of diet, pharmaceuticals and monitoring equipment will potentially reduce risks of adverse inflight medical events to lower than those in known or undiagnosed diabetics not using insulin. Documentation of compromising symptoms and plasma glucose levels is readily available. Pilots in single pilot operations have a long history of safe operations while monitoring plasma glucose in flight and correcting extremes of glucose levels. **SIGNIFICANCE:** Policies allowing for certification of ITDM pilots may improve pilot health by encouraging diabetic standard of care treatment. This would reduce the risk of adverse medical events and potentially sudden or subtle inflight incapacitation, thus making aviation operations safer. Carefully designed protocols for documenting regular treatment and for appropriate inflight glucose monitoring making medical certification acceptable for CAA's and medical management better defined for pilots and their treating physicians.

Learning Objectives:

1. Participants will understand potential operational safety improvements and enhancement of medical health if civil aviation authorities implemented medical certification of diabetic pilots using insulin.
2. Participants will understand diabetic commercial pilots' motivations to seek medical certification when treated with insulin.

[322] FAA FRAMEWORK FOR MEDICAL CERTIFICATION OF INSULIN-TREATED DIABETES MELLITUS PILOTS

J.R. DeVoll

Office of Aerospace Medicine, Federal Aviation Administration, Washington, DC

INTRODUCTION: The FAA monitors advances in diabetes and has evolved risk assessment and acceptance based on current evidence-based literature. The challenge to aeromedical risk assessment is variability in ITDM pathogenesis, clinical presentation, treatment, side-effects, progression, and complications. Hypoglycemia remains the chief concern. Diabetes also is unique because it is a cellular level abnormality affecting the instantaneous regulation of energy metabolism, and the only disease that requires ongoing self-monitoring by the pilot in the cockpit. The current challenge is how to address certification for commercial pilot duties. **METHODS:** This presentation reviews the FAA's recent history with ITDM pilots, current aeromedical safety concerns, and evolving framework for risk assessment. **RESULTS:** Prior to 1996, pilots with ITDM were not certificated due to the concern for the risk of hypoglycemia. Since 1996, the FAA has allowed ITDM pilots special issuance (SI) certification only for FAA third-class (general aviation). To mitigate hypoglycemia risk, a protocol for testing serum blood sugar prior to and during flight was developed and implemented. Though the experience with third-class has not proven overtly unsafe, a policy for ITDM for commercial pilot duties has been challenging due to: Part 67 mandates for less risk; treatment advances not necessarily translating to reliably reduced hypoglycemia risk; hypoglycemia risk increasing with tight glucose control and duration of disease; recognition of the impact of glycemic variability; hypoglycemia unawareness and associated autonomic failure; warnings by diabetes experts of the continued hazards of hypoglycemia; and U.S. case law restricting operational limitations/requirements on first-/second-class medical certificates. **DISCUSSION:** A risk stratification approach is under development by the FAA. Anticipated key elements will include: coordinated use of traditional and continuous glucose monitoring systems; glycemic variability and control metrics; types of insulin and treatment protocols; patient characteristics; disease

progression; presence of co-morbidities; and a flight protocol acceptable across the spectrum of commercial pilot duties.

Learning Objectives:

1. Understand the FAA's perspective regarding challenges to an acceptable risk assessment process for first- and second-class medical certification.
2. Understand the requirements for a protocol for monitoring ITDM during performance of commercial pilot duties within the U.S. air space.
3. Understand the FAA's current approach to developing an evidence-based risk stratification model, and the elements under consideration.

Wednesday, April 27

10:30 AM

Avalon 1-3

S-57: PANEL: NEUROLOGICAL EFFECTS OF HYPOBARIC EXPOSURE

Chair: Paul Sherman

Boerne, TX

PANEL OVERVIEW: This panel presents the results of national as well as international collaborative research regarding the effects of hypobaric exposure on the human brain. A strong association has been demonstrated between subcortical white matter injury and exposure to U.S. Air Force operational non-hypoxic hypobaric conditions. The first presentation describes new evidence of diffuse axonal injury in normal appearing white matter in U-2 pilots, correlating with hypobaric exposure and impact on spatial orientation. The second presentation describes structural magnetic resonance imaging changes in the brain in U.S. Air Force personnel associated with a single exposure to hypobaric hypoxic conditions in an altitude chamber. The following two presentations outline brain magnetic resonance imaging changes and white matter status in Norwegian altitude chamber instructors and altitude chamber trainees in the United Kingdom. These presentations outline the international engagement in white matter brain injury evaluation related to hypobaric and represent a subset of current North Atlantic Treaty Organization involvement. Our final presentation discusses the utility of brain MRI in repetitive hypobaric exposure in a swine animal model. The goal of our multinational research is to understand the pathophysiology behind hypobaric exposure related white matter injury changes and optimally protect our aircrew and astronauts during mission performance.

[323] LOSS OF AXONAL INTEGRITY FOLLOWING REPETITIVE HYPOBARIC EXPOSURE

S. McGuire², P.M. Sherman¹ and P. Kochunov³

¹Human Performance/Radiology, USAF School of Aerospace Medicine; Wilford Hall ASC, Boerne, TX; ²USAF School of Aerospace Medicine, San Antonio, TX; ³Maryland Psychiatric Research Center, Catonsville, MD

INTRODUCTION: We performed high resolution magnetic resonance imaging on 106 U-2 pilots (U2P), 83 chamber technicians (AOP), and 162 doctorate controls (DOC), previously reporting increased subcortical white matter hyperintensity (WMH) burden associated with repetitive hypobaric exposure. We postulated that additional structural changes would be occurring and these changes might suggest an underlying pathophysiological mechanism. **METHODS:** We compared fractional anisotropy (FA) derived from diffusion tensor imaging between groups and to WMH burden. Statistical analysis was performed utilizing two-tailed parametric t-test with age as a nuisance covariate. **RESULTS:** Compared to DOC, average global FA was significantly reduced in U2P ($P < 0.001$) and marginally reduced in AOP ($P = 0.065$). Additionally, there was a stepwise change in individual tract values with AOP intermediate between U2P and DOC. **DISCUSSION:** Repetitive normoxic hypobaric exposure above 25,000 ft is associated with a loss of axonal integrity that parallels the WMH burden increase. This implies an "intensity of exposure" effect. The pathophysiology behind this cerebral white matter injury is unknown, but any proposed hypothesis

must account for both the discrete WMH increase and the diffuse global average FA decrease.

Learning Objectives:

1. Understand the structural changes occurring in normal appearing white matter following repetitive exposure to nonhypoxic hypobaric.

[324] PHASE 2 U-2 STUDY - SINGLE EXPOSURE TRIAL: FINDINGS AT 1 YEAR

P.M. Sherman^{1,2}, P. Kochunov³ and S. McGuire^{1,4}

¹USAF School of Aerospace Medicine/FHOH, San Antonio, TX;

²Radiology, 59MDW, San Antonio, TX; ³Psychiatry, University of

Maryland, Catonsville, MD; ⁴Neurology, 59MDW, San Antonio, TX

INTRODUCTION: Our goal is to characterize the pathophysiologic response of the brain to high altitude exposure to understand its association with subcortical white matter injury. A single exposure to a hypobaric environment (7,620 m [25,000 ft]) with or without hypoxia induces transient MRI changes in addition to changes in inflammatory biomarkers. **METHODS:** This study was approved by the 59th MDW Institutional Review Board. 4 study limbs were established: 1) hypobaric, hypoxic [initial altitude chamber training]; 2) hypobaric, non-hypoxic [inside observer technicians]; 3) hypoxic, non-hypobaric [reduced oxygen breathing device refresher training]; and 4) normal controls without exposure. MRI performed on a 3-T Siemens Verio magnet 1 d prior, 1 d post, and 3 d post exposure. MR protocol included axial MPRAGE, MRS with TE of 30 and 135, diffusion tensor and Q-space imaging, arterial spin labeling perfusion imaging, and 3D FLAIR images. Phlebotomy was performed prior to MRI #1, immediately prior to and post exposure, and prior to MRI #2 and #3. Laboratory analyses included S100B, TNF-alpha, IL-6, IFN- gamma, and microparticle analysis. Control patients underwent blood draws at equivalent times during the day as the other three study limbs. **RESULTS:** At 1 yr, 75 subjects have been imaged, (46 from limb 1, 8 from limb 2, 3 from limb 3, and 18 from limb 4). MRI demonstrates an increase in cerebral blood flow to white matter 24 h after altitude chamber exposure and an up-regulation of glutamate/glutamine in the anterior cingulate gyrus. Serology demonstrates a correlation with MRI quantitative changes and S100B. Microparticle data are inconclusive at this time. **DISCUSSION:** MRI results suggest that a single altitude exposure to 25,000 ft results in an increased metabolic demand on the brain and oxidative stress and a potential neuroinflammatory process. Further assessment of microparticle data and potential platelet-neutrophil interactions is required. Quantifying the effects of a single hypobaric exposure may result in identification of the pathophysiology of hypobaric-associated subcortical white matter injury.

Learning Objectives:

1. Understand current structural and serological effects of hypobaric exposure on the human brain.

[325] PROGRAM REVIEW OF CURRENT UK RESEARCH INTO DYSBARIC EXPOSURE AND WHITE MATTER INJURY

D.M. Connolly¹, V.M. Lee¹ and P.D. Hodkinson²

¹Aircrew Systems, QinetiQ PLC, Farnborough, United Kingdom; ²RAF Centre of Aviation Medicine, Hitchin, United Kingdom

MOTIVATION: Increased white matter hyperintensities (WMH) on magnetic resonance imaging (MRI) brain scans of USAF U-2 pilots and altitude chamber workers imply subcortical injury associated with non-hypoxic hypobaric exposure. If related to intensity of decompression stress then frequent (e.g. occupational) diving should also be associated with WMH. A meta-analysis of case-control studies was conducted to investigate this. A follow-on MRI survey of UK altitude chamber research and training participants is planned; the methodology and reasoning are described to inform international collaborators. **OVERVIEW:** Studies eligible for meta-analysis examined brain MRI of healthy divers and controls for WMH. Methodological quality assessment examined cohort size, recruitment bias, control matching, MRI sensitivity and confounding factors. Odds ratio (OR) meta-analysis was performed and repeated following exclusion of low quality studies. From 11 studies, 136 of 410 divers (33%) and 79 of 339 controls (23%) exhibited WMH (OR 1.925, $P = 0.025$). Excluding four low quality studies eliminated heterogeneity with 98 of 279 divers (35%) and 44 of 232 controls (19%) having WMH (OR

2.654, $P < 0.001$). The increased prevalence of WMH in divers, without past decompression illness, is consistent with intensity of decompression stress following hyperbaric exposure and with recent findings in altitude workers. This has supported proposal of a follow-on MRI survey to investigate WMH and hypobaric decompression stress in UK participants who have undertaken ≥ 10 hypobaric chamber profiles to equivalent pressure altitudes $> 15,000$ ft for research or training. **SIGNIFICANCE:** The survey methodology will reproduce USAF techniques for quantifying WMH total numbers and volumes, validating non-parametric comparison of UK and USAF cohorts. Information collected on participants' past dysbaric exposure histories, medical, lifestyle and recreational factors may enable consideration of regression analysis. The protocol will be shared with international investigators to facilitate collaboration, encourage data pooling and enhance inferential statistical analysis.

Learning Objectives:

1. Present evidence that diving promotes white matter injury.

[326] WHITE MATTER HYPERINTENSITIES IN CEREBRAL MRI OF NORWEGIAN ALTITUDE CHAMBER INSTRUCTORS

J. Owe¹, B.H. Munkeby¹ and A. Bjornerud²

¹Norwegian Armed Forces Medical Services, Institute of Aviation Medicine, Oslo, Norway; ²Department of Physics, University of Oslo, Oslo, Norway

INTRODUCTION: Subcortical White Matter Hyperintensities (WMH) have been detected in a group of USAF altitude chamber instructors with > 50 chamber flights $> 25,000$ ft. At the Institute of Aviation Medicine, Norwegian Armed Forces Medical Services a standardized chamber training procedure aimed at reducing decompression sickness risk has been used since 1980. No cases of DCS have been reported with this procedure, and no venous gas emboli were detected on initial ultrasound evaluation. Contributing factors may be long preoxygenation, 45-60 min, including moderate exercise, no exposures above 25,000 ft and less than 12 min at this altitude. The aim of the study is to investigate if these extra safety measures have a protective effect on the development of WMH. **METHODS:** The majority of Norwegian altitude chamber instructors with > 10 exposures to 25,000 ft for the last 40 years have had cerebral MRI using a 3 Tesla clinical scanner with a protocol similar to the USAF regarding WMH evaluation. For each instructor a healthy age, sex and background matched control has been scanned. In a NATO collaborative support activity anonymized copies of all MRI-scans have been sent to the USAF for quantification of WMH number, volume and location, at the University of Maryland in the same way as for the USAF study groups. **RESULTS/DISCUSSION:** So far 16 instructors and 13 controls have been scanned. Means of subcortical WMH count/volume in the instructor group is lower than in the control group. Upper limit for subject age in the USAF studies is 50 years. Only 6 of our scanned instructors of age 50 or below have > 40 exposures to 25,000 ft. Age of these 6 instructors is 38-50 years, average 45. Number of exposures 41-125, average 78. Means of subcortical WMH count in this group: 1.3 ± 2.183 (0-4) and volume 0.011 ± 0.030 ml (0,000-0,031). Total subcortical WMH count in the matching control group: 3.2 ± 2.388 (0-6) and volume 0.040 ± 0.039 ml (0,000-0,096). This instructor group appears to have lower subcortical WMH count/volume than their matching control group and the USAF control group of flight surgeons & personnel with PhD (DOC). Preliminary results indicate that our extra safety measures protect against the development of WMH.

Learning Objectives:

1. To determine if a standardized, low DCS-risk altitude chamber training procedure will protect the chamber instructors from developing WMH.

[327] UTILITY OF MRI IN REPETITIVE HYPOBARIC EXPOSURE IN A SWINE MODEL

J. Bernot¹, S. McGuire³, P.M. Sherman² and P. Kochunov⁴

¹Radiology, 59 Medical Wing, JBSA-Lackland, TX; ²Human

Performance/Radiology, USAF School of Aerospace Medicine;

Wilford Hall ASC, Boerne, TX; ³USAF School of Aerospace Medicine,

San Antonio, TX; ⁴Maryland Psychiatric Research Institute,

Catonsville, MD

INTRODUCTION: We are developing a swine model to replicate the magnetic resonance imaging (MRI) changes in humans related to repetitive hypobaric exposure. We postulated that MRI would be a useful assessment technique in this swine model and that this would permit translation of findings from this model to humans. **METHODS:** Five miniature pigs (*Sus scrofa domestica*) were repetitively exposed to 30,000 ft for 8 h while three served as controls. We obtained pre- and post-exposure dynamic susceptibility (DSC) gadodiamide-contrasted MRIs with results fitted to a natural logarithmic function. Statistical analysis was performed utilizing a two-tailed parametric *t*-test. **RESULTS:** Highly reproducible DSC was demonstrated within and across subjects. No difference was detected on pre- and post-DSC within individual subjects or between controls and study groups ($P > 0.05$). **DISCUSSION:** DSC can be utilized in this pig model with high reliability and thus will provide a translational assessment for human MRI findings following repetitive hypobaric exposure. The lack of change pre- to post-exposure suggests the blood brain barrier remained intact. Further model development is necessary.

Learning Objectives:

1. Understand the value of a swine model and MRI for evaluation of an animal model for hypobaric exposure.

Wednesday, April 27

10:30 AM

Avalon 7-9

S-58: PANEL: AVIATION SAFETY CENTERS YEAR-IN-REVIEW: 2015

Sponsored by AsMA Aerospace Safety Committee

Chair: Tyler Brooks

Ottawa, Ontario, Canada

Chair: Charles DeJohn

Oklahoma City, OK

PANEL OVERVIEW: This panel presents the results of a review of 2015 aviation safety data. Representatives from military and civil aviation organizations will present a summary of safety-related events from FY-2015. Presentations will focus on the analysis of mechanical and human factors causes of aviation and space mishaps with an emphasis on trends over previous years. Updates on the progress of mitigation intervention strategies to reduce mishap rates will also be discussed.

[328] FLIGHT SAFETY PANEL: ROYAL CANADIAN AIR FORCE 2015 YEAR IN REVIEW

T. Brooks

Director of Flight Safety, Canadian Armed Forces, Ottawa, ONCanada

MOTIVATION: The Flight Safety panel presents statistics and analysis of key cause factors identified within the past year by a variety of military aerospace operators. Awareness of trends within Flight Safety is essential for aerospace medical professionals who fulfill multiple flight safety-related roles, including the provision of aeromedical certification, aeromedical advice, and incident investigation expertise. This presentation will contribute to the Flight Safety panel discussion by presenting data collected by the Royal Canadian Air Force (RCAF) in 2015. **OVERVIEW:** The RCAF operates all Army, Navy and Air Force aircraft in the Canadian Armed Forces. The Director of Flight Safety (DFS) investigates aviation occurrences with the goal of preventing accidental loss of aircraft and personnel. Class A and B accidents in FY15 were reviewed to identify human factors which may have caused or contributed to these occurrences. These factors were reviewed in the context of previously identified hazards which include: fatigue, culture, and substances hazardous to aviation. RCAF initiatives aimed at mitigating these hazards will be discussed. **SIGNIFICANCE:** Fatigue, culture and substances hazardous to aviation continue to be relevant to Flight Safety in the RCAF, and initiatives are underway within the RCAF to address these hazards. Panel discussion on these topics will be of interest to participants who may be dealing with similar hazards within their organizations.

Learning Objectives:

1. Understand aircraft accident rates within the Royal Canadian Air Force.
2. Understand the highest priority hazards that have been identified as causative or contributory factors in aircraft accidents within the Royal Canadian Air Force.
3. Understand the initiatives that are underway to mitigate the hazards with the highest priorities.

[329] NASA 2015 SAFETY YEAR IN REVIEW

T. Dillinger

HQ S&MA, NASA, Washington, DC

INTRODUCTION: This presentation provides information regarding NASA reportable mishaps, close calls, and hi-visibility events during the year 2015. In addition to occurrence data, Human Factors information is also provided to help us move towards better mishap prevention efforts in the future. **METHODS:** NASA collects Class A, B, C and D mishap information as well as close calls and hi-visibility events in an Agency-wide database (NMIS). NMIS data, along with Human Factors (HF) data from the NASA Safety Center database is annually analyzed and reported. **RESULTS:** While improvements in safety-related events are occurring, recent experience reminds us of the need to; maintain vigilance, continually seek information, and respond in a timely fashion to prevent mishaps. **DISCUSSION:** Individual, preconditions, supervisory and organizational human factors continue to challenge development and operations of NASA institutional and programmatic efforts. By sharing NASA mishap and HF analysis and initiatives, perhaps 2016 will show continued safety improvements.

Learning Objectives:

1. Review the overall trend in NASA reportable events and common factors associated with those events.

[330] U.S. CIVIL AVIATION IN 2015

C.A. DeJohn and W.D. Mills

Medical Research Division, FAA Civil Aerospace Medical Institute, Oklahoma City, OK

INTRODUCTION: The National Transportation Safety Board investigates all civil aviation accidents and reports current and historical accident data. Trends in accident rates and performance data were analyzed for all types of civil aviation operations with emphasis on 2015 data. **METHODS:** U.S. civil aviation accident data was analyzed to determine trends from 1990 to 2015, whereas safety performance measures were analyzed for various time periods depending on available data. **RESULTS:** Fatal accident rates for all types of operations significantly decreased for the period 1990 to 2015 ($P < 0.05$). Air taxi and general aviation accident rates decreased more rapidly than their respective fatal accident rates ($P < 0.01$). Safety performance measures for commercial air fatalities, runway incursions and general aviation fatal accidents all showed that actual rates were significantly below the target rates ($P < 0.01$) for 2008 to 2015. **DISCUSSION:** An analysis of accident rates between 1990 and 2015 and safety performance measures trends from 2008 through 2015 for all types of operations indicated steady improvements in civil aviation safety.

Learning Objectives:

1. Become familiar with trends in U.S. civil aviation accident trends for all types of operations.
2. Become familiar with specific FAA Safety Performance measure trends.
3. Become familiar with measures the FAA uses to track safety performance.

[331] U.S. ARMY AVIATION SAFETY: FY 2015 YEAR IN REVIEW

R.J. Dickinson¹ and M. McPherson^{1,2}

¹*U.S. Army Combat Readiness Center, Fort Rucker, AL;* ²*U.S. Army School of Aviation Medicine, Enterprise, AL*

INTRODUCTION: Discuss (FY) 2015 statistics and analysis for USA Class A aviation mishaps including Human Factors Analysis. **METHODS:**

FY2015 data was obtained from the USA Combat Readiness Center database (ASMIS) for Class A thru C aviation mishaps and reviewed for human factors as determined by the Centralized Accident Investigation Boards. **RESULTS:** In the manned aircraft category, Army Aviation experienced 70 Class A-C aircraft mishaps in FY15. This is a decrease (4%) from the 73 Class A-C aircraft mishaps reported in FY14. The U.S. Army experienced 13 Class A aviation flight mishaps during FY15 (a decrease of 13% from the 15 Class A flight mishaps in FY14). The accident rate for Class A flight mishaps (per 100,000 flying hours) was 1.52 in FY15, the same rate as the 1.52 in FY14. There were 13 fatalities in FY15. **DISCUSSION:** Overall the Class A mishap rate showed no change from FY14 to FY15 although a 13% reduction in total flying hours flown occurred. 23% (3) of the aviation Class A flight mishaps occurred in theater. Human error accounted for 77% of the Class A flight mishaps, 92% of the Class B and 50% of the Class C mishaps. 32% (14) of the 44 Class C incidents have an unknown or not yet reported cause factor.

Learning Objectives:

1. Review the overall trend in U.S. Army flight mishaps and the most common identified causal factors.

[332] NAVAL AVIATION SAFETY: 2015 YEAR IN REVIEW

M. Penny, R. Frick, K. Littel and K. Hodges
Naval Safety Center, U.S. Navy, Virginia Beach, VA

INTRODUCTION: The Naval Safety Center analyzes Navy and Marine Corps aviation safety investigation reports in order to identify mishap causal factors. **METHODS:** All Class A flight mishaps involving U.S. Navy and Marine Corps aircraft during fiscal year 2015 (FY15) were reviewed using the Human Factors Analysis and Classification System (HFACS). **RESULTS:** During FY 15 there were 9 Class A mishaps in the U.S. Navy (1.06 per 100,000 flight hours) and 7 Class A mishaps in the U.S. Marine Corps (2.83 per 100,000 flight hours). A review of Class A flight mishaps over the past 10 years demonstrated that human factors were the predominant causal factors. Current emerging topics of discussion related to Naval Aviation Safety will also be presented. **DISCUSSION:** HFACS is a useful tool in safety investigation analysis and assists in identifying causal factors to focus mitigation strategies to prevent future mishaps. Its standardization across the Department of Defense should facilitate cross-analysis and shared efforts to prevent future mishaps. While regulation of Unmanned Aerial Systems continues to be a hot topic in the media, delineation of physiological events and real-time integration of physiological sensors and countermeasures continues to be a top priority in the Naval Aviation community. On-going challenges include human systems integration in new and legacy platform upgrades.

Learning Objectives:

1. Review the overall trend in U.S. Navy and Marine Corps flight mishaps and the most common human factors identified as causal factors.
2. Identify the most common Human Factors Analysis and Classification System (HFACS) categories for Naval Aviation mishaps.
3. Review the trends in Naval Aviation mishap HFACS causal factors over the last decade.
4. Become familiar with the emerging topics of discussion at the Naval Safety Center related to aviation.

[333] U.S. AIR FORCE AVIATION SAFETY: FY 2015 YEAR IN REVIEW

D. Windhorst¹, D. Porter² and T.S. Strongin¹

¹Air Force Safety Center, Kirtland AFB, NM; ²U.S. Air Force, Kirtland AFB, NM

INTRODUCTION: Review of fiscal year (FY) 2015 statistics and analysis for USAF Class A, Aviation mishaps including classification with DoD Human Factors Analysis and Classification System (DoD HFACS). **METHODS:** FY15 data was obtained from the USAF Safety Center database for Aviation mishaps and reviewed for human factors as determined by the Safety Investigation Boards (SIB). The human factors present were categorized for the present year and the preceding 8 years. **RESULTS:** The U.S. Air Force experienced 20 Class A, Aviation mishaps during FY13 (a rate of 1.25 per 100,000 flight hours) with 7 destroyed aircraft and 14 fatalities. The review of Class A, Aviation mishaps over the past year, demonstrated that most are attributed to human factors. The use and analysis of DoD HFACS will be discussed. **DISCUSSION:** Although

the Class A, Aviation mishap rate increased slightly from FY14, FY15 was, nevertheless, one of the safest years in USAF history. Human factors analysis reveals patterns of contributory factors that appear to be amenable to organizational influence.

Learning Objectives:

1. The audience will know the overall trend in USAF mishaps and human factors contributing to current year mishaps in comparison with data from previous years.
2. The audience will know how human factors appear to have influenced the occurrence of these mishaps.

Wednesday, April 27

10:30 AM

Avalon 10-12

S-59: PANEL: RESIDENT GRAND ROUNDS, II

Sponsored by ASAMS

Chair: Patrick Storms

Dayton, OH

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

[334] USAF AEROSPACE OPHTHALMOLOGY CORNEAL REFRACTIVE SURGERY UPDATE

T.C. Richardson

Aerospace Ophthalmology, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH

PROBLEM STATEMENT: The United States Air Force (USAF) approved corneal refractive surgery (CRS) for use in aviators in August 2000. Since that time over 3,400 flying personnel have undergone CRS, including over 800 pilots. Initially, refractive surgery options were limited to surface ablative procedures (e.g., photorefractive keratectomy) in limited treatment groups. After extensive Department of Defense research and observed stability, intrastromal procedures (e.g., laser-assisted in situ keratomileusis) were approved for aircrew in 2007. To date, approximately 400 stromal procedures have been accomplished. The majority of USAF aircrew treated were men (92%) with a mean age of 35.3 years. What are the outcomes of refractive surgery in USAF aircrew, and how has this changed USAF policy on refractive surgery in aviators? **TOPIC:** Initially, treatment options were limited to procedures up to -5.50 D of myopia. Parameters were later expanded to allow procedures to treat up to -8.00 D of myopia (8.7%) and up to +3.00 D of hyperopia (0.44%). The majority of USAF aircrew treated with refractive surgery were low myopes who had an average spherical equivalent of -2.73 D of myopia. Treatment of myopes above -5.50 D accounted for only 296 procedures (8.7% of total treatments) and only 15 (0.44%) aircrew were treated for hyperopia. I will present data from the USAF Aeromedical Consultation Service to report the refractive outcomes of both approved CRS modalities and their relationship to various levels of preoperative refractive error. We will also look at the prevalence of photorefractive keratectomy versus laser-assisted in situ keratomileusis in aircrew by crew position and in relation to visual outcomes including refractive status and visual acuity. **APPLICATIONS:** Current aeromedical guidelines will be reviewed related to CRS in aviators and the waiver experience will be discussed. There will be discussions about possible future policy changes/initiatives.

Learning Objectives:

1. To become familiar with the history of refractive surgery in USAF Aircrew.
2. To become familiar with the outcomes of refractive surgery in USAF aviators.
3. To be reacquainted with current aeromedical guidelines in regards to corneal refractive surgery.

Wednesday, April 27**10:30 AM****Avalon 13-14**

S-60: PANEL: ADVANCING THE AIR FORCE'S CRITICAL CARE AEROMEDICAL TRANSPORT CAPABILITIES: RESEARCH FROM THE CENTERS FOR THE SUSTAINMENT OF TRAUMA & READINESS SKILLS

Chair: Susan Dukes*Wright-Patterson AFB, OH***Chair: Raymond Fang***Baltimore, MD*

PANEL OVERVIEW: This panel introduces the diverse en route care research portfolio conducted by the U.S. Air Force Centers for the Sustainment of Trauma and Readiness Skills (CSTARS). Created primarily as pre-deployment training sites, the CSTARS platforms are embedded within major civilian University medical centers. Sharing the common goal of optimizing care for the critically ill and injured, synergies between military and civilian researchers promise to improve outcomes for military trauma patients in the wartime setting as well as civilian trauma patients at home.

[335] AEROMEDICAL EVACUATION-RELEVANT HYPOBARIA WORSENS TBI IN RATS EXPOSED TO UNDERBODY BLAST-INDUCED HYPERACCELERATION

Y. Hsieh², J. Proctor², A. Puche², A. Faden², R. Fang¹ and G. Fiskum²¹U.S. Air Force, Baltimore, MD; ²Anesthesiology, University of Maryland Baltimore, Baltimore, MD

INTRODUCTION: Occupants of vehicles targeted by improvised explosive devices are often victims of TBI and are typically air evacuated (AE) to a regional medical center within a few days post-injury. This study tested the hypothesis that exposure of rats to AE-relevant hypobarica worsens damage to white matter and blood vessels caused by blast-induced acceleration. **METHODS:** The underbody blast paradigm resulted in peak vertical acceleration of adult male rats equal to 100 G without exposure to blast overpressure. Rats remained under normobaric conditions or were exposed to hypobarica equal to 8000 ft for 6 h, starting at 6, 24, or 72 h or 6 days post-blast. At 7 days post-blast, rats were perfusion-fixed and their brains analyzed for evidence of axonal fiber injury and cerebrovascular injury. Other rats were used for neurobehavioral assays at 14 days. **RESULTS:** The number of de Olmos silver-stained axonal fibers present in the internal capsule was two times greater in animals (10/group) exposed to 100 G blast than in shams. Animals exposed to 6 h hypobarica at 6, 24, and 72 h and 6 days after blast all exhibited significantly more silver-stained fibers than those not exposed to hypobarica. Rats exposed to 100% O₂ during hypobarica at 24 h post-blast displayed significantly greater silver staining than those exposed to 21% O₂ (room air) during hypobarica. The cortical area occupied by von Willebrand Factor (vWF) immunoreactivity was very low in shams and over ten times greater in blast/normobaric animals or blast/hypobaric animals. Quantitative rtPCR indicated a 10-fold increase in vWF gene expression at 7 days post-blast. The number of foot-faults observed during the balance beam test was significantly greater in blast/hypobaric (100% O₂) animals compared to shams or blast/hypobaric (21% O₂) animals. **DISCUSSION:** We conclude that AE-relevant hypobarica worsens brain injury in rats caused by blast-induced acceleration and that this injury is further exacerbated by exposure to 100% O₂ during hypobarica.

Learning Objectives:

1. The participant will be able to understand how hypobarica exacerbates traumatic brain injury.

[336] CLOSED LOOP CONTROL TECHNOLOGY: ENHANCING COMBAT CASUALTY CARE IN AUSTERE ENVIRONMENTS

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INTRODUCTION: Every combat contingency that suffers wounded warriors mandates the skillful application of mechanical ventilation/oxygen delivery to meet patient demands. Establishing a technology that would improve the safety/efficacy of this critical care intervention should prove beneficial to the entire en route care system. Closed loop control of oxygenation has proven successful in clinical trials and should be considered for implementation in military medical operations. **METHODS:** Trauma/surgical intensive care unit patients between the ages of 18-65 requiring mechanical ventilation were selected as a surrogate population to combat casualties. All were enrolled per a randomized, cross-over trial of closed loop control of fraction of inspired oxygen compared to manual control. Arterial blood gases/hemodynamic parameters were assessed every 2 h. The ventilator and computer system permitted automatic adjustment of fraction of inspired oxygen in response to pulse oximetry. Ventilator parameters, pulse oximetry, and heart rate data were recorded every 5 s and stored as .csv files for later analysis. Safety/efficacy criteria were evaluated based on prevention of hypoxemia (oxygen saturation (SpO₂) ≤ 88%), ability of the controller to maintain SpO₂ within the targeted range of 92-96%, and oxygen consumption. **RESULTS:** Enrollment of 95 subjects yielded a mean age of 35 and mean Injury Severity Score of 34±13. The mean duration of hypoxemia in the closed loop group was less than half of that experienced by the control population. Amount of time in the target range was 189.95 min in the closed loop group compared to 74.52 min in the control group, with a 34% savings in oxygen volume. Hyperoxia (97-100% SpO₂) was reduced by almost 300%. **DISCUSSION:** Evidence supports the utility of closed loop control of oxygenation in trauma patients in an effort to mitigate the incidence of hypo/hyperoxemia, while reducing oxygen consumption. We propose a multi-center clinical trial to assess validity of closed loop control of oxygenation in an effort to obtain Food and Drug Administration approval for military application. Subsequent studies will include autonomous control of PEEP and ventilation.

Learning Objectives:

1. Establish an understanding of the risks involved in oxygen delivery to critical care patients.
2. Understand a novel method to delivering oxygen through mechanical ventilation utilizing closed loop control technology.
3. Attendee will be able to define the benefits and risks of delivering oxygen generated by a concentrator through a ventilator equipped with closed loop control algorithms.

[337] PREDICTING BLOOD TRANSFUSION USING AUTOMATED ANALYSIS OF VITAL SIGN INPUT FROM ALL AVAILABLE SOURCES

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INTRODUCTION: Prediction of blood transfusion needs for trauma patients in near real-time is an unrealized goal. We hypothesized that automated analysis of vast quantities of vital sign data routinely monitored could accurately predict the need for blood transfusion and that input from multiple sources would improve accuracy over single monitor input. **METHODS:** Continuous vital sign data from pulse oximetry and electrocardiography (ECG) waveforms and non-invasive blood pressure (BP) cuff monitors were recorded for direct-admit trauma patients with abnormal pre-hospital shock index (heart rate/systolic blood pressure) ≥ 0.62. Predictions of blood transfusion in the first 3 hours were compared using Delong's method for area under receiver operating characteristic (AUROC) curves to determine the accuracy of prediction for each monitoring device and combinations of monitoring sources in multivariate logistic regression models. **RESULTS:** We enrolled 1191 patients; 339 were excluded due to

incomplete data; 40 received blood within 3 hours. Blood use in the first 15 minutes was not included to allow time for data collection. Pulse oximetry waveform analysis alone predicted transfusion within 3 hours with AUROC = 0.86; ECG waveform analysis = 0.96, noninvasive BP trends = 0.82. Analysis of all three input sources predicted transfusion with AUROC = 0.96.

CONCLUSION: Blood transfusion can be accurately predicted using automated analysis of data from any single vital sign monitor, however when data from all three sources is available, the accuracy is further increased. Prediction of transfusion may allow rapid recognition of hemorrhagic shock and improved triage. The capability to predict transfusion from various input sources creates a reliable and redundant capability for forward deployment.

Learning Objectives:

1. The participant will be able to understand the utility of continuous physiological data to predict the need for life saving interventions, such as blood transfusion.

[338] ENSURING OPTIMAL MANAGEMENT OF MODERATE-TO-SEVERE TRAUMATIC BRAIN INJURIES DURING AEROMEDICAL TRANSPORT

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MOTIVATION: As of August 2014, moderate-to-severe traumatic brain injuries (TBI) sustained by members of the Department of Defense (DoD) worldwide since 2000 totaled 32,996 cases. Moderate-to-severe TBIs causes significant wartime morbidity and mortality, and avoidance of secondary brain injury during aeromedical transport is crucial to optimize outcomes. This presentation will describe efforts by the Air Force Centers for Sustainment of Trauma and Readiness Skills (CSTARS) to facilitate the safe and successful aeromedical evacuation of these casualties by not only educating Air Force Medical Service (AFMS) rotators to treat, but also conducting research to improve TBI management. **OVERVIEW:** The majority of AFMS personnel do not manage moderate-to-severe TBI patients in their in-garrison practices, yet they are potentially tasked to do so in deployed, isolated, resource-austere settings to include aeromedical transport. The Joint Trauma System (JTS) created evidence-based Clinical Practice Guidelines (CPG) for the "Management of Patients with Severe Head Injury" in March 2005 with annual revisions to encompass advances in care. Surprisingly, many deploying AFMS personnel remain unaware of these guidelines until their CSTARS pre-deployment rotations. CSTARS utilizes this JTS CPG as a core curriculum component to educate pre-deploying rotators with clinical concepts reinforced through small group discussions, simulation training, and real-patient exposures. Key considerations for management of moderate-to-severe TBI during aeromedical transport will be presented and CSTARS research endeavors to improve both the training program as well as the clinical care itself will be described. **SIGNIFICANCE:** Compliance with the evidence-based JTS CPG for the management of moderate-to-severe TBI will improve outcomes for our nation's wounded warriors with these injuries. The military-civilian CSTARS collaboration remains committed to optimize the care of these casualties by educating AFMS rotators with this current "best practice" reference tool, while executing DoD-supported research that seeks to revise future care by generation of new knowledge to improve clinical practice.

Learning Objectives:

1. The participant will be able to understand the medical management principles of moderate-to-severe traumatic brain injury to minimize secondary brain injury and to optimize casualty outcomes throughout the care continuum to include en route care during aeromedical transport.

[339] ADVANCED EN ROUTE CARE: A CASE-CONTROL ANALYSIS OF THE ACUTE LUNG RESCUE TEAM

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INTRODUCTION: The Air Force acute lung rescue team (ALRT) was developed to transport patients with severe pulmonary failure who

exceeded standard critical care air transport team (CCATT) capability. Activation decisions have been based on a physiologic and clinical dialogue between deployed providers and ALRT physicians. Evidence-based criteria have not been previously established and we sought to examine characteristics distinguishing ALRT from CCATT patients.

METHODS: A retrospective case-control analysis comparing ALRT versus CCATT patients was performed between 2005 and 2014. Patient cohorts were 1:1 matched by age and sex. Characteristics were compared to include injury severity, physiologic covariates, and outcomes. **RESULTS:** Forty-nine ALRT patients were matched to 49 CCATT patients. The combined mean age was 28 ± 1 yr and 94% male. The predominant injury mechanism was blunt (77% CCATT, 60% ALRT). Distinguishing factors (CCATT vs. ALRT) included Injury Severity (23.0 ± 1.8 vs. 31.8 ± 2.7), Abbreviated Injury Scale chest (2.3 ± 0.2 vs. 3.1 ± 0.2), pre-flight central venous pressure (8.0 ± 0.9 vs. 12.0 ± 0.9), pre-flight pH (7.39 ± 0.01 vs. 7.35 ± 0.02), pre-flight partial pressure of carbon dioxide (40.6 ± 1.1 vs. 51.6 ± 4.4), initial tidal volume (551 ± 7.3 vs. 490 ± 32.3 mL), initial positive end-expiratory pressure (5.6 ± 0.3 vs. 11.5 ± 0.6 cmH₂O), and initial fraction of inspired oxygen (0.4 ± 0.01 vs. 0.7 ± 0.03). Early acute respiratory distress syndrome increased the risk sevenfold (odds ratio 6.8, 95% CI 2.4-19.9) and vasopressor use twofold (odds ratio 2.6, 95% CI 0.99-6.93). There was no difference in total length of stay or mortality.

DISCUSSION: Pre-flight ALRT patients were more physiologic deranged with clear characteristics distinguishing them from CCATT. These objective data may assist in future utilization decisions to deploy a resource-intensive and personnel-limited team.

Learning Objectives:

1. The participant will be able to describe the purpose of the acute lung rescue team.
2. The participant will be able to describe the clinical conditions appropriate for utilization of the acute lung rescue team.
3. The participant will be able to describe the general physiology of a patient require use of the acute lung rescue team.

Wednesday, April 27

10:30 AM

Avalon 15-16

S-61: PANEL: MARS EXPLORATION: EVIDENCE-BASED RECOMMENDATIONS FOR FATIGUE MANAGEMENT

Chair: Lauren Leveton

Houston, TX

Chair: Alexandra Whitmire

Houston, TX

PANEL OVERVIEW: The Behavioral Health and Performance (BHP) Element in NASA's Human Research Program conducts and supports research to address three human health risks, including the *Risk of Performance Decrements and Adverse Health Outcomes Resulting from Sleep Loss, Circadian Desynchronization, and Work Overload*. Studies have shown that circadian misalignment exists in space, and average nightly sleep duration is around 6 hours, with some nights before critical operations averaging 4 hours. Mitigation strategies include the strategic use of hypnotic medications. A recent investigation evaluated the effects of commonly used hypnotics at abrupt awakening, leading to a standard operational protocol for ground-testing medications before flight. Additionally, clinicians provide recommendations for fatigue management, and objective and subjective measures for crewmembers during training to self-assess sleep efficacy relative to countermeasure use. These current practices will help to inform clinical practices in current and future spaceflight missions. Additionally, terrestrial studies focusing on environmental factors have informed recommendations for the volume and design of a Mars habitat. The effects of noise, relative to sleep, and ambient lighting, on circadian rhythms, continue to be assessed. Lighting remains an especially important component of specific habitat design, as it can either greatly hinder or greatly facilitate circadian entrainment, sleep, alertness, and performance. And finally, while ensuring an optimal environment plays a key role protecting behavioral health in future spaceflight, it is expected that biomarkers that characterize individual vulnerabilities and resiliencies to sleep loss could be key toward personalized

countermeasure implementation. This panel will incorporate five data-rich presentations that highlight current spaceflight practices for fatigue management; how research on environmental factors (including noise and lighting) can inform a Mars habitat design; and, how incorporating an omics approach towards individual countermeasure recommendations, could all enable risk mitigation in future Mars Exploration missions.

[340] BIOMARKERS FOR PREDICTING SUSCEPTIBILITY OR RESILIENCE TO SLEEP LOSS: IMPLICATIONS FOR PERSONALIZED COUNTERMEASURES

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INTRODUCTION: Sleep loss degrades neurobehavioral functions including behavioral attention, cognitive throughput and memory, and increases sleepiness. However, there are stable and trait-like individual differences in such responses to sleep loss: some individuals show few neurobehavioral decrements (resilient), others show intermediate decrements, and others show marked decrements (susceptible). This study examined whether metabolomics (an “omics” methodology) could differentiate such susceptible and resilient individuals, and thus serve as a biomarker for personalized countermeasure implementation. **METHODS:** Ten healthy subjects (27.5±5.6 y; 5 f) participated in one of two 14-18 day lab protocols approved by the University of Pennsylvania's Institutional Review Board. Metabolomic blood samples were taken following 10-12h of fasting after: one night of baseline sleep [10h time in bed (TIB), 2200h-0800h]; chronic sleep restriction (5 consecutive nights of 4h TIB, 0400h-0800h); and one night of recovery sleep (12h TIB, 2200h-1000h). The Psychomotor Vigilance Test (PVT), the Digit Symbol Substitution Task (DSST), the Digit Span Task (DS), the Karolinska Sleepiness Scale (KSS) and the Profile of Mood States (POMS) were administered every 2h while awake. OPLS regression was used for statistical analysis. **RESULTS:** Preliminary data analyses indicate the metabolite acetylcarnitine associated with 6 neurobehavioral variables during sleep loss, but not at baseline or recovery: PVT lapses + errors, PVT response speed (1/RT), DSST total correct, DS total correct, KSS scores, and POMS vigor scores. Higher levels of acetylcarnitine predicted poorer performance on the PVT, DSST, and DS, and higher KSS scores. **DISCUSSION:** This study provides the first experimental evidence that acetylcarnitine may be a predictor of differential neurobehavioral vulnerability to sleep loss in healthy adults. Reliable prediction using valid biomarkers of who is more or less likely to experience neurobehavioral decrements from sleep loss will make it possible to mitigate stress and other behavioral health and performance risks autonomously via personalized countermeasures during long-duration space flight, including future Mars Exploration missions.

Learning Objectives:

1. The participant will be able to understand the value of metabolomics for predicting resilience or susceptibility to sleep loss in healthy adults.

[341] TOWARDS LIGHTING COUNTERMEASURES TO IMPROVE CIRCADIAN ADAPTATION, SLEEP, AND PERFORMANCE DURING A MANNED MARS MISSION

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Sleep deficiency has been documented in astronauts during space shuttle and International Space Station (ISS) missions (Barger et al., *Lancet Neurol.*, 2014). Light can be a powerful countermeasure for both circadian

misalignment and sleepiness. The ISS is currently illuminated by fluorescent lamps for the astronauts' living environments. Beginning in 2016, there will be a staged replacement of the ISS lighting with Solid-State Lighting Assemblies (SSLAs) capable of emitting three different correlated color temperatures and luminances (NASA S684-13489, JSC, 2013). Ground studies are testing light emitted by SSLAs for their efficacy in supporting astronaut vision as well as circadian, neuroendocrine, neurobehavioral and sleep physiology (Brainard et al., *Acta Astronautica*, 2013). Advanced versions of SSLAs are likely to provide illumination of vehicles and habitats for Mars missions. A study on ground-based engineers and scientists living on a Martian day length of 24.65 hours during the Mars Phoenix Lander mission demonstrated that a blend of countermeasures including timed exposure to narrow bandwidth blue solid-state light was effective in enhancing alertness and improving circadian entrainment (Barger et al., *Sleep*, 2012). Ambient light on the surface of Mars is a potential resource for a component of lighting countermeasures. A number of studies have been completed or are in process that will contribute to optimizing light for long duration Mars missions. For example, nocturnal melatonin suppression by exposure to differing intensities of simulated Martian surface light was studied in 8 healthy subjects (23.4 ± 0.8 years). Preliminary results showed that exposure to 90 minutes of simulated Martian light at 6, 22, and 197 W/cm² elicited relatively weak melatonin suppression with mean plasma percent change scores of 2%, -7% and -18%, respectively. Such studies will help determine relative contributions of electrical and ambient lighting that can be used to serve as a lighting countermeasure for circadian misalignment, sleep disruption and performance deficits on a long duration Mars mission. Primary support: NSBRI through NASA NCC 9-58, NASA#s NNX09AM68G, NNX08AD66A, NNX04CC16C and NNX15AC14G.

Learning Objectives:

1. Understand that sleep and circadian disruption is a health and performance risk factor in manned space flight.
2. Understand that lighting can be a nonpharmacological countermeasure for sleep and circadian disruption in manned space flight.
3. Learn the status of studies on using lighting countermeasures for future manned missions to Mars.

[342] COGNITIVE IMPAIRMENT TESTING SUBSEQUENT TO SLEEP MEDICATION ADMINISTRATION

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INTRODUCTION: Johnson Space Center's (JSC) Fatigue Management Services (FMS) in Behavioral Health and Performance (BHP) Operations is responsible for fatigue management support of astronauts during pre-flight training, in-flight operations and post-flight rehabilitation as well as for mission critical personnel. One facet of FMS support is individualized testing to identify medications that are efficacious. The goal is to evaluate medications that promote sleep and assess the cognitive function upon emergent awakening during slow wave sleep and /or the Tmax of the medication. **METHODS:** Current FMS activities involve collecting sleep assessments, clinical evaluations and the providing countermeasure recommendations. Individuals who are preparing for spaceflight, mission support, international travel, or present with sleep issues establish a sleep baseline using objective measures. These measures show the quantity and quality of sleep as well as sleep onset and duration. Data are reviewed by a FMS flight surgeon and a countermeasure regimen (which may or may not include prescription for sleep training, sedative hypnotic medication or alertness medication) can be provided as necessary. **RESULTS:** Future ground medication testing will align closely to the protocol used in the recently completed research study, *Operational Ground Testing Protocol to Optimize Astronaut Sleep Medication Efficacy and Individual Effect* by Principal Investigators Drs. Smith Johnston and David Dinges. Ground testing will incorporate a brief, standardized measure of cognitive performance that can be placed on a laptop for home testing. The cognitive testing will follow two emergent awakenings, one at slow wave sleep and the second at the calculated Tmax of a medication. Alertness medication will be tested using the same measures after first establishing a baseline and then testing a medication at the time of the greatest cognitive impairment during the day as defined by the established baseline. **DISCUSSION:** Objective measures used in this ground testing protocol will be imperative as both astronauts

and mission support personnel continue their challenging schedules, and as new sleep medications are approved by the Food and Drug Administration.

Learning Objectives:

1. Participants will understand the value and need for ground testing medications.
2. Participants will be able to duplicate the process for evaluating medications preflight.
3. Participants will be able to use this process in an operational environment.

[343] EFFECTS OF ENVIRONMENTAL STRESSORS ON SLEEP AND FATIGUE

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PROBLEM STATEMENT: The sleep environment can greatly influence sleep duration, continuity, and quality. Good sleep hygiene is characterized, among others, by optimal room temperature and humidity, and by low levels of ambient light and noise. The spaceflight environment is full of environmental stressors that can affect sleep and cognitive performance. These include microgravity, non-24 hour light dark cycles, inadequate lighting, noise, hypercapnia, hypoxia, noise, radiation, nutrition, frequent shifts of sleep time (so-called slam-noise), high workload, medication use, and psychological stressors related to living in an isolated, confined, and extreme environment. **TOPIC:** Noise is a prevalent and potent environmental stressor in both aviation and spaceflight that can disturb sleep and impair sleep recuperation, and will be handled as a model case. The auditory system has a watchmen function, and environmental sounds are continuously perceived and evaluated during sleep. Both laboratory and field studies have demonstrated exposure-response functions between acoustic characteristics of noise events (e.g., the maximum sound pressure level) and the probability to arouse or awake. Habituation effects are usually prominent, but they are not complete (i.e., subjects will still react to noise events after several years of exposure), and we know little about who will habituate and who will not. In general, inter-individual differences in the sensitivity to noise-induced sleep disturbance are large, and markers of noise sensitivity are currently missing. The epidemiologic evidence on associations between long-term noise exposure and cardiovascular disease has increased substantially. On the International Space Station, daytime and nighttime noise levels are measured regularly and assessed for their potential harm on astronaut hearing and sleep. **APPLICATIONS:** We need to identify how exactly the diverse environmental stressors prevalent in aviation and spaceflight affect sleep and fatigue. It will be important to start investigating scenarios that involve more than one stressor at a time. These findings will have implications for the design of future spacecraft that need to support crews during exploration type missions.

Learning Objectives:

1. Understand the effects of various environmental stressors on sleep and fatigue.

[344] COGNITIVE EFFECTS OF EMERGENT AWAKENING FROM SLEEP AFTER INGESTION OF ZOLPIDEM AND ZALEPLON

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INTRODUCTION: Astronauts can experience difficulty sleeping in spaceflight, requiring the need for FDA-approved sleep medications. If awakened for an emergency, these drugs may impair astronaut performance and pose a risk to operational safety. To evaluate and mitigate this risk, a ground-based, double-blind, placebo-controlled trial was conducted on the emergent awakening effects of zolpidem and zaleplon. **METHODS:** N = 34 subjects (age M = 42.1 ± 9.7; 25 males; 9 astronauts, 7 astronaut candidates, 18 flight controllers) spent 3 nights at NASA JSC's astronaut crew quarters. Each visit subjects ingested one of the following: placebo, 10mg zaleplon, either 5mg (N = 20) or 10mg (N = 14) zolpidem. They responded to an ISS alarm 1h after lights out for zaleplon, and 1.5h for placebo and zolpidem. At awakening subjects ambulated to turn off the alarm and then performed

cognitive tasks: working memory (DST), cognitive processing (DSST), psychomotor vigilance (PVT-B) and word recall (WRT). They remained awake and performed the tasks again 30 minutes later. They returned to sleep and were awakening to perform the same tasks an average of 6.7h after lights off.

RESULTS: Relative to placebo, 10mg zaleplon increased errors in vigilance and working memory, while 5mg zolpidem reduced cognitive processing speed and working memory performance. In contrast, 10mg zolpidem resulted in large deficits on nearly all cognitive performance outcomes, both immediately after awakening 1 (near Tmax) and 30 minutes later. However, there were substantial inter-individual differences in vulnerability to sedating effects of the sleep medications on performance. **DISCUSSION:** The sleep-promoting medications zaleplon and zolpidem (especially 10mg zolpidem) resulted in more severe deficits in cognitive performance than sleep inertia (placebo), 10mg zaleplon, and 5m zolpidem, when emergent awakening occurred near the expected Tmax of plasma concentrations and at terminal awakening. Astronaut performance may be adversely affected during emergent awakenings, necessitating the development of an evidenced-based personalized medicine approach to the use of sleep medications in astronauts.

Learning Objectives:

1. Hypnotic medications used for sleep in space flight should be adjusted for type and dose for astronauts to mitigate the adverse effects of the medications on emergent awakening from sleep in spaceflight.

Wednesday, April 27

10:30 AM

Avalon 17

S-62: PANEL: DIVERSITY IN AVIATION AND SPACE MEDICINE (ENGLISH LANGUAGE)

Sponsored by German Society of Aviation and Space Medicine (DGLRM)

Chair: Jochen Hinkelbein
Cologne, Germany

Chair: Carla Ledderhos
Cologne, Germany

PANEL OVERVIEW: This panel is presented by the German Society of Aviation and Space Medicine (DGLRM). It is presented in German language with slides in English language. The panel focuses on different important and up-to-date topics in aerospace medicine. The topics are related to aviation medicine and space medicine.

[345] EJECTION SEAT DEVELOPMENT IN GERMANY WHILE WWII

V. Harsch

Center for Aviation and Travel Medicine, Neubrandenburg, Germany

INTRODUCTION: In 1939, Heinkel Corporation designed an ejection-seat for high-performance aircraft. Until end of war more than 1,000 ejection seats were delivered by Heinkel and saved up to 60 lives. This presentation discusses the medical background of development of this pioneering rescue device. **METHODS:** Archive research, literature research, oral history. Presentation concerns also medical ethical aspects of humans used in aeromedical research in WWII. **RESULTS:** This Heinkel seat was powered by compressed air and had an acceleration range between 9.75 and 14 Gz. This rescue technology was first tested on a vertical ejection trajectory. Thereafter the seats usability was proved in Rechlin with dummies in flight before test persons were ejected. Also several flight tests in Rechlin ended with the need of ejection of flight personnel and demonstrated its practicability. By a directive of the Air Ministry, from 1944 all prototype airplane had to be equipped with this technology. The Heinkel seats were distributed to high performance aircraft in WWII and rescued dozens of airman lives. **DISCUSSION:** The advanced technology was necessary, as the test flying of high performance aircraft became more and more dangerous. The Luftwaffe Test Center in Rechlin was evaluating the ejection seats and giving its approval for a wide use in the Luftwaffe. Though the ejection seats were of tremendous use to save airman, the way to evaluate them was also questionable. Heinkel engineers used at least 10 test persons from the concentration camp Sachsenhausen in 1944. Though no injuries are

reported, this point demonstrates the abuse of test persons in a plight for aeromedical and technical research in Germany in WWII.

Learning Objectives:

1. Learn about human performance limitations in flight tests.
2. Understand and discuss need for in flight tests of rescue devices as an ejection seat.
3. Know the historical background of ejection seat developments in the 30s and 40s.

[346] SPEECH INTELLIGIBILITY IN NOISE: WHAT IS UNDERSTOOD AND HOW CAN IT BE TESTED?

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OBJECTIVE: During flight operations significant background noise levels may occur. Beside elevated stress levels intelligibility of crew and radio communication can be affected. As the impact of background noise and individual hearing ability is generally not well determined, standardized and reproducible audiological methods to test speech intelligibility in noise are required. **METHODS:** First the background noise level during flight in several types of airplanes and helicopters was determined. Beside the determination of ambient noise levels in cockpits the level experienced by flight personnel was measured in the ear canal using (1) passive and (2) active noise cancellation ear protection headsets. Secondly, the dependency of speech understanding in cockpit noise from individual hearing loss was investigated in normal hearing and hearing impaired crew members using the Freiburg Monosyllable test. As a possible alternative the Oldenburg Sentence Test (OLSA) was investigated in a cohort with varying degree of hearing impairment. This test is the German version of matrix sentence tests that adaptively determines the signal-to-noise-ratio (SNR) at a given noise level where 50% of words are correctly understood and is available in various languages with reference data for comparison. **RESULTS:** Cockpit background noise levels determined in the ear canal often exceed 85 dB (A) and make passive and active noise cancellation necessary to prevent from potential temporary and permanent threshold shifts. Slightly hearing impaired subjects required significant higher speech presentation levels to overcome background noise and to obtain the same word recognition scores in the monosyllable test. Our results in the OLSA demonstrate that hearing impaired subjects require higher speech presentation levels but also higher SNRs to correctly understand. **CONCLUSION:** Medical examinations of crew members usually include the determination of intelligibility of numbers or monosyllables in quiet, but to fully understand the effect of elevated noise levels, more elaborate and standardized tests are required to predict reliably the impact of noise on speech intelligibility.

Learning Objectives:

1. Examples of in-the-ear measured background noise levels in airplanes and helicopters and the noise reduction achieved by active and passive protection.
2. Overview of matrix tests to determine signal-to-noise-ratios necessary for proper understanding in individual subjects.
3. Understand the impact of background noise on speech intelligibility and communication.

[347] EXTENDED PSYCHOPHYSIOLOGICAL ASSESSMENT DURING A SIMULATED SPACECRAFT DOCKING EXPERIMENT

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INTRODUCTION: In former joint space studies of the IBMP, RSC Energia and the Institute of Aerospace medicine (DLR) on MIR and ISS cardiovascular measures were registered to assess the physiological cost of cosmonauts during their docking training. In parallel the fundamental frequency of voice was analyzed to obtain information about the unconscious subjective evaluation of the subject's perception of situation control. The results of the studies onboard MIR and ISS provided evidence that the docking training did not increase "voice-stress" indicators or indicators of

enhancement of the cardiovascular arousal. As far the performance of the cosmonauts was rather good this could be seen as a valid indication of cosmonaut's proficiency and their expectable reliability in running a docking maneuver. As a next step a very classic but robust Event Related Potential (ERP) design was implemented. We tested the possibility to use the component P300 to assess and monitor the individual cognitive difficulty of operators in a certain docking task. The space study is still in preparation; a ground based study was run. It was expected that during difficult tasks the secondary task is performed worse and the P300 has smaller amplitude and longer latency. **METHODS:** The study was run within the complex "envihab" of the DLR. The participants were volunteers. The test session consisted of 6 standard tasks (condition "easy") and one really difficult task (condition "difficult"). A training model of the flight hardware in the Russian segment of the ISS was used. An EEG-electrode system with active dry electrodes was applied. **RESULTS:** The magnitude of the P300 was smaller and its latency was larger for the difficult task than for the easier task. We consider it important, that it was possible that for the P300 differences statistical significances could be assessed within single subjects using all evoked EEG-episodes for each channel. **CONCLUSIONS:** In a ground-based study we demonstrated the possibility to assess the cognitive difficulty by means of the ERP component P300. This additional psychophysiological assessment could improve the performance and behavioral assessment during the docking training and thus enhancing mission safety.

Learning Objectives:

1. Learn what is indicated by a P300 and what is new in the present use.

[348] OXIDATIVE DEFENSE IN MAMMALIAN MACROPHAGES - THE INTERNATIONAL SPACE STATION EXPERIMENT TRIPLE LUX A

O. Ullrich^{1,2} and C.S. Thiel^{1,2}

¹Faculty of Medicine, University of Zurich, Zurich, Switzerland;

²Faculty of Mechanical Engineering, Otto-von-Guericke University, Magdeburg, Germany

INTRODUCTION: Due to their exceeding sensitivity to gravitational changes, immune cells represent an ideal model system to understand how gravity on Earth is required for normal mammalian cell function, how cell function is impaired by altered gravity, and how cells adapt to the new situation. Knowing the cellular mechanisms of how gravity influences macrophage cells is an invaluable requirement for the provision of therapeutic or preventive targets, for a better risk assessment, and the development of in vitro tests for medical monitoring. **METHODS:** The International Space Station (ISS) experiment TRIPLE LUX A investigated the oxidative burst reaction in NR8383 rat alveolar macrophages during longer periods of microgravity, determined the gravitational threshold for the burst reaction, and elucidated possible adaptation mechanisms. After an extensive test and development program, the experimental conditions and timeline for TRIPLE LUX A and the mission logistics, involving labs in Switzerland, Germany and the U.S. (Space Life Science Labs SLSL at Kennedy Space Center) were successfully established, optimized and verified. TRIPLE LUX A was uploaded with Space X CRS-6 and two complete experiment runs were performed in the BIOLAB of the COLUMBUS module. **RESULTS:** In preceding parabolic flight, 2D clinostat and centrifuge experiments, we investigated the influence of gravity on the release of reactive oxygen species (ROS), which responded rapidly and reversibly to altered gravity within seconds. ROS release was reduced in microgravity and enhanced in hypergravity. During the TRIPLE LUX A ISS experiment, we confirmed that ROS release is highly sensitive to altered gravity, detected a fast adaptation to the new gravitational environment and were able to quantify the relation between the gravitational force and ROS release. **DISCUSSION:** Phagocytes and the NADPH oxidase enzyme – triggered oxidative burst reactions are part of the ancient innate immune system, and represent the most important barrier for microbes invading the body. Thus, it could be possible that the gravitational conditions on Earth were one of the requirements and conditions for development of the molecular machinery of the oxidative burst reaction.

Learning Objectives:

1. The combination of parabolic flights, 2D clinostat and ISS experiments provides the possibility to investigate how cell function is impaired in altered gravity and how cells adapt to the new situation. We provided experimental evidences that the oxidative burst reaction in mammalian macrophages is strongly dependent from the gravity field on Earth.

Wednesday, April 27
Avalon 6

10:30 AM

S-63: PANEL: AEROMEDICAL ETHICS PANEL

Sponsored by American Society of Aerospace Medicine Specialists

Chair: Jeffrey Jones
Houston, TX

Chair: Allen Parmet
Kansas City, MO

PANEL OVERVIEW: A of review major theories and historical approaches to problem solving will be followed by a series of panel vignettes will present topics for discussion by the senior aerospace medicine specialist panel members and audience. The Examples and follow-on discussions will demonstrate aerospace medicine value conflicts and potential resolutions. Intense audience participation will occur. Certificates of attendance in ethics training will be available.

[349] AEROMEDICAL ETHICS PANEL

A. Parmet¹, J.A. Jones³, G.W. McCarthy², H. Reed⁴ and P. Llig⁵
¹Viterbi School of Engineering, University of Southern California, Kansas City, MO; ²AvMedSafet, Dayton, OH; ³Baylor College of Medicine, Houston, TX; ⁴Operational Consult Service, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; ⁵Quarantine Station, Centers for Disease Control and Prevention, Anchorage, AK

INTRODUCTION: Physicians in aerospace medicine recognize that being a flight surgeon and aviation medical examiner raises significant ethical dilemmas. Over 30 years ago, Drs. Urbano and Jones addressed such concerns in terms of value conflicts. Conflicts arise between due to outside influence on medical practice, loss of confidentiality, legal restraints and limitations, duty requirements and forced decisions. **METHODS:** A didactic review of ethical standards including Ethical Guidelines of the American Society of Aerospace Medicine, the 1975 Declaration of Helsinki a set of ethical principles regarding human experimentation developed for the medical community by the World Medical Association and endorsed by the American medical Association, a document that should be considered the property of all humanity, and the Genetic Information Nondisclosure Act of 2008. **RESULTS:** A of review major theories and historical approaches to problem solving will be followed by a series of panel vignettes will present topics for discussion by the senior aerospace medicine specialist panel members and audience. The Examples and follow-on discussions will demonstrate aerospace medicine value conflicts and potential resolutions. Intense audience participation will occur. **DISCUSSION:** Competence in ethics is demonstrated by aerospace medicine specialists who recognize value conflicts when they occur and articulate the relevant ethical perspective for dealing with them compassionately, professionally and medico-legally. Certificates of attendance in ethics training will be provided.

Learning Objectives:

1. Learn the process of ethical decision making.
2. Understand the ethical resources available and in particular, the ASAMS Ethical Guidelines.
3. Encourage thought and discussion of the ethical issues in Aerospace Medicine.

Wednesday, April 27
Avalon 1-3

2:00 PM

S-64: SLIDE: HYPOXIA TRAINING AND SUSCEPTIBILITY

Chair: Nicholas Green
Henlow, Bedfordshire, United Kingdom

Chair: Peter Hodgkinson
Hitchin, Bedfordshire, United Kingdom

[350] THE IMPACT OF HYPOBARIC VERSUS HYPOXIC HYPOXIA TRAINING IN ELEVEN HIGH PERFORMANCE MILITARY PILOTS

A. Macovei and D. Popescu

National Institute of Aerospace Medicine, Bucharest, Romania

INTRODUCTION: Recently, the new modality of physiological training has emerged from the research labs into the specific market. The reduced oxygen breathing devices (ROBD) have the potential to enhance and/or replace our current hypoxia training altitude chamber. **METHODS:** A total of 11 experienced high performance pilots had undergone physiological training in the hypobaric facility of The National Institute of Aerospace Medicine in Bucharest, Romania. All pilots were fighter pilots, currently flying the MiG 21 LanceR fighter. Two days after the chamber profile, the pilots volunteered to take the ROBD hypoxia test. The ROBD profile was a two-step (3500m, 7500m) ascent to 7500 m over 3 minutes. The ROBD is a high-grade commercially available medical device, certified for use on humans. The ROBD device software had the ability to perform psychometric testing built in. **RESULTS:** There were generally more symptoms reported in the ROBD. Most recognized symptoms were the mental and motor skills category. Statistically, there were no significant differences for symptoms distribution, p value ranging from 0.06 to 0.6, except for the mental symptom reporting ($p=0.018$, $Z=2.36$). Recorded variations in heart rate differed significantly with a Z of 2.80 and a p of 0.004. Recorded oxygen saturation did significantly differ for the two setups, at 7500 meters in chamber and in ROBD with a Z of 2.40 and a p of 0.015. **DISCUSSION:** At debriefing, all pilots reported that it was harder to cope with hypoxia with ROBD than in the chamber. This was borne out by the greater number of symptoms with ROBD. Although air hunger might have been a factor, all the pilots gave negative responses to this issue. Our results give the general impression off adding value for training over the normal altitude chamber training. The ability to take motor coordination skills in the hypoxic environment was most appreciated by pilots. The ROBD simulation managed to drop the oxygen saturation lower than for the chamber for most cases (10 out of 11) with marked effect for some cases. The ROBD training is not without peril. We did not encounter any medical issues with our subjects, both in chamber or on ROBD, but there are case reports in the literature. **CONCLUSION:** Optimal hypoxia training can still be best realized in an altitude chamber. However, ROBD training is a reasonable alternative if costs preclude altitude chamber facilities.

Learning Objectives:

1. The participant will be able to figure out the role of a reduced oxygen breathing device in physiological training.
2. The participant will learn of commonly perceived hypoxia symptoms.

[351] THE ADOPTION OF GROUND-BASED HYPOXIA TRAINING BY THE UK ARMED FORCES

A.J. Wrigley¹ and I.A. Mollan²

¹Institute of Naval Medicine, Gosport, United Kingdom; ²Aviation Medicine Training Wing, RAF Centre of Aviation Medicine, Henlow, United Kingdom

INTRODUCTION: Hypoxia training traditionally involved hypobaric chamber exposure; training risks included decompression sickness (DCS) (1), fire (2) and potential for white matter hyper-intensities (3). To mitigate risks, the UK instigated ground-based hypoxia training in 2012 for some aircrews. Using crew/position-specific scenarios, this normobaric 'mask on' technique has been termed Scenario-Based Hypoxia Training (SBHT) in UK parlance. **METHODS:** Records of hypoxia training were examined for adverse incidents between February 12 and October 15 (normobaric) and January 10 and October 15 (hypobaric). A benefit analysis of training modalities (comparing incident rates with those from the literature) and a program of evaluation of SBHT integration into existing simulators were undertaken. **RESULTS:** There were 5198 chamber experiences (student and instructor); 9 adverse incidents recorded (6 DCS, and 2 LOC with one convulsion). This equates to 1.7 incidents/1000 exposures. 2579 participants undertook SBHT; 2 adverse incidents were recorded (both involving loss/near loss of consciousness). This equates to 0.8 incidents/1000 exposures. **DISCUSSION:** Our results suggest SBHT is safer than chamber training, though the incident rates described are heavily dependent on the choice of time period studied, given the fact that incidents can cluster. Smart and Cable (4) undertook a literature review of

incidents of decompression illness (DCI) associated with hypobaric training, and found a mean incidence of 1 case/1000 exposures (but with a range of 0.3-2.9 cases). Our rate, however, related to all events. There is a paucity of SBHT incident data in the literature, though some information about the technique has been published (5,6). Aircrew prefer SBHT: it mimics common hypoxia presentations and scenarios are representative of airborne tasks. However, aviators undertaking SBHT cannot experience pressure change and rapid decompression; for these reasons, limited hypobaric training continues in initial training courses. Some new simulators have been delivered with built-in hypoxia training. Examination so far has revealed that retro-fitting hypoxia training apparatus engenders technical and health and safety concerns.

Learning Objectives:

1. The participant will be able to recognize that the adverse incident rate for normobaric hypoxia training is less than that of hypobaric hypoxia training.
2. The participant will be able to appraise the relative significance of adverse incidents in the hypobaric training environment compared to those in the normobaric training environment.
3. The participant will be able to relate the UK armed forces' hypobaric hypoxia training significant event rate to previously published event rates.

[352] EFFECTS OF HYPEROXIA AND HYPOXIC HYPOXIA ON SIMPLE AND CHOICE REACTION TIMES

T. Dart², M. Clayton Gallo¹, J. Beer², T. Morgan³, J. Fischer² and A. Pilmanis²

¹USAF School of Aerospace Medicine, Wright-Patterson AFB, OH;

²Wyle, Brooks City-Base, TX; ³71st HPW/HPI, Air Force Research Laboratory, San Antonio, TX

INTRODUCTION: This study evaluated the effect of hyperoxia and hypoxic hypoxia on simple cognitive tests at representative cabin altitudes and at ground level 60 min after exposure. **METHODS:** Each of 10 subjects was tested in four hypobaric chamber flights during exposures occurring on four separate days. Subjects were tested initially at ground level (182.9 m [600 ft] above sea level), followed in random sequence by altitude test sessions at 3,048 m (10,000 ft), 4,572 m (15,000 ft), and 6,096 m (20,000 ft). The ground level condition involved two contiguous 20-min segments, each subject randomly assigned to breathing 100% oxygen during one segment and 21% oxygen during the other. The altitude conditions involved breathing 100% oxygen for 15 min for within test control (baseline assessment) before being covertly switched to 21% oxygen for a maximum of 60, 45, or 20 min, respectively, or until subjects terminated due to the onset of hypoxia symptoms. One hour after completion of each altitude test, a 15-min post hoc assessment was conducted with the subject breathing air at ground level to assess any residual impairment. Simple and choice reaction tasks were scored for reaction time (ms), movement time (ms), and total response time (ms). Blood oxygen saturation and heart rate were also measured. **RESULTS:** Cognitive performance, as measured by total response time and reaction time, showed statically significant degradation at all three altitude test conditions. For the two lower altitudes, response times were equal to, or slightly higher than, baseline responses at the beginning of the hypoxic phase, but increased over the duration of the exposures. For the 20,000-ft condition, the degradation was more immediate and greater in magnitude, but no increase was seen over time. No statistical differences were seen for any of the outcome measures when comparing the recovery phase data to the baseline phase data. **DISCUSSION:** Cognitive performance, as measured by the simple and choice reaction tasks, is significantly impacted by hypoxia at altitudes as low as 3,048 m (10,000 ft.). No significant residual effect on cognitive performance was seen 60 min after exposure.

Learning Objectives:

1. Comprehend the effects of hyperoxia and low to moderate hypoxic hypoxia on response time and simple decision making.

[353] HELICOPTER AIRCREW HYPOXIA SUSCEPTIBILITY DUE TO HIGH COGNITIVE DEMANDS IN ELEVATED OR MOUNTAINOUS AREAS

J.G. Nelson, D. Jacobs and A. Scott

AF Medical Service, U.S. Air Force, Albuquerque, NM

INTRODUCTION: There is concern that helicopter aviators may push themselves to a high hypoxic state (low SpO₂) before recognizing symptoms due to the high cognitive attention required for helicopter operations. Additionally, helicopter aircrew put themselves at risk when operating for long dwell times in elevated areas or high altitude mountainous areas. **METHODS:** Hypoxia recognition and recovery SpO₂ levels were compared between helicopter (UH-1/HH-60) aircrew and fixed-wing (C-130) aircrew. Each aircrew member participated in a training scenario breathing on the Reduced Oxygen Breathing Device (ROBD) while simultaneously flying their respective simulator and mission. Utilizing a standardized computerized training profile, an ascent of 5000 feet per minute was initiated by changing the percentage of breathing oxygen from 21% to as low as 7% (25,000 foot simulation). Helicopter aircrew flew a Search and Rescue (SAR) mission while fixed-wing aircrew flew an unpressurized high altitude low opening (HALO) mission profile while each aircrew member's SpO₂ data was recorded prior to the instructor activating the ROBD and after trainee recognition of hypoxic symptoms. **RESULTS:** A total of 64 (30 helicopter and 34 fixed-wing) individuals went through the training scenario. Helicopter aircrew SpO₂ levels were recorded with a decrease to 70.56% +/- SD of 5.6% along with 34 fixed-wing aircrew SpO₂ levels showing a decrease to 78.23% +/- SD of 9.3%. Helicopter SpO₂ levels were 7.67% lower than fixed-wing SpO₂ levels before trainee symptom recognition and recovery was initiated. **DISCUSSION:** Helicopter aircrew have shown a vulnerability for hypoxia due to high cognitive demands required for helicopter operations while flying in elevated or mountainous areas for long dwell times. It is postulated that helicopter aircrew become cognitively task saturated or mission fixated during helicopter operations and are unaware or disregard the development of their hypoxic symptoms until they reach low SpO₂ levels. Additional emphasis on hypoxic risk, recognition, and recovery should be implemented for helicopter aircrew when flying occurs at high altitudes.

Learning Objectives:

1. Understand the high cognitive demands required for helicopter operation and the resultant high aviation-related risk of hypoxic hypoxia during operations in elevated or mountainous areas.

[354] DETERMINING METRICS TO PROVIDE EARLY WARNING OF HYPOXIA SUSCEPTIBILITY

B.S. Shender¹, J. Beer², D. Chauvin², C. Mattingly¹, M. Warren¹, S. Coleman¹ and G. Askew¹

¹Human Systems, NAVAIR, Patuxent River, MD; ²Wyle Laboratories Science, Technology and Engineering Group, Brooks City-Base, TX

INTRODUCTION: Physiologic events similar to hypoxia have increasingly occurred in U.S. military fast jets, often with uncertain cause. To mitigate the risk of injury, a monitoring/alert system is being developed. The challenge is to predict who is more susceptible to hypoxic stress to provide an early warning. This study describes physiologic response differences between those who completed a 20min 5486m exposure (CM) and those who terminated early (TM). **METHODS:** Trials were conducted at Wyle Laboratories' Brooks City-Base, TX hypobaric chamber. Twelve volunteers (23-40 yr; 3 female) gave their informed consent and established baseline physiologic responses during 15min at ground (GND), then were exposed to 3048m for 10min. At this point, subjects were given 100%O₂ for 30min. Then, subjects switched back to air while the chamber was brought to 5486m for up to 20min. At plateau's end (or if finger pulse oximetry = 60% or subjects asked to stop), subjects received 100%O₂ for ~60s during descent to GND. Profiles were repeated on two separate days. Pulse oximetry at finger (PROPAQ CS Model 242) and forehead (SpO₂, Masimo RAD87), relative regional cerebral tissue oxygenation (rSO₂, Nonin 7600 Equinox), and heart rate (HR, beats/min; bpm) were recorded and change relative to GND determined (Δ HR (bpm); Δ rSO₂ (% decline)). **RESULTS:** Ten 5486m trials (N = 7) were terminated early (300-980s). Mean GND metrics: CM (SpO₂ = 98.5%, HR = 71.2 bpm, rSO₂ = 76.8) and TM (SpO₂ = 98.1%, HR = 74.5 bpm, rSO₂ = 80.6). Mean TM SpO₂ and Δ rSO₂ tended to drop faster and to a lower level over the final 5min at 3048m (SpO₂ at -0.005/min, ending at 90.9%; Δ rSO₂ at -0.007%/min, ending at -7.5%) than CM (SpO₂ at -0.003/min, ending at 93.3%; Δ rSO₂

at -0.004%/min, ending at -6.1%), while Δ HR was similar. The initial 5min 5486m data were compared based on the shortest TM trial; Mean TM: SpO₂ fell at -0.05%/min, ending at 75.7%; Δ rSO₂ at -0.05%/min, ending at -17.5%; Δ HR rose at 0.03 bpm/min, ending at 21.9 bpm; CM: SpO₂ fell at -0.044%/min, ending at 79.8%; Δ rSO₂ at -0.04%/min, ending at -15.7%; Δ HR rose at 0.04 bpm/min, ending at 18.5 bpm. One-way ANOVA comparing 5486m TM vs. CM indicated minimum TM SpO₂ was significantly lower ($p=0.03$) and mean SpO₂ and Δ HR approached significance ($p=0.07$). Mean 3048m TM SpO₂ was lower at $P=0.10$.

DISCUSSION: Additional chamber studies are planned to confirm that these trends are repeatable. If so, these may be used to detect those at a higher risk of having a physiologic event.

Learning Objectives:

1. To understand how physiological response can possibly detect individuals with lower tolerance to hypoxia.

[355] DEMONSTRATION OF THE EFFECTS OF HYPOXIA AND BENEFITS OF OXYGEN ON UNAIDED TWILIGHT VIEWING AND ASSISTED NIGHT VISION

I.R. Moorhead¹, D.M. Connolly² and J. Sadler²

¹SciVision, Ashford, United Kingdom; ²Aircrew Systems, QinetiQ PLC, Farnborough, United Kingdom

INTRODUCTION: Visual function deteriorates as light levels fall. In military aviation this is countered using night vision devices (NVDs) but display luminance remains relatively low, while night-time aircraft cabin light levels are also typically mesopic. Altitude-induced hypoxia further degrades visual function progressively as light levels fall. Hypoxic decrements and benefits of oxygen have been quantified for various visual tasks under representative viewing conditions. Recent work for the UK Royal Air Force Centre of Aviation Medicine has generated imagery to simulate these effects, to convey the findings intuitively to aircrew and thereby enhance night vision training. **METHODS:** A detailed image-manipulation model of early human visual perception was adapted to incorporate a model of the effects of hypoxia and hyperoxia. The model incorporates key features of early vision relevant to the requirement, including both rod and cone vision; spatial frequency channels (i.e. multiple scales); opponent color mechanisms; non-linear contrast mechanisms; and visual adaptation. The effects of different levels of oxygenation were represented by "equivalent" changes in light level. A critical component of the project was simulation of two of the laboratory studies to validate the visualization. **RESULTS:** The components of the model and its implementation will be presented with details of the validation simulations. The output is a set of training imagery and examples will also be presented. These demonstrate the kinds of visual information that may be lost due to hypoxia and how supplementary oxygen may enhance visual performance at representative light levels. **DISCUSSION:** The model has been applied to visual band images and demonstrates the hypoxic reduction in visual function found experimentally. It also reproduces the improvement found when supplementary oxygen is provided. The model includes simulation of the effects when viewing with NVDs and can provide direct visualization of how hypoxia can compromise visual perception during military flying.

Learning Objectives:

1. The participant will be able to understand how light level and oxygen partial pressure interact to affect visual performance in an air environment.

Wednesday, April 27
Avalon 7-9

2:00 PM

S-65: SLIDE: THE PRACTICE OF AEROSPACE MEDICINE

Chair: Colonel William Dodson
Beavercreek, OH

Chair: Brent Haskell
Georgetown, KY

[356] EVOLUTION OF THE PARARESCUE FLIGHT SURGEON DURING OEF AND THE NEED FOR SPECIALIZED TRAINING

S. Rush

Pararescue, USAF/NYANG, Great Neck, NY

INTRODUCTION: The role of PFS in Operation Enduring Freedom (OEF) followed changes in tactical combat casualty care (TCCC), the robust role of Pararescue men (PJs) in CASEVAC, and occurred when great strides were made in human performance optimization (HPO) for PJs. **TOPIC:** The role of the PFS prior to and during the early parts of OEF was primarily flight medicine and training the PJs in hospital based emergency medicine that was only partially applicable to combat and austere rescue environments, but was not designed for that. Since 2001, and more significantly since 2009 upon commencement of CASEVAC missions, this role has evolved and expanded. The primary role of operational medical educating and training of PJs has conformed to both the explosion of TCCC as well as novel applications of hospital based medicine in specific environments, particularly the HH-60. These included the introduction of video laryngoscopy and insertion of bilateral humeral head IOs for hemorrhagic shock patients to deliver blood and TXA, and now includes the performance of fresh whole blood transfusions. In other instances, PFSs flew missions when appropriate to accompany PJs for critically injured pediatric patients as well as unstable post-op patients on rotary and fixed wing airframes. Other new and expanded roles included creation and participation in human performance optimization including injury prevention and management and mental health care, EMS type oversight and quality assurance of medical care during rescue operations, clinical research regarding operational medicine and PJ mental and physical health, interaction with the AF Trauma service to provide continuity of care from the point of injury to the operating room, and medical leadership roles at the joint level.

APPLICATIONS: The need for improving the knowledge base of the PFS, training a physician to effectively train and sustain PJ operational medical capabilities, oversee HPO programs, screen for and manage PTSD and depression and handle the unique mindset of special operators are amongst several reasons for which a Pararescue Medical Director Qualification Course has been established.

Learning Objectives:

1. To understand the unique duties of the PFS.
2. Understand the unique nature of training operational medicine.
3. Understand the challenges faced in managing injuries and PTSD among USAF PJs.

[357] THE CONCEPT OF THE FLIGHT TEST DOCTOR OR PHYSIOLOGIST

G.G. Kennedy¹, S.G. Phillips² and P.D. Hodkinson^{3,4}

¹Aviation Medicine Flight, RAF Centre of Aviation Medicine, Salisbury, United Kingdom; ²Ministry of Defence, London, United Kingdom; ³RAF Centre of Aviation Medicine, Hitchin, United Kingdom; ⁴Department of Medicine, University of Cambridge, Cambridge, United Kingdom

MOTIVATION: This paper will discuss the concept of the Flight Test Doctor or Physiologist (FTD/P). In the UK clarification is ongoing to define what qualifications are required of Aerospace Medicine Professionals (AMPs) who provide life support systems (LSS) and personal protective equipment advice; specifically what test and evaluation (T&E) training they require. **OVERVIEW:** FTD/P roles have been performed for many years but neither these roles, nor what qualifies an AMP to undertake them, are formalized as they are for Test Pilots (TPs) or Flight Test Engineers (FTEs); there are few if any courses on T&E specifically designed for AMPs. Training considerations for AMPs should be appropriate to their role within the overall T&E process. They do not lead or direct the flight clearance processes but provide specific pieces of advice within the overall jigsaw. We invite discussion regarding the content of any FTD/P training, but the objectives should include: what information is required of the FTD/P (by the TP/FTE or decision making authority); how FTD/P information can best be delivered (format, language); appreciation of test philosophy and methodology; and what implications there may be for AMP research methodologies. Through the delivery of this training there will almost certainly be a reciprocal education benefit within the T&E community regarding the role of the FTD/P. This will include the

limitations of AMP test methodologies and a greater appreciation of the appropriateness of the aerospace medicine training they currently receive. Such training is important as experimental testing of aircraft inherently implies testing of the LSS and the TP/FTE may be the main sensor to detect LSS issues or failures. **SIGNIFICANCE:** It is anticipated that AMPs who provide advice that relates to airworthiness, air safety or informs release to service decisions will be required to provide evidence as to what qualifies them to perform this role. Tailored FTD/P training would enable an objective qualification to be offered. More broadly this topic invites a review of what the AMP and T&E communities can learn from each other. The re-invigoration of relationships and closer integration of these communities will enable better understanding of Risk-to-Life considerations, improved air safety and deliver greater operational effectiveness. The potential for better equipment and systems is also beneficial for both operational capability and industry.

Learning Objectives:

1. Understand the role and deliverables required of Aerospace Medicine Professionals in airworthiness assessments and the test and evaluation process for new aircraft, life support systems and personal protective equipment.
2. Consider and recommend what test and evaluation (aviation/engineering) training would be appropriate for Aerospace Medicine Professionals to undertake the role of a Flight Test Doctor or Physiologist.

[358] THE BASE OPERATIONAL MEDICINE CELL: REVIEWING ONE-YEAR OF DATA FROM THE TEST AND EVALUATION CENTER AT KEESLER AIR FORCE BASE

C. Uptegraft¹, D. Ritter¹, A.P. Tvaryanas² and P. Nelson³

¹Base Operational Medicine Cell (BOMC), 81st Medical Group, Biloxi, MS; ²Human Systems Integration Directorate, Air Force Research Laboratory, Centerville, OH; ³International Security Studies, Air War College, Air University, Maxwell AFB, AL

MOTIVATION: Before the Base Operational Medicine Cell (BOMC), internal data from the Air Force Medical Service (AFMS) revealed significant shortcomings in how the AFMS performs standardized exams and applies occupational health dispositions. Various internal audits showed that up to 24% of all initial flying class physicals are submitted with errors, 53% of all clinical encounters have inaccurate or missing occupational health dispositions, and 66% of all preventive health assessments were performed incorrectly. This presentation will address how the BOMC has already and will continue to address these significant shortcomings to help create and sustain the healthiest and highest performing segment of the United States by 2025. **OVERVIEW:** The BOMC has several objectives: Utilize personnel resources appropriately, batch similar workflows together for efficient clinical operations, standardize workflows into universal, reliable algorithms, and start a culture of continuous process improvement to help transform the AFMS into a high reliability organization. Using workflows and training designed by the 711th Human Performance Wing at Wright-Patterson AFB, the initial results from the test and evaluation BOMC at Keesler AFB support this BOMC concept of operations. All workflows consistently yield disposition quality greater than 90%, technicians with appropriate training accomplish previous provider-expected work reliably and effectively, and hundreds of previously missed, mission-impacting medical conditions are now receiving appropriate occupational dispositions. **SIGNIFICANCE:** BOMC service-wide implementation will begin in early 2016. Implementation will dramatically change Flight and Operational Medicine Clinics around the Air Force. As the Keesler data demonstrates, the BOMC will improve the overall readiness of special duty operator, aviator, and non-special duty populations. However, any change fosters questions and skepticism. This presentation will objectively show BOMC's benefit to aerospace medicine and human performance and answer any questions from the USAF and international aerospace medicine communities.

Learning Objectives:

1. To present the objective benefit of the BOMC applied concept to occupational and operational medicine.
2. To illustrate how the BOMC affects Flight and Operational Medicine Clinics around the United States Air Force.
3. To answer any questions from the Aerospace Medicine community regarding the Base Operational Medicine Cell.

[359] AN OVERVIEW OF THE USAFSAM OPERATIONAL CONSULT SERVICE

H. Reed and A. Turner

Force Health Protection, USAF School of Aerospace Medicine, Centerville, OH

MOTIVATION: The U.S. Air Force School of Aerospace Medicine (USAFSAM) has provided consultative expertise throughout its storied history. A few years ago it recognized a gap in coverage to USAF operational units needing rapid responses to operational physiological, epidemiological, and human factors issues affecting mission attainment and operational performance. Several incidents involving the F-22 and culminating in the identification of high-performance aircraft respiratory syndrome highlighted this gap. **OVERVIEW:** Within the past year, USAFSAM has developed a new capability referred to as the Operational Consult Service (OCS). It is a standing team whose studies and analysis mission is to leverage all the varied capabilities and human factors expertise resident within the larger aeromedical community (both civilian and governmental) to address current human factors issues in U.S. military operations and to do so in a rapid response, short-term manner. The purpose of this presentation is to familiarize a larger audience of U.S. Government agencies, civilian academia, and industry as well as the international community with this new USAFSAM capability.

SIGNIFICANCE: The OCS has served as a "proof of concept" for leveraging bench-level emerging aeromedical science directly for operational issues. It brings together a wide range of subject matter experts quickly in a focused manner to provide practical useful answers, recommendations, and vectors. It provides major commands and operational units with rapid responses to a wide array of questions from every level of interest – from the operator in the field to the highest levels of leadership. While the OCS concept is still relatively new, it has proven itself repeatedly by providing impactful solutions and information to numerous USAF Special Program Offices, major commands, and operational elements on issues such as the harmful effects of Aeolian dust, recurring neck pain in pilots, and concerns about life support equipment on USAF aircraft. As the OCS capability matures, its focus could potentially expand to include operational queries from our international partners.

Learning Objectives:

1. The participant will be able to understand and solicit a new consultative capability at the USAF School of Aerospace Medicine for rapid response solutions for operational aeromedical challenges.

[360] DOES PRIOR RESIDENCY TRAINING PRODUCE POOR AEROSPACE MEDICINE SPECIALISTS? A COHORT STUDY

J.E. Miles¹, R.C. Kipp² and D.R. Pizzino³

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INTRODUCTION: Board certification is frequently offered as a surrogate for currency, competence, commitment, and expertise in a medical specialty. As such, it may serve as a tool for assessing the quality of physicians who have trained in multiple specialties. Are these physicians high achievers able to master multiple medical fields, or do they simply allow their knowledge and skills in one area to lapse as they pursue new interests? This study attempts to determine whether aerospace medicine residents with prior residency training in another specialty obtain and maintain aerospace medicine board certification at the same rate as residents with no prior residency training. **METHODS:** This was a cohort study following all residents who began the United States Air Force (USAF) Residency in Aerospace Medicine (RAM) between 1996 and 2001. Residents with prior training in another medical specialty were considered "exposed." Residents with no prior residency training were considered "unexposed." Groups were then compared based on board certification status at the time of this study in March 2015. Relative risk of either failing to obtain aerospace medicine board certification or allowing aerospace medicine board certification to lapse was calculated. The study protocol was approved by the Air Force Research Laboratory Institutional Review Board. **RESULTS:** One hundred six physicians began the USAF aerospace medicine residency between 1996 and 2001; 65 (61%) of these residents had received training in another medical specialty prior to beginning the RAM, and 41 residents (39%) had received no prior residency training. Fifty-seven

of the 106 residents (54%) were board certified in aerospace medicine in March 2015. Residents with prior residency training in another specialty were significantly less likely ($RR = 0.53$, 95% CI 0.37-0.75, $P = 0.0002$) than those with no prior residency training to be board certified in aerospace medicine at the time of this study. **DISCUSSION:** If board certification is an accurate marker for currency, competence, commitment, and expertise in aerospace medicine, then aerospace medicine specialists with prior residency training in another specialty are less likely to remain current, competent, committed, and expert in aerospace medicine after graduation. This finding may have important implications for residency programs attempting to select residents most likely to succeed in and contribute to the field.

Learning Objectives:

1. To understand the relationship between maintenance of aerospace medicine board certification and prior residency training in another specialty.

[361] WHAT YOU NEED TO KNOW ABOUT HYPERBARIC MEDICINE

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PROBLEM STATEMENT: Undersea hyperbaric medicine (UHM) is an American Board of Medical Specialties subspecialty that is supported by the American Board of Emergency Medicine and the American Board of Preventive Medicine. In the United States, from 1994 to 2014, the number of hyperbaric chamber sites expanded from approximately 200 to over 1,200, a growth rate during that time period of over 500%. In carefully selected patients with certain diagnoses, hyperbaric oxygen treatment (HBOT) has the ability to save life, limb, and eyesight. Unlike most other specialties, exposure to the basics in UHM is not offered at many medical schools nor in many residencies. **TOPIC:** There is a list of diagnoses, which has grown over the decades, maintained by the Undersea & Hyperbaric Medical Society. To be placed on the list, data from research and experience are carefully assessed by panels of experts with expertise in multiple specialties, not just UHM. Over the recent years, the list has grown; currently, the list comprises 14 diagnostic categories. Carefully selected patients with diagnoses on this list who have failed to improve in a timely manner with other indicated interventions may be considered for HBOT consultation (bearing in mind that not all HBOT consultations will necessarily be determined to be appropriate for HBOT). **APPLICATIONS:** Regarding implementation of this information, the hope is that those who attend will remember the key information and have HBOT consultation considered when appropriate in carefully selected patients (remembering that not all patients referred for HBOT consultation will be selected for HBOT). An aspect of this presentation is looking at some of the parameters used in this careful patient selection process. This medical knowledge is broadly applicable to ASMA membership since during their careers, be they physicians, nurses, or other professionals, many members may become aware of a patient who might benefit from an HBOT consultation.

Learning Objectives:

1. Learn the current diagnoses that are indications for hyperbaric medicine consultation in carefully selected patients and where to find the current list of these diagnoses.
2. Learn the resources that are manned 24/7 for hyperbaric medicine information.

Wednesday, April 27

Avalon 10-12

2:00 PM

S-66: PANEL: RESIDENT GRAND ROUNDS, III

Sponsored by ASAMS

Chair: Patrick Storms

Dayton, OH

PANEL OVERVIEW: This panel will consist of pairs of aerospace medicine residents presenting clinical cases of aeromedical interest or significance. During their residency practicum years, residents provide evaluations of patients with diverse medical problems. Residents prepare and present a case report based on a patient encounter undertaken

during their practicum experience. One resident from each pair presents the history of the presented problem. The other resident presents the physical findings and a discussion of the aeromedical policies associated with the condition. Learning aerospace medicine at the specialist level involves understanding the impact of medical conditions on aircrew health and mission accomplishment. The cases presented will not only be of academic interest but will also illustrate aeromedical decision-making in the operational environment.

Wednesday, April 27

Avalon 13-14

2:00 PM

S-67: SLIDE: EDUCATIONAL TOPICS FOR AE/PM PROVIDERS

Chair: Karen Klingenberg

Williamsburg, VA

Chair: Maximilian Lee

Wright-Patterson AFB, OH

[362] ANALYSIS OF TWO VALIDATING FLIGHT SURGEONS' EXPERIENCE

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INTRODUCTION: One of the reasons military combat medical care is the best ever is aeromedical evacuation (AE). Unfortunately, the flight environment offers stressors injurious to the patient. The gatekeeper who clinically validates a patient may fly is the validating flight surgeon (VFS). To date, the various actions of the VFS have not been seriously studied. **METHODS:** Two VFSs' experiences, successively deployed in 2007, are the focus of this study. These VFSs created an operational worksheet to manage the AE queue; it tracked the many patients concurrently considered in the clinical validation process. It was used for ~5-6 mo and is the basis for this analysis. **RESULTS:** In total, 1389 patients were recorded, the majority male (94%), mean age 30 yr. Most came from Operation Iraqi Freedom (77%). Army predominated (71%) followed by Marines (6%), Air Force (4%), and Navy (2%); most were enlisted (75%). Contractors (8%) and allies (7%) were also transported. Interestingly, Battle Injury (55%) surpassed Disease, Non-Battle Injury (45%). Injuries seen included extremity (48%), neurological (22%), face-neck (18%), chest (13%), abdomen (13%), pelvis (6%), and burns (6%). Of note, 14% had cardiac reasons for AE. VFS prescriptions levied were supplemental oxygen (85%), no "remain overnights" (79%), head of bed elevation (78%), cabin altitude restriction (57%), no stops (44%), Critical Care Air Transport Team (27%), head first load (6%), transfusion (6%), and overweight litter (2%).

DISCUSSION: This study is a first look at the VFS experience that proffers an initial accounting of the many VFS prescriptions and serves as a jumping point for future research.

Learning Objectives:

1. To understand the role of the validating flight surgeon in aeromedical transport of patients.
2. To understand the clinical spectrum of patients validated for AE transport by the validating flight surgeon.
3. To understand the prevalence of various prescriptions used by the validating flight surgeon.

[363] AEROMEDICAL EVACUATION IN THE PACIFIC: CLINICAL CONSIDERATIONS THAT MUST BE ADDRESSED FOR LONG DISTANCE PATIENT MOVEMENT.

M.L. Martin

USTRANSCOM, USAF, Honolulu, HI

PROBLEM STATEMENT: Aeromedical Evacuation (AE) missions across the Pacific Ocean and from Antarctica pose extreme challenges due to the length of the AE missions and lack of divert options. Careful observance of AE clinical concepts, strong standing orders sets, as well as,

development of stringent criteria for calling medical command and control are necessary for safe patient movement. **TOPIC:** Case examples of AE patient movements from Antarctica and the Western Pacific will be used to highlight the hazards of AE due to altitude, vibration, noise, aircraft environment and acceleration, as well as the challenges posed by the multiple patient hand offs and the isolated, medically austere setting of an aircraft in flight. Different medical problems from psych, to trauma, to hemorrhages and anemia, to infectious diseases pose additional challenges and techniques to cope with them will be discussed.

APPLICATIONS: There are significant challenges for AE patient movement and hazards and risks to the AE patients. Providers moving patient by AE should become familiar with these risks and the techniques and concepts to eliminate or mitigate these risks.

Learning Objectives:

1. Learn the risks and challenges of AE patient movement and the techniques needed to eliminate or mitigate these risks.

[364] ASSEMBLING YOUR OWN EMERGENCY MEDICAL FIRST-RESPONSE BAG

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PROBLEM STATEMENT: Aerospace medicine specialists have to occasionally provide medical care in austere environments away from immediate medical centers. One's own medical bag is the single most important tool in caring for your patients and ensuring mission accomplishment -- in both the military and civilian setting. What follows is a listing of my medical bag contents and a description of why I include them. **TOPIC:** Having a perfectly constructed medical bag has been a crucial factor in my current 18 year military career. I started building my kit while assigned to the Air Force Special Operations Command (AFSOC) and continued to revise it during my multitude of deployments and temporary duty (TDY) assignments. The culmination of which was critical during my years with the USAF Air Demonstration Team -- the Thunderbirds. The Thunderbird assignment was unique in that we were on the road to a different location every week. Some weeks we were at an Air Force base and I could have access to everything my team could need. Other times we were at civilian airshows and sometimes in foreign countries where my prescriptions meant nothing and I had to be completely self-sufficient. I had to provide care whether I was at the hotel, or at the airshow flight line, or in a hanger. Therefore, I had to have my bag readily available at all times; keeping the weight down was a critical factor. During this two year assignment as Thunderbird #9 Team Flight Surgeon, I continued to closely monitor what meds I was using and adjust my bag accordingly. I found that the easiest way to have everything readily available was to place all the medications and equipment into 8 main categories: URI, GI, GU, ER, Skin, Pain, Eye and Equipment. This educational tutorial presentation is a detailed description of my continuously revised first response emergency travel medical bag.

APPLICATIONS: The goal of the medical bag is to have everything you need with as little as you can manage. If the kit is light enough, you will carry it with you everywhere. Having the perfect emergency medical bag tailored specifically to your mission and patient needs is applicable to all aerospace medicine specialists in the civilian and military environment.

Learning Objectives:

1. The participant will be able to build his or her own first-response emergency medical bag in order to successfully accomplish any traveling aerospace medicine adventure position.

[365] A CORE CONCENTRATION IN AEROMEDICAL TRANSPORTATION AS A TRACK IN THE WRIGHT STATE UNIVERSITY AEROSPACE MEDICINE RESIDENCY PROGRAM

R.T. Garrison

Aerospace Medicine, Wright State University, Dayton, OH

PROBLEM STATEMENT: A Core Concentration in Aeromedical Transportation as a Track in the Wright State University Aerospace Medicine Residency Program. **TOPIC:** The transport of patients has always been an area of competence in aerospace medicine residency training. Graduates of the Wright State training program have extensive training in

the factors, either physiological or operational, concerning these transports, but have little exposure to these operations. In the USA alone it is estimated that over 800 aircraft and 361 operators perform combined 450,000 patient transfers annually (1). In most instances these programs receive their medical direction from physicians with core training in emergency medicine and other critical care disciplines. The Air Medical Physicians Association (AMPA) has outlined the qualifications of a director in a position paper (2). AMPA offers a 24-hour course for medical directors, which awards a certificate of completion (3). This has been a laudable effort, but the addition of formal aerospace medicine training, to emergency medicine and critical care physicians is our goal. Our program has developed a curriculum, which serves to allow the resident to receive traditional training in aerospace topics, but gives them exposure to transport operations at high volume aeromedical transport operations under the direction of experienced practitioners. Their specific knowledge will lead to a true expertise in medical direction of these operations and elevates aeromedical transport to a new level of knowledge and expertise.

APPLICATIONS: The Wright State residency track will be offered to physicians with board certification in applicable fields. They will spend clinical time with the leaders of aeromedical transport organizations in domestic, international and military settings. The goal is to train a physician with an in-depth knowledge of the intricacies of patient transport in any environment. They will be prepared to become the future educators and administrators of aeromedical transport operations.

RESOURCES: 1. Association of Air Medical Services, Air Med 101, January 9, 2014, <http://aams.org/>. 2. Medical Physicians Association, Position Papers, Medical Direction and Medical Control of Air Medical Services, August 16, 2012; https://ampa.org/sites/default/files/position_papers/position_statements_med_control.pdf. 3. Medical Director Core Curriculum, Air Medical Physicians Association, <http://ampa.org>.

Learning Objectives:

1. To understand the need for aerospace medicine to further education of its educational content in the area of aeromedical transport.
2. To outline the curriculum pertaining to allow residents to experience and master the fundamentals of transporting patient in the aerospace environment.
3. To foster the mentorship of residents in the administration of aeromedical transport and be a capable training personnel who serve as air crew on these missions.

[366] JOINT EN ROUTE CARE COURSE (JECC): ROTARY WING MEDICAL SIMULATION TRAINING FOR COMBAT CARE

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U.S. Army School of Aviation Medicine, Enterprise, AL

INTRODUCTION: The Joint EnRoute Care Course began in 2005 to meet the need to improve the care from Role 2 to Role 3 intra-theater transfer of complicated post-surgical patients. The course has evolved into an Interservice course that uses state of the art back of the aircraft simulation, complex patient simulator modeling current poly-trauma from in-theater and training to protocols using patient movement items currently used in theater. **DESCRIPTION:** The course includes 80 hours of distance learning, 2 weeks on site and includes operationalization of medical skills using complex simulations and extensive aircraft training. Since 2005 over 1199 Army, Navy, USAF and Allied nation medical personnel have been trained. **DISCUSSION:** This presentation will include a brief overview of rotary wing en route care in theater and focus on the methodology used to enhance training using protocols and complex simulation in operationalizing medical personnel for this complicated care environment.

Learning Objectives:

1. Describe the current rotary wing en route care environment in combat.
2. Demonstrate the current simulation technology and protocols used in training for rotary wing post surgical evacuation in theater.
3. Discuss future opportunities for improvement in Joint EnRoute Care.

[367] THE EFFECTIVENESS OF AN EDUCATIONAL PROGRAM ON PREVENTING AND TREATING COMPASSION FATIGUE

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INTRODUCTION: Health care providers are predisposed to compassion fatigue (CF). Forensic nurses (FN) may be predisposed to CF fatigue from challenges of the profession including high caseloads, role ambiguity, prosecution goals, vicarious traumatization & survivors' emotional needs. Emergency nurses (EN) work in a stressful environment & bear witness to personal tragedies. No previous studies evaluating interventions aimed at CF prevention & treatment in these groups. Two qualitative studies; one in ENs & one in FNs examining the prevalence & treatment effectiveness of a multifaceted education program to decrease CF & burnout (BO) symptoms and increase compassion satisfaction (CS) in those participating in the training. Hypothesis was the intervention would demonstrate a statistically significant improvement in the 3 CF subscales: increase CS, decrease on Secondary Traumatic Stress (STS) & BO in the participants' pre/posttest scores. **METHODS:** Qualitative studies were used to examine the treatment effectiveness of a multifaceted education program to decrease CF & BO symptoms & increase CS. Convenience samples were used with a pre-/posttest design. Participants served as their own control group & pre/posttests were linked for comparison. Quantitative data were obtained from The ProQOL test & demographic questionnaire. **RESULTS:** In the EN sample, 52% had low to mod levels of CS, 59% reported mod to high levels of BO, 60% had mod to high levels of STS. 60% of the EN reported at least 1 symptom of CF in the past 30 days. In the FN, the multifaceted education program showed statistical significance in increasing CS ($p = 0.004$) decreasing BO ($p = <0.001$) & decreasing STS symptoms ($p = 0.001$). In the FN prevalence sample 100% reported at least 1 symptom of CF in the past 30 days, 69% had moderate to low CS, 73% had mod to high BO & 73% had mod to high levels of STS. In the FN intervention group, the education program resulted in a statistically significant increase in CS ($p = <0.001$), decreases in BO ($p = 0.04$) & STS symptoms ($p = 0.003$). **DISCUSSION:** As the first intervention study for CF in EN & FNs, the results have important implications to organizational leaders in treating & preventing CF. Positive outcomes cited by the participants included development of skills necessary to maintain resiliency & prevent future occurrences. The evaluations suggest that the material would be beneficial to other healthcare professionals including those working in aerospace medicine.

Learning Objectives:

1. Discuss the compassion fatigue risk in trauma care providers/aerospace medicine.
2. Summarize the results of this study: "The effectiveness of an educational program in preventing and treating Compassion Fatigue."
3. Discuss the implications of this research related to aerospace medicine.

Wednesday, April 27
Avalon 15-16

2:00 PM

S-68: SLIDE: BIOMARKERS AND BIOSENSORS FOR HUMAN PERFORMANCE

Chair: Takashi Nagai
Pittsburgh, PA

Chair: William Porter
Fort Sam Houston, TX

[368] PHYSIOLOGIC RESPONSES OBTAINED FROM WEARABLE BIOSENSORS DURING HIGH PERFORMANCE JET AIRCRAFT MANEUVERS

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BACKGROUND: Few studies have evaluated physiologic responses to high accelerative forces during actual flight and to our knowledge no normative data has been acquired by newer technologies such as wearable/portable biosensors during high performance jet aircraft operations. The primary objective of this report is to describe the physiologic data captured by a commercially available wearable biosensors during high G maneuvers (>5 G). **METHODS:** Subjects were five active duty F-18 pilots of the Naval Flight Demonstration Squadron, (3 formation pilots

and 2 solo pilots). The device evaluated was a FDA approved portable triaxial accelerometer & bio-sensor which was attached to the aviator via ECG transdermal patches. Variables monitored were heart rate, heart rate variability, respirations, V2 ECG waves, Kcal expenditure, Avg G/sec, and number of accelerations over >5G. Data was excluded from the study if it was not complete throughout the entire flight or not consistent with ECG recording. **RESULTS:** Of the 10 flights analyzed, 7 complete biosensor data sets were obtained from three formation and four solo performances, with average flight lasting 2546 seconds for formation and 2633 seconds for solo demonstrations. Formation pilots averaged 8.4 peak accelerations > 5 in the +Gz axis/per flight, while solo pilots averaged 18.2 peak accelerations > 5 in the +Gz axis. Average HR for formation pilots was 90 bpm (Min 64, Max 178), while solo pilots averaged 107 bpm (Min 64, Max 200). Average Kcal expenditures for formation pilots were 276 Kcal (Min 184, Max 378), and for solo pilots was 348Kcal (Min 280: Max 457). **DISCUSSION:** The elevations in heart rate detected from this portable biosensor seem to be associated with increased gravitational exposures. Predictably solo pilots who had a greater number of peak accelerations also had significantly higher average heart rates and average kcal expenditure. On some occasions significantly elevated heart rates were found to be due to double counting of both q and t waves, validation of these biosensors during inflight exposure to high Gs with a Holter monitor would be a logical next step.

Learning Objectives:

1. Discuss operational advantages of new portable/wearable biosensors for use in monitoring physiologic responses of aviators in high performance aircraft.
2. Discuss the limitations of new portable/wearable biosensors for use in monitoring physiologic responses of aviators in high performance aircraft.
3. Discuss the observed physiologic data obtained from wearable biosensors during these high performance jet flights and compare these findings to that of prior inflight studies.

[369] BIOPLASMONIC PAPER DEVICES TO MONITOR BIOMARKERS

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¹Air Force Research Lab, WPAFB, OH; ²711 Human Performance Wing, Air Force Research Laboratory, Dayton, OH; ³Washington University St Louis, St Louis, MO

INTRODUCTION: The optical properties of Au nanorods (Au NRs) are derived from intense localized surface plasmon resonances (LSPR). Collectively, these are extremely sensitive to changes in the local surrounding environment in the form of electronic, refractive index, and polarization changes that occur from binding events at or near the gold surface. As a result, LSPR based sensing nanostructures offer the potential to detect a broad spectrum of biomarkers, to achieve low detection limits by using biological recognition elements such as antibodies, aptamers and peptides to promote binding near the gold surface and to operate in complex biological fluids. Paper substrates can be utilized for device fabrication by exploiting simple adsorption and wicking processes of paper. This creates a highly sensitive and inexpensive bioplasmonic paper device to sense and detect human performance biomarkers. As proof of concept, human cardiac troponin I biomarker was detected using bioplasmonic paper at sub-picogram amounts based on LSPR shifts. **METHODS:** To create bioplasmonic paper, gold nanorods were adsorbed onto paper substrates by immersion of a 1cm x 1cm piece of filter paper in an aqueous solution of gold nanorods functionalized with short recognition elements. For testing, bioplasmonic paper was exposed to a broad concentration range (fM to mM) of troponin I spiked into biofluids and measured using a portable UV-Vis spectrophotometer. **RESULTS:** Using bioplasmonic paper and a troponin-binding peptide, we measured an LSPR shift of ~4 nm when incubated with ~35 pg/mL of troponin in human serum. At higher concentrations of troponin, the bioplasmonic paper exhibited a maximal LSPR shift of ~12 nm. Notably, the limit of detection for troponin was 0.14 pg/mL. **DISCUSSION:** The performance and sensitivity of bioplasmonic paper devices was greatly enhanced using short recognition peptides. We achieved lower detection limits, using a simple bioplasmonic paper device and a portable spectrophotometer. By comparison, bioplasmonic paper functionalized with antibodies exhibited a 10-fold higher detection limit, shorter shelf-life and decreased optical response.

Learning Objectives:

1. Evaluate the performance of paper based gold nanorod biosensor for the detection of human performance biomarkers.

[370] HUMAN PERFORMANCE MOLECULAR BIOMARKER DETECTION USING ELECTRONIC GRAPHENE SENSOR

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INTRODUCTION: The cognitive level assessment is a crucial element in human performance monitoring (HPM). Physiological signatures, such as heart rate, body temperature, and epidermal conductivity, have been measured for human test subjects along with their specific tasks and psychological stress levels. Complementing with the physiological traits, biochemical sensing of the cognitive and other biomarkers is expected to increase the accuracy and precision level in HPM. **METHODS:** Electronic sensing platform based on single atomic thin 2-dimensional (2D) graphene was investigated for its use in human biomarker detection. The 2D transistors were functionalized various bioreceptors, such as aptamers, antibodies, and oligo-peptides. Sensing tests were performed in both biochemical buffer and artificial perspiration media. **RESULTS:** Chemical vapor deposition (CVD) graphene field effect transistors (FETs) were fabricated, and functionalized with Interleukin-6 (IL-6) binding aptamer or Neuropeptide-Y (NPY) antibody. The charge neutrality point (CNP) of the transfer curve decrease was observed upon the binding of target molecules. A linear/nonlinear increase in CNP signal change was observed for the aptamer/antibody functionalized graphene FET when the sensor was spiked with 1 fg/mL – 1 µg/mL target. Label-free peptide-functionalized graphene FET sensors show pM-level detection NPY in artificial sweat. ROC analysis shows the GFET device can be integrated as a sensitive and selective NPY biomarker sensor when interfaced with microfluidics, noise-reducing data process, and differential sensing. **DISCUSSION:** Graphene (or other 2D layered nano materials) can be an ultimate building block for wearable HPM sensors by proving ultrahigh sensitivity, while satisfying the electronic, chemical, and physical requirements. In this research, the sensing tests for sub-pM level human cytokine targets have shown the GFETs to be promising biomarker sensor platform.

Learning Objectives:

1. Developing sensors to detect trace amount of cognitive biomarkers by interfacing atomically thin graphene nano transistors with bioreceptors.

[371] IDENTIFICATION OF GENETIC BIOMARKERS FOR COGNITIVE IMPAIRMENT FROM TOTAL SLEEP DEPRIVATION

H.A. Uyhelji¹, D.M. Kupfer¹, V.L. White¹, M.L. Jackson³, H.P. Van Dongen² and D.M. Burian¹
¹Bioaeronautical Sciences Research Lab, CAMI, FAA, Oklahoma City, OK; ²Washington State University, Spokane, WA; ³RMIT University, Bundoora, Australia

INTRODUCTION: Pilot fatigue from sleep deprivation presents serious risks to passengers and crew when it impairs performance. Currently, there is no practical diagnostic method to operationally detect impairment from fatigue or its contribution to aviation accidents. Because gene expression can be a sensitive indicator of physical stress, it may present a metric for evaluating fatigue levels. We hypothesized that sleep deprivation would cause detectable gene expression changes, resulting in a panel of biomarkers correlated to impaired performance. **METHODS:** Healthy human volunteers (ages 22-40) stayed in the laboratory for six 24 h days, where they had two baseline nights with 10 h time-in-bed (TIB), were then kept awake for 36 h (sleep deprived group; n=8) or obtained normal nighttime sleep at 10 h TIB (control group; n=6), and finally had two recovery nights with 10 h TIB. Subjects' fatigue levels were measured with the psychomotor vigilance test (PVT) every 2 h of scheduled wakefulness. Blood samples were taken every 4 h through an intravenous line during one baseline day, the initial 36 h of the 62 h of sleep deprivation, and a recovery day. Institutional Review Board approval for this project was obtained from both the Civil Aerospace Medical Institute and Washington State University. **RESULTS:** More than 200 genes were differentially expressed between the sleep deprived and control

individuals, including cytokines commonly associated with sleep (e.g., interleukin-1 beta). The majority of these genes were down-regulated during sleep deprivation. Additionally, expression profiles of 31 genes were correlated moderately ($r < 0.40$) with subjects' PVT performance. Functional analysis in the Database for Annotation, Visualization and Integrated Discovery (DAVID) revealed enrichment of WNT signaling among the genes responding to sleep deprivation. **DISCUSSION:** Although future studies will be needed to validate the biomarkers, this research is a significant step towards detecting and understanding performance impairment due to sleep loss.

Learning Objectives:

1. Understand the importance of objectively measuring performance impairment when testing for biomarkers of sleep deprivation.
2. Explain the utility of gene expression as a measurement of fatigue.

[372] MINIATURE BIOSENSOR WITH HEALTH RISK ASSESSMENT FEEDBACK

A. Hanson¹, M. Downs³, K. Kalogera⁴, R. Buxton³, T. Cooper², A. Cooper² and R. Cooper²

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INTRODUCTION: Heart rate (HR) monitoring is a medical requirement during exercise, fitness tests, and extravehicular activity (EVA) on the International Space Station (ISS); however, NASA does not currently have the technology to consistently and accurately monitor HR or other physiological data during these activities. Performance of currently available HR monitor technologies is dependent on uninterrupted contact with the torso and is prone to data drop-out and motion artifact. Here, we seek an alternative to the chest strap-electrode based sensors in use on the ISS today. This project aims to develop a high performance, robust earbud-based biosensor with focused efforts on improved HR data quality during exercise. **METHODS:** All protocols were approved by the Institutional Review Board at NASA Johnson Space Center. Subjects were asked to complete a treadmill (n=5) or cycle (n=5) session at a range of intensities. HR data were compared to a 3-lead ECG beat-to-beat analysis. Data was considered comparable if ECG and biosensor data were within ± 5 bpm. Qualitatively, the ear bud HR sensor performed better when HR was < 150 bpm. Data were analyzed both across the full session and for periods of activity where HR was < 150 bpm. A subset of subjects (n=4) also completed a long-term wear session and were asked to record their temperature with a commercial ear probe thermometer at hourly intervals, which were compared to temperature data collected by the biosensor. **RESULTS:** During cycle tests, 96% of the ECG and biosensor data were within the ± 5 bpm tolerance. During treadmill tests, 55% of the data were within tolerance with higher levels of accuracy at heart rates below 150 bpm. Temperature data collected with the biosensor were on average $< 1^\circ\text{F}$ different from that collected with the ear probe thermometer. **DISCUSSION:** The biosensor performed better during cycling than during treadmill running, and generally, during lower intensity exercise. The biosensor provided high quality temperature data during all test scenarios. Motion artifact and ear bud fit are likely the cause of the decreased HR data quality on the treadmill and with HR > 150 bpm. An industrial design for a new biosensor form factor was completed and a health risk algorithm was developed to provide the user with real-time biometric feedback. Partnerships with the military have been established to evaluate the biosensor for use during casualty care in the field.

Learning Objectives:

1. The participant will be able to appreciate methods used in biomedical engineering in the emerging field of wearable biosensing technologies, and validation criteria used to determine the quality of data and ultimately the efficacy of the product in a variety of use scenarios.

[373] PLASMONIC CROSS-REACTIVE SENSORS FOR BIOMARKER SIGNATURE PROFILING

I.V. Drachuk, J.L. Chávez and N. Kelley-Loughnane
 711 Human Performance Wing, Wright-Patterson AFB, Dayton, OH

INTRODUCTION: Continuous monitoring of cognitive performance and stress levels are key priorities for human performance assessment in

airmen. Hence, sensor platforms with the potential for simultaneous monitoring of different biomarkers related to cognitive and stress processes would provide tools to characterize these conditions and the effect of different remediation strategies. **METHODS:** Current technologies of biomarkers quantification usually require multi-step sample preparation and lengthy processing that prevents timely characterization of biomarker level changes. Therefore, fast and simple methods for monitoring biomarker concentrations changes simultaneously have the potential to realize the promise of using biomarker signatures as a tool for human performance characterization. **RESULTS:** We present initial data on multiplexed biomarker detection using the plasmonic response of DNA aptamer-gold nanoparticle conjugates (Apt-AuNPs). Our research has demonstrated that these conjugates expand the selectivity of the aptamers to respond to a number of chemically related molecules through the combination of binding interactions between the surface, the DNA nucleotides and the analyte, resulting in cross-reactive sensors. Moreover, the plasmonic response of these sensors can be rapidly analyzed with clustering analysis tools for on-the-spot analysis. **DISCUSSION:** We report on the initial characterization of the sensor response to a sub-set of biomarkers related to stress and initial testing of the optimal array density to identify each biomarker family.

Learning Objectives:

1. Presented technique utilizes cross-reactive plasmonic responses between chemically related molecules for multiplexed detection of biomarkers.

Wednesday, April 27

2:00 PM

Avalon 17

S-69: PANEL: NATO & EUROPEAN ASSOCIATION OF CARDIOTHORACIC SURGEONS AVIATION CARDIOLOGY WORKING GROUP: INTERACTIVE CASE STUDIES IN AVIATION CARDIOLOGY

Chair: Eddie Davenport

Wright-Patterson AFB, OH

Chair: Ed Nicol

Hitchin, Bedfordshire, United Kingdom

PANEL OVERVIEW: This session will present aviation cardiology case histories for debate and discussion in each of the five main sub-groups of the NATO Aviation Cardiology Working Group. These will be: Coronary Artery Disease; Electrical Abnormalities including Arrhythmia; Valvular Heart Disease; Heart Muscle Disease including Cardiomyopathy; Adult Congenital Heart Disease. Each case will present a case dilemma that will be discussed interactively with the audience and then with the members of the NATO Aviation Cardiology Working Group, highlighting a common approach to risk assessment and general principles of investigation, management and aircrew disposition, whilst discussing the challenges and differences in the way that each of the represented Nations approach cardiovascular disease in their aircrew.

[374] NATO & EUROPEAN ASSOCIATION OF CARDIOTHORACIC SURGEONS AVIATION CARDIOLOGY WORKING GROUP: AN INTERACTIVE VALVE CASE STUDY

T. Syburra², G. Gray³, N. Guettler⁴, R. Wetterholm⁵, D. Bron⁶ and E. Nicol¹

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PROBLEM STATEMENT: Bicuspid aortic valve (BAV) is the most common congenital heart disease. Many will need surgery in adulthood. Pilot licensing after aortic valve surgery is a challenge for the cardiac surgeon and the aeromedical examiner (AME).

The cockpit is an exceptional physiological environment, particularly under high +Gz conditions, which the surgeon needs to consider. **BACKGROUND/LITERATURE REVIEW:** Two case studies from the Swiss Air Force are presented. Aviation medicine publications, surgical literature and European Aviation Safety Agency (EASA) regulations were reviewed. EASA states that pilots can return to flight duties after the 6th postoperative month, limited by: bioprosthesis only, unrestricted cardiac function, no cardioactive medications, multi-crew only (OML), echocardiographic follow-up every 6 months with Holter ECG. The Swiss Air Force added: no high-performance aircrafts, no accelerations above 3 +Gz, Pilatus P7 aircraft allowed solo or with second pilot qualified on type, OML in all transport operations. **CASE PRESENTATION:** Two Swiss Air Force fighter pilots with BAV developed severe symptomatic aortic valve disease whilst on duty. Both underwent tissue aortic valve replacement with Carpentier Edwards Perimount. One patient retrained as transport aircraft pilot, the second left the Air Force and flies now business jets. **OPERATIONAL/CLINICAL RELEVANCE:** Pilot licensing after cardiac surgery requires a high level of coordination between the surgeon and the AME. Return to flight duties is possible with restrictions. Best flow characteristics of the valve prosthesis are paramount. The choice of bioprosthesis type is crucial in aviation for low transvalvular gradients and best coronary perfusion. Scheduled cardiological follow-up is essential for the early detection of structural valve disease (SVD) ahead of clinical symptoms. Early re-do surgery shall be warranted in accordance to the current cardiac surgery guidelines.

Learning Objectives:

1. Learn the role of the cardiac surgeon in the management of a pilot with symptomatic aortic valve disease.
2. Learn the prevalence of bicuspid aortic valve.
3. Learn the surgical options for aortic valve disease and the planning of re-do surgery due to SVD.

[375] NATO & EUROPEAN ASSOCIATION OF CARDIOTHORACIC SURGEONS AVIATION CARDIOLOGY WORKING GROUP: AN INTERACTIVE ARRHYTHMIA CASE STUDY

N.J. Guettler¹, R. Rienks², G. Gray⁴, E.D. Davenport³, J. d'Arcy² and E. Nicol²

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PROBLEM STATEMENT: Atrial fibrillation (AF) is the most common type of cardiac arrhythmia. It is often caused by an underlying structural heart disease, by hyperthyroidism or hypertension. Aeromedical concerns are hemodynamic instability, thromboembolic risk, and requirement for chronic medication to maintain sinus rhythm or to control ventricular rate. The issue is ruling out underlying structural heart disease, providing optimal treatment, and assessing the aeromedical risk of returning such individuals to flight duties. **BACKGROUND/LITERATURE REVIEW:** Risk factors leading to AF including genetic factors responsible for familial lone AF have been progressively identified. Treatment of AF especially by catheter ablation has been improved significantly within the last years. Indication for anticoagulation is assessed by risk scores like CHA2DS2Vasc Score. **CASE PRESENTATION:** A 44 year old cargo pilot suffered from multiple episodes of symptomatic paroxysmal AF within the last two years. Besides family history for coronary artery disease, there were no identifiable cardiovascular risk factors and no risk factors for thromboembolic events. He was first treated with beta blockers, but AF episodes still occurred. An underlying structural heart disease and a hyperthyroidism were excluded. He underwent catheter ablation, a pulmonary vein isolation was successfully performed. After another three months without any AF episodes he returned to flight duties. **OPERATIONAL/CLINICAL RELEVANCE:** AF is the most common cardiac arrhythmia and can have operational implications because of a reduced exercise tolerance, thromboembolic events, and the requirement for medication to maintain sinus rhythm, to control ventricular rate, and to prevent thromboembolism. Identification of at-risk individuals, diagnosis of underlying diseases, and selecting patients for adequate therapeutic interventions will reduce the burden of AF and improve flight safety.

Learning Objectives:

1. Learn the role of possible risk factors for the pathogenesis of atrial fibrillation.
2. Learn diagnostic algorithms for the identification of atrial fibrillation and underlying diseases and to select patients for the adequate treatment.

[376] NATO & EUROPEAN ASSOCIATION OF CARDIOTHORACIC SURGEONS AVIATION CARDIOLOGY WORKING GROUP: AN INTERACTIVE CORONARY ARTERY DISEASE CASE STUDY

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PROBLEM STATEMENT: Coronary events in a military aviator-age population often occur without prior symptoms, in some the presenting event being sudden death. Most are not identified as being at increased risk based on traditional cardiac risk factors. The problem is understanding as-yet-unidentified factors which lead to atherosclerosis and plaque rupture events in such individuals. Once optimally treated, the issue is assessing the aeromedical risk of returning such individuals to flight duties.

BACKGROUND/LITERATURE REVIEW: Non-traditional risk factors including genetic markers and novel metabolic pathways for atherosclerosis such as the PCSK9 pathway are being progressively identified. Enhanced screening methods including CT imaging are improving identification of at-risk individuals, with the goal of risk intervention before an acute coronary event. Mitigation of risk factors post-event may lead to acceptable risk for a return to flight duties. **CASE PRESENTATION:** A 44 year old fighter pilot with no identifiable risk factors apart from a positive family history suffered an acute coronary event with cardiac arrest from which he was successfully resuscitated. He underwent urgent intervention with a drug-eluting stent in the single right coronary artery lesion. He made a complete cardiac and neurologic recovery. **OPERATIONAL/CLINICAL RELEVANCE:** Coronary disease remains a leading cause of loss of trained aviators and loss of aeromedical certification. Identification of at-risk individuals through evolving understanding of risk factors and enhanced screening procedures will reduce the burden of atherosclerotic coronary events, reduce the loss of trained resources and improve flight safety.

Learning Objectives:

1. Learn the role of genetic and non-traditional risk factors in the pathogenesis of atherosclerosis in a younger population.
2. Understand the mechanism of acute coronary syndrome due to plaque rupture.
3. Learn a risk matrix approach to aeromedical decision making.

[377] NATO & EUROPEAN ASSOCIATION OF CARDIOTHORACIC SURGEONS AVIATION CARDIOLOGY WORKING GROUP: AN INTERACTIVE CONGENITAL HEART DISEASE CASE STUDY

J. d'Arcy⁵, E.D. Davenport⁶, G. Gray², N.J. Guettler¹, E. Nicol⁴, R. Rienks³ and T. Syburra⁷

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PROBLEM STATEMENT: Although congenital heart disease in civil and military aviators is unusual and almost always a bar to entry into military service, milder forms may be detected after entry. Some congenital abnormalities may be associated with shunting, arrhythmias and eventual heart failure due to volume overload if left uncorrected. Timely

correction of straightforward congenital defects is associated with extremely good outcomes, but additional considerations may be warranted when considering a return to flying and operational deployment. **BACKGROUND/LITERATURE REVIEW:** The use of device-closure techniques in appropriately selected cases and advances in surgical techniques have resulted in excellent overall results when intervention is required for simple congenital heart disease. Risks of device embolisation, arrhythmia and infection still need to be considered when re-certifying aviators with a history of such lesions. **CASE PRESENTATION:** A 29 year old air transport pilot complained of occasional short-lived palpitations. During investigation of these, trans-thoracic echocardiography demonstrated an atrial septal defect and a mildly dilated right ventricle; Holter monitoring recorded isolated ventricular ectopics. Cardiac magnetic resonance imaging confirmed an ostium secundum ASD with a significant shunt, and anatomy suitable for percutaneous device closure of the defect. A closure device was subsequently implanted without complication, although follow up imaging demonstrated a very small residual shunt. **OPERATIONAL/CLINICAL RELEVANCE:** Although the finding of simple congenital heart lesions in trained aviators is uncommon, intervention to treat such defects may be compatible with continued flying. The potential implications for individuals operating high-performance aircraft warrant careful consideration.

Learning Objectives:

1. Learn the potential sequelae of simple congenital heart defects.
2. Understand the considerations involved in managing these lesions.
3. Understand the potential complications of intervention in simple congenital heart disease, with specific consideration for the aviation environment.

[378] NATO & EUROPEAN ASSOCIATION OF CARDIOTHORACIC SURGEONS AVIATION CARDIOLOGY WORKING GROUP: AN INTERACTIVE HYPERTROPHIC CARDIOMYOPATHY (HCM) CASE STUDY

R. Rienks¹, E.D. Davenport², J. d'Arcy³, N.J. Guettler⁴, E. Nicol³ and G. Gray⁵

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PROBLEM STATEMENT: HCM is characterized by hypertrophy of the left ventricle, usually in an asymmetric fashion involving the base of the left ventricular (LV) septum. Multiple anatomic variations are known to occur, however, including concentric and apical-only patterns. HCM is characterized by the development of scar tissue and disorganized myofibrils. The main risks are ventricular arrhythmias and sudden cardiac death (SCD). The diagnosis HCM is usually disqualifying for all classes of flying duties. However, there may be a subset of HCM patients that can be allowed to remain in or return to flying duties.

BACKGROUND/LITERATURE REVIEW: New ways of calculating risk of sudden cardiac death allow a better risk stratification in HCM patients (HCM Risk-SCD Calculator_V2). Presence of non-sustained Ventricular Tachycardia (NSVT) and unexplained syncope are highly significant predictors of SCD. In addition, left atrial diameter, maximum LV wall thickness, a family history of SCD, and an increased LV outflow tract gradient are also predictors of SCD. **CASE PRESENTATION:** An asymptomatic 48 year old boom operator was already known with an abnormal ECG. Initially, no abnormalities were found on echocardiogram and MRI. Eventually, the diagnosis HCM could be established. He has a negative family history for SCD, a normal exercise tolerance, no pressure gradient over the LVOT and no NSVT on Holter or stress test. He continues to be on flying duty and is under annual cardiology review. **OPERATIONAL/CLINICAL RELEVANCE:** The diagnosis HCM in asymptomatic aircrew does not equal a disqualification for flying duties. Depending on the class, type of aircraft, type of mission and function the aircrew member may continue to be fit for flying duties.

Learning Objectives:

1. Learn the nature of hypertrophic cardiomyopathy.
2. Understand the risk calculation for SCD in hypertrophic cardiomyopathy.
3. Learn a risk matrix approach to aeromedical decision making.

Wednesday, April 27
Avalon 6

2:00 PM

S-70: PANEL: AEROSPACE DENTISTRY

Chair: Michael Hodapp
Houston, TX

PANEL OVERVIEW: Aerospace Medicine encompasses many facets of science to accommodate the broad range of events that occur when exposing humans to harsh environments. Expeditions below the earth, under the sea, during flight, and in the far reaches of outer space can wreak havoc on the human body. Aerospace dentistry addresses issues that occur in the maxillofacial complex during changes in atmospheric pressure, evaluates methods and techniques for dental emergencies, and assists in dental preparedness during exploration to remote locations. Prevention is the gold standard. Dentists also help identify and provide treatment of oral sleep apnea, as well as assist in forensic identification. Barotrauma, barodontalgia, and barosinusitis, are conditions that have been known to incapacitate crewmembers, and cause early cessation of missions, due to intense pain, vertigo, and lack of ability to focus. Diagnosis can be challenging since the symptoms may not be reproduced clinically, and the pain may be referred from other facial cavities not be related to the oro-facial environment. This panel will present case reports on barometrically related conditions that occurred in the maxillofacial complex due to subclinical pathologies and the treatment performed to resolve the issue, a case of a noncompliant oral sleep apnea patient with an alternate treatment method, and an evaluation of modern caries detecting technologies, with a focus towards exploration class missions.

[379] DENTIST AND ORAL SURGEONS AND OBSTRUCTIVE SLEEP APNEA

J.L. Dominguez-Mompell¹, V. Lopez Pizarro², J. Lara Chao³ and A. Restoy⁴

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INTRODUCTION: Sleep apnea is classified as a dyssomnia, meaning abnormal behavior or psychological events occur during sleep. In this disorder, in which breathing repeatedly stops and starts during sleep. Each pause in breathing (called an apnea) can last for several seconds or even minutes. Several types of sleep apnea exist, but the most common type is obstructive sleep apnea, (OSA) which occurs when your throat muscles intermittently relax and block your airway during sleep. The most noticeable sign of obstructive sleep apnea is snoring, and a lapse in normal breathing. The severity of the sleep apnea can then be quantified. Mild OSA (Obstructive Sleep Apneas) ranges from 5 to 14.9 events per hour of sleep, moderate OSA falls in the range of 15–29.9 events per hour of sleep, and severe OSA would be a patient having over 30 events per hour of sleep. **CASE REPORTED:** A 32 year-old air assistant with an OSA index of 29 who has been using a continuous positive airway pressure (CPAP) for the last 4 years is referred to our department to find a surgical approach to her problem because she refused to continue using her CPAP. A maxillomandibular advancement (MMA) was considered to be the most effective surgery for this case because it increases the posterior airway space (PAS). The main benefit of this type of surgeries is that the oxygen saturation in the arterial blood increases. **DISCUSSION:** With proper use, CPAP improves outcomes and decreases the risk of death due to heart disease. Long term compliance; however, is an issue with more than half of people not appropriately using the device. Although CPAP therapy is effective in reducing apneas and less expensive than other treatments, some people find it extremely uncomfortable. Patients complain of feeling trapped, and skin or nose irritation. Many patients refuse to continue the therapy or fail to use their CPAP machines on a nightly basis, especially in the long term. **CONCLUSIONS:** Although they are normally a third line of treatment for those who reject or are not helped by CPAP treatment or dental appliances. Surgical treatment for obstructive sleep apnea has to be considered as a reliable and stable treatment that needs to be individualized for every patient.

Learning Objectives:

1. To be able to suspect a dyssomnia in our patients and address him/her to the specialist.
2. To know different kinds of treatment for this sleep disorder.

[380] MAXILLARY SINUS PROBLEMS RELATED TO ORAL IMPLANTOLOGY

I. Hernandez Hoyos³, J.L. Dominguez-Mompell², J. Lara Chao¹, V. Lopez Pizarro⁴ and A. Restoy⁴

¹DL Cirugia Oral, Aranjuez, Madrid, Spain; ²Oral Surgery, DL Cirugia Oral, Madrid, Spain; ³Permament, Madrid, Spain; ⁴Maxillofacial, Hospital Principe de Asturias, Madrid, Spain

INTRODUCTION: Dental implantology has become a very common practice around the world. The incidence of complications associated with this treatment is quite low. These complications might be increased when bone augmentation procedures are needed in order to place implants in a three dimensional ideal position. A complication that can occur is the migration of dental implants into maxillary sinus, when doing a sinus lift augmentation procedure. Foreign bodies within the maxillary sinus should be removed since they may cause inflammatory sinusitis. When symptoms are present, intervention is indicated. Implant removal with oroantral communication closure during a single procedure reduces treatment time, the number of surgeries, and can reduce the number of complications with multiple surgeries. **CASE REPORT:** This is a case report of a patient with a chief complaint of sinus pain during flight. It was determined by radiographic evaluation and an extensive health history to be caused by dental implants that had been displaced into the maxillary sinus. **METHOD:** A Caldwell-Luc approach was performed to remove the implants, and obtain primary closure of the maxillary sinus. **CONCLUSION:** Migration implants into the maxillary sinus is rare. A foreign body, such as an implant within the sinus cavity can create an inflammatory process, as presented in this case report. The surgical approach was the only valid treatment for this case.

Learning Objectives:

1. To be able to identify possible complications and its treatment when performed oral implantology in the posterior area.

[381] IATROGENIC SINUSITIS IN AN A-320 CAPTAIN

J. Lara Chao¹, J.L. Dominguez-Mompell¹, A. Restoy², V. Lopez Pizarro² and I. Hernandez Hoyos³

¹Oral Surgery, DL Cirugia Oral, Madrid, Spain; ²Maxillofacial, Hospital Principe de Asturias, Alcala de Henares, Spain; ³Oral Surgery, Permament, Madrid, Spain

INTRODUCTION: Dental extractions are one of the most common surgical procedures performed in the history of humankind. Several potential complications may occur during oral surgical procedures. Hemorrhage, cellulitis, osteitis, hypoaesthesia, root or bone fracture, intense pain, as well as local or systemic infections are some of the issues the surgeon has to address. It is imperative for the clinician performing these procedures to know how to deal with the potential ramifications. **CASE REPORT:** The case reported is a 53 year old male, captain of an A320 who was experiencing occasional pain during ascent of his last 3 flights. Patient's dental history shows a first molar extraction several months ago. A CT-Scan revealed a sinusitis caused by the iatrogenic migration of a root into the maxillary sinus. A Caldwell-Luc approach was performed to access the Schneiderian membrane, once the membrane was visualized a small incision was made to remove the root. The membrane was then sutured and the cortical plate was then replaced. This surgical approach allows for the clinician to do a reentry in 4-5 months, to perform a sinus augmentation procedure, and place implants in the posterior maxilla, thus replacing the lost molar. **DISCUSSION & CONCLUSION:** Odontogenic sinusitis is normally caused by an infected maxillary molar or premolar with antral roots. An infection of the maxillary sinus causes an inflammatory process that can affect its ability to compensate for changing barometric pressures (barosinusitis). Clinical manifestations of barosinusitis range from being totally asymptomatic to an acute incapacitating pain when barometric changes occur.

Learning Objectives:

1. To identify an occupied maxillary sinus in a CT Scan and its possible implications in an aeronautical environment.

[382] BAROTRAUMA IN RESCUE DIVERS**M. Fresno***Poder Judicial Córdoba, Cordoba, Argentina*

Whenever differential gas pressure happens between the inner and outer environment in the human body many events are carried out trying to counterbalance those pressure changes mainly those physiological and pathological effects. Medical ground transport is quite often assisted by air transport, determined by different factors such as distance, access and severity, becoming an utmost relevant mean of medical emergency prior to hospitalization. In case of a disaster, air transport become essential for localization, evacuation and rescue of the affected population. Besides it is very important as well for supplying first need equipment, food and APS. In many occasions rescue tasks require not only the air means but aquatic means as well. Therefore workers allocated to these tasks must be under a health periodical surveillance program. In these cases divers are the ones more prone to be affected by pressure changes. Quite often divers are transported by air once they have finished their specific tasks. This means a great effort to the body to keep adapted the pressure balance in an acceptable range. In the particular case of divers, pressure change issues must be close considered. They are affected by great changes of pressures during both routines descending and ascending. Atmospheric pressure during the flight and hydrostatic pressure during diving are added up. Being diminished the first one and increased the second one while descending and all the way round while ascending. This forces the body structure to be adapted to the pressure changes. From a dental point of view, all treatment concerning barodontalgia must be foreseen, not only concerning the hard structures (teeth) but soft structures (TMJ, sinuses, muscles) as well. Correct treatments and surveillance of these structures will allow workers involved in these tasks not to have side effects and to perform their job in a healthy manner.

Learning Objectives:

1. To understand the implication of dental issues in rescue mission involving divers' deployment.

[383] CARIES DETECTION WITHOUT ELECTROMAGNETIC RADIATION: A FOCUS TOWARDS EXPLORATION CLASS MISSIONS**M.H. Hodapp***University of Texas Dental Branch, Houston, TX*

All manned missions to date have yielded the luxury of a rapid return to earth. Dentistry's primary role for space travel has been, and always will be prevention. Manned exploration class missions to our second closest planet, Mars, would require about 21 months with current rocket technology, and would demand a closer look at preventative measures, one which will require an active role of the crewmembers. The ability to identify carious lesions before they become symptomatic is one of the key methods to prevent true dental emergencies. One of the concerns during space travel is the fact that astronauts are exposed to high doses of radiation. The estimated dose of radiation an astronaut would be exposed to during the shortest round trip mission to Mars is estimated at 0.66 Sieverts, the equivalent of an entire CT body scan every five to six days. Until recently diagnosing interproximal caries without the use of electromagnetic radiation was difficult if not practically impossible. New commercially available technologies have emerged that not only make diagnosing interproximal caries, without the use of electromagnetic radiation possible, but can also aid in the early diagnosis of incipient carious lesions that may not be detected radiographically. As with all technologies there are limitations as well as learning curves to overcome. This presentation evaluates some of the recent commercially available caries detection technologies with a focus towards exploration class mission usage.

Learning Objectives:

1. To gain a basic understanding of some of the latest caries detecting technologies not requiring electromagnetic radiation.
2. To understand some of the limitations of the latest caries detecting technologies.
3. To be able to identify carious lesions utilizing the latest technology available.

Wednesday, April 27**Avalon 1-3****4:00 PM****S-71: SLIDE: HYPOXIA PREDICTION AND PREVENTION****Chair: Kathryn Hughes***Dayton, OH***Chair: Jeffrey Woolford***Sykesville, MD***[384] F-22 OXYGEN SCHEDULE PANEL RECOMMENDATION****R.S. Mayes², T. Morgan¹, K. West³, B. Wright² and L. Tripp⁴**¹711th HPW/HPI, Air Force Research Laboratory, San Antonio, TX;²Aeromedical Research, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; ³Office of the Dean, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; ⁴Human Effectiveness Directorate, 711 Human Performance Wing, Wright-Patterson AFB, OH

After several unexplained physiologic incidents among F-22 pilots, the F-22 Life Support Systems (LSS) Task Force conducted a thorough investigation to determine the root cause of those events. Among the recommendations stemming from the investigation was that the F-22 System Program Office (SPO) investigate changes to the oxygen schedule of the F-22, with the goals of protecting against hypoxia as well as maximizing pilot performance. The SPO consulted experts at the 711th Human Performance Wing (711 HPW) to provide a recommended oxygen schedule. The 711 HPW conducted a comprehensive literature review to establish whether relevant gaps remained in existing research. Although the risks of both high and low levels of oxygen have been well studied, the potential benefits of higher than sea level equivalent oxygen were not well understood. The 711 HPW coordinated two studies to help close this gap; both studies looked at performance under several levels of hyperoxia at several altitudes and with exercise. The 711 HPW then convened an expert panel consisting of experts from across the Wing as well as the Air Force Life Cycle Management Center to evaluate all data and issue a recommendation. As a review of existing research, Institutional Review Board approval was not required. All available information was considered when evaluating the F-22 oxygen (O₂) schedule; this included new studies as well as decades of previous research. New research suggested no benefits to high O₂, and all available O₂ schedules were found adequate to protect against hypoxia. The panel made one minor recommendation to protect against rapid decompression and recommended further analysis. Based on recent research, the panel made a recommendation to provide additional protection against decompression sickness. Finally, the panel found that the risk of acceleration atelectasis was likely lower than existing research suggested. Based on the atelectasis and decompression sickness findings, the panel recommended no change to the O₂ schedule for the F-22. The 711 HPW presented findings and recommendations to the F-22 SPO in mid-2015. Based on the data, an LSS Working Group decided not to recommend a planned change to the F-22 O₂ schedule.

Learning Objectives:

1. Understand the physiologic factors affected by aircraft oxygen schedules.

[385] THE IDENTIFICATION OF HYPOXIA BIOMARKERS FROM EXHALED BREATH UNDER NORMOBARIC CONDITIONS**S. Harshman², B. Geier², L. Drummond⁴, J. Phillips⁴, D.K. Ott³ and C.C. Grigsby¹**¹711th Human Performance Wing, Air Force Research Laboratory, Wright-Patterson AFB, OH; ²UES, Inc., Wright-Patterson AFB, OH;³711th Human Performance Wing, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; ⁴Naval Aeromedical Research Unit - Dayton, Wright-Patterson AFB, OH

INTRODUCTION: Pilots have reported experiencing in-flight hypoxic-like symptoms since the inception of high-altitude aviation. Such

an event poses an immediate threat to the pilot, aircraft and civilians on the ground. As a result, the need to monitor pilots, in-flight, for the onset of hypoxic conditions is of great interest to the aviation community. We propose that exhaled breath is an appropriate non-invasive medium for monitoring pilot hypoxic risk through volatile organic (VOC) compound biomarkers. **METHODS:** Human volunteer subjects were affixed with a modified flight mask in line with a Reduced Oxygen Breathing Device. Subjects were exposed to simulated flight profiles of three, five-minute stages in sequential order, sea level O_2 , O_2 equivalent of altitudes up to 25,000 feet and recovery gas, 100% oxygen. Exhaled breath was collected serially, each minute, throughout the course of the experiment on to Tenax TA thermal desorption tubes using the Logistically-Enabled Sampling System-Portable. Alternatively, exhaled breath was also collected via 1L ALTEF polypropylene bags (pre, post and 2h posttest) and loaded onto Tenax TA thermal desorption tubes. All thermal desorption tubes were analyzed by TD-GC-MS using 70eV electron impact ionization. Data was analyzed for variability in VOC metabolite abundances.

RESULTS: The TD-GC-MS analysis of the time series exhaled breath samples shows seven VOCs have a decreased \log_2 abundance ratio (treated/placebo), which coincides with each subject's minimum SpO_2 . Similarly, the mean \log_2 abundance ratios of the seven compounds, across each exposure level (sea level, exposure and 100% O_2), exhibit a statistically significant decrease at altitude equivalent oxygen. Furthermore, six of the seven compounds return to sea level \log_2 abundance ratios during the 100% O_2 time points, suggesting a recovery from hypoxic stress. The TD-GC-MS analysis of the bag samples, taken immediately prior to, following and 2 hours after an experimental exposure, identified isoprene (2-methyl-1,3-butadiene) as the only compound with a \log_2 abundance ratio that increased in more severely oxygen-deprived subjects (post-pre). Additionally when the \log_2 abundance ratios were calculated for the 2h-post samples, a reversed correlation was observed.

Learning Objectives:

1. This study establishes an experimental means for monitoring changes in volatile organic compounds in response to hypoxic conditions, a computational workflow for compound analysis and identifies potential VOC biomarkers of hypoxia exposure.

[386] USE OF A NEUROLOGICAL MODEL TO PREDICT COGNITIVE DEFICIT DURING NORMOBARIC AND HYPOBARIC HYPOXIA

P.E. Whitley¹ and B.S. Shender²

¹Criterion Analysis, Inc., Miami, FL; ²Human Systems, NAVAIR, Patuxent River, MD

INTRODUCTION: Hypoxia-induced cognitive deficit onset prediction would be beneficial to military personnel operating in altitude extremes. This study used a neurological model to predict cognitive deficits exhibited by volunteers experiencing normobaric (NB) and hypobaric (HB) hypoxia. **METHODS:** NB dataset (18 trials, N=15), using a Reduced Oxygen Breathing Device with peak exposures of up to 20min at 5486m and 7620m (ASEM 84:340, 2013), consisted of forehead SpO_2 (Masimo RAD-87) and cognitive performance (SYNWIN Ver. 1.2.39) in short term memory, math, visual and auditory monitoring tasks. HB dataset (24 trials, N=12) used the same tasks and sensor, however, prior to 5486m and 7620m exposures subjects had a 20min 100% O_2 pre-breathe. All volunteers provided their informed consent. A U.S. Navy neurological model (IEEE Trans BME 45:1017, 1998) was exercised using the SpO_2 data from these exposures. The minimum active node capacity (ANC) results were compared to the averaged minimum SpO_2 at plateau and 20sec mean change in Math Task results compared to baseline at 3048m, 5486m and 7620m exposures. **RESULTS:** NB and HB minimum predicted ANC and SpO_2 results correlated on a logistic dose response basis. The NB was shifted to lower SpO_2 values compared to the HB response curve. The logistic response curve predicted greater than 90% ANC corresponding to the 3048m results where no cognitive deficit was observed. SpO_2 from 80 to 70% related to an ANC from 90 to 80%, which then started an initial sharp response decline. A sharp decrease in ANC from 80 to 20% was seen over the SpO_2 span from 71 to 65%, which corresponded to significant decline in Math performance at 5486m and 7620m. **DISCUSSION:** A four-level paradigm for cognitive state was proposed where ANC > 90 indicated functional, 90-70 indicated impairment induction, 70-50 indicated mild impairment, and

below 50 indicated severe impairment states. Some 5486m responses corresponded to impairment induction. The majority of 5486m and 7620m responses corresponded to mild impairment with one subject severely impaired. Maturation of this paradigm will continue.

Learning Objectives:

1. To understand a new methodology to predict and quantify hypoxia-induced cognitive deficit.

[387] MODELING OF ALVEOLAR OXYGEN PARTIAL PRESSURE FOLLOWING RAPID DECOMPRESSION

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¹71th HPW/HPI, Air Force Research Laboratory, San Antonio, TX;

²Human Performance, Wyle Science, Technology & Engineering Group, Brooks City-Base, TX

INTRODUCTION: During development of an Automatic Back-up Oxygen System (ABOS) for high performance aircraft, concerns emerged that an OBOGS operating at the lower end of schedule tolerance might not supply sufficiently enriched gas to support an adequate alveolar oxygen value (PA_{O_2}) after decompression. Thus we modeled oxygen concentration values at and above the OBOGS warning band to estimate what PA_{O_2} might be, and conducted a series of decompressions to verify the system's adequacy. **METHODS:** A state of the art life-support system was installed in a two-compartment decompression chamber at Brooks City-Base, TX. One compartment contained the subject and equipment normally installed in the pressurized cockpit (to include the ABOS), the other contained parts of the system normally carried in an unpressurized bay (OBOGS and control hardware). We confirmed ABOS automatic activation and post decompression function in a series of rapid decompressions to 44,000 ft (n=4), 50,000 ft (n=2) and 60,000 ft (n=2). The pressure breathing for altitude (PBA) schedule of the oxygen regulator began at 39,000 ft and increased linearly (with the ambient pressure drop) to maximum of 70mmHg at 53,000 ft, which was maintained until 60,000 ft. A mass spectrometer was used to sample respiratory gasses and inspiratory flow profiles were measured using a Fleish flow-meter. **RESULTS:** Oxygen enrichment by the OBOGS was quite high and averaged 92%. This resulted in a pre-decompression PA_{O_2} ranging from 280 to 210 mmHg, and post-decompression PA_{O_2} s averaging 80 mmHg at 44,000 ft, 76 mmHg at 50,000 ft and 60 mmHg at 60,000 ft. **DISCUSSION:** The combination of high pre-decompression oxygen enrichment (92%) and the steep PBA curve of the breathing regulator provided very favorable post-decompression PA_{O_2} values: Calculations from an unpublished memo by the late John Ernsting accurately predicted what the end-tidal PA_{O_2} would be after each decompression. They were far higher than that needed to guarantee the minimum P30, which corresponds to breathing air at 25,000 ft. Indeed, the post-decompression PA_{O_2} measured above correspond to those found breathing air at 5,000, 6,000 and 10,000 ft respectively, making the system's decompression protection far more effective than expected.

Learning Objectives:

1. Describe partial pressure changes occurring in the lung following rapid decompression.
2. Predict the pre-decompression oxygen enrichment required to avoid significant hypoxia post-decompression.
3. Relate the resulting post-decompression oxygen partial pressure to an equivalent altitude breathing air.

[388] DIFFERING OXYGEN CONCENTRATIONS AND THE EFFECT ON POST-HYPOXIA RECOVERY

L. Drummond, J.B. Phillips, S.A. Warner, M.B. VerStraten and M. Funke

Navy, NAMRU-D, Wright-Patterson AFB, OH

INTRODUCTION: Given the consistent rise in hypoxia-like in-flight emergencies and the negative effects of hypoxia on human performance, it is important to garner a cogent understanding of performance recovery following a hypoxic event. Phillips et al. (2014; 2015) reported differing oxygen concentrations following a hypoxic event afford dissimilar recovery profiles. In their initial investigation, performance deficits on a reaction time task persisted up to 4 hours when recovering on sea-level O_2 (21%). Conversely, a subsequent study found that hypoxia

related performance deficits on a similar reaction time task were rapidly mitigated following five minutes of recovery on 100% O₂. Interestingly, the largest performance deficits in the study were observed during the five minutes of recovery on 100% O₂. Thus, the goals for the present study were to examine operator performance on a tracking task during a hypoxic event and to document differences in the tracking task performance recovery profile for both O₂ concentrations (100% vs. 21%). **METHODS:** Ten participants completed a tracking task while being subjected to a 25,000ft equivalent O₂ concentration (~7%) using the Reduced O₂ Breathing Device for 5 min. Each exposure was preceded by a 5 min baseline breathing 21% O₂ and was immediately followed by a 5 min recovery period, during which either 21% or 100% oxygen was supplied. Task performance was surveyed for an additional 15 min, and then again 30 min, 1 hr, 2 hrs, 3 hrs, 4 hrs, and 24 hrs following the exposure to catalogue remaining performance deficits, all while breathing 21% O₂. **RESULTS:** A repeated measures ANOVA revealed no significant differences between the speeds at which participants recovered from hypoxic exposure, regardless of which O₂ concentration was used. **DISCUSSION:** With regard to tracking task performance, results of this study indicate that participants' recover immediately following administration of both the 100% and 21% O₂ recovery gases. Thus for tracking task performance, there was no delay in recovery and administration of 100% O₂ following exposure did not lead to increased deficits in performance as previously observed. Given the pattern of results, it is plausible to assert that disparate brain processes possess different hypoxia recovery profiles and react independently to varying concentrations of recovery gas.

Learning Objectives:

1. Hypoxia exposure does not appear to affect all cognitive processes at the same rate. The effects appear to be process specific.

Wednesday, April 27

4:00 PM

Avalon 7-9

S-72: SLIDE: AIRCREW NEUROPSYCHOLOGY

Chair: Desmond Connolly

Farnborough, Hampshire, United Kingdom

Chair: Johann Westphal

Fairfax, VA

[389] ONLINE AVIATION MEDICINE AWARENESS PACKAGE FOR MENTAL HEALTH PROFESSIONALS IN THE UK MOD

J.A. Rollo and C. Ben

AMW, RAF CAM, Henlow, United Kingdom

MOTIVATION: On 3 July 2012 two RAF Tornado fast jets collided in mid-air above the Moray Firth north of Lossiemouth, Scotland. One of the aircrew killed had been suffering from a phobic anxiety disorder and had been under the care of the Defence Community Mental Health (DCMH) team. The Service Inquiry recommended that the Surgeon General ensure "CPNs have the appropriate level of Aviation Medicine knowledge and understanding to treat aircrew." **OVERVIEW:** The Defence Consultant Advisors in Psychiatry and Av Med were directed to sponsor this work. We conducted a search of all literature on MHP training in Av Med. Internationally, in civilian aviation, there is no Av Med training for any MHPs involved in the care of aircrew outside of the AME structure. This directive was then used to produce an online training program to provide Av Med Awareness to all MHPs within Defence Primary Health Care. In order to confirm understanding and knowledge, an exam was included at the end of the training package. The pass mark was set at 60% and as the training package itself is mandatory and carries a competency. A feedback panel was included which has to be completed before a certificate of completion can be issued. We will present on the outcomes of the first year of this training package, uptake and feedback. **SIGNIFICANCE:** We believe this to be a unique training program (TP), both in the civil and military aviation medicine worlds. In light of the GermanWings disaster, we believe that the core thrust of this TP, communication, will enhance safety in the operational setting. This package has shown to improve understanding of the roles and responsibilities of MHPs in the treatment of aircrew and their understanding of the aircrew environment. We believe

that this package shows clear cross Service (it is tri-Service here in the UK) applicability but that there are also elements that could easily transfer to the civilian world.

Learning Objectives:

1. The participant will be able to understand the process required to create an online training program for aviation medicine awareness.
2. The participant will be able to understand the communication processes for Fitness to Fly in the UK MOD.

[390] RESEARCH ON AGE-RELATED CEREBRAL CORTEX STRUCTURAL CHANGES OF CHINESE AIRLINE PILOTS

Y. Cao, Y. Qi, C. Zhao, C. Qiu, Y. Zhang and S. Li

Civil Aeromedicine Center of CAAC, Beijing, China

INTRODUCTION: Generally, trends of pilot's age-related brain morphometric changes characterized by shrinkage of grey matter have been studied by our formal researches. In this project, we analyzed pilots' age-related cerebral cortex structural changes of different cortical regions, and considered with flight occupational characteristics to find out the most significant part of cerebral cortex which should be focused on future. **METHODS:** 1065 pilots with ages ranging from 35 to 64 years (mean age = 47.64±3.95 years) were included in this projects. Magnetic resonance imaging examination confirmed no brain lesions, no bleeding and infarction, no major neurological diseases. Three dimensional structural MRI scans were acquired on a 1.5T GE scanner using a T1-weighted 3D-T1 BRAVO sequence. Images were processed by FREESURFER software (version 5.1.0, based on Ubuntu12.04). After manually visual inspection and automatically calculation, we ensured 797 valid data and did the statistical analysis with R(version 3.2.2) based on 68 anatomical typical cortical parcel defined by Freesurfer's atlas. **RESULTS:** The rate of trends were different in distinguished areas. For the regional age-related changes in cortical thickness, predominant reductions were seen in the parahippocampal, isthmus cingulate, para central, and precentral. Parahippocampal, caudal middle frontal, pars opercularis, lingual, and inferior temporal showed the greatest age-related reduction in surface area. The cortical regions showing the greatest age-related volume reduction are the parahippocampal, caudal middle frontal, lingual and pars opercularis, para central. **DISCUSSION:** Though negative correlation existed between total cortical grey matter volume, total surface area, average cortical thickness and age, the rate of trends were different in distinguished areas and the rate of cortical atrophy of pilots is relatively slower than normal group. Moreover, the cortical regions showed the greatest change are different between two groups as well. For pilots the most significant reductions occurred in limbic lobe while frontal lobe for normal group. Flight occupational characteristics might be one factor in influencing cortical atrophy.

Learning Objectives:

1. Participants will learn how pilots' age-related cerebral cortex structural changes of different cortical regions are different.
2. Learn how to analyze the data of cranial nuclear magnetic resonance examination.
3. Discuss how further research would be done centered on the parahippocampal and certain cortical areas in order to find the influence on flight occupation.

[391] OCCUPATIONAL EXPOSURE TO ORGANOPHOSPHATE ESTERS AND DEPRESSION IN U.S. AIR FORCE AIRCRAFT MAINTAINERS

J. Hards¹, L.W. Whitehead², I. Han², D.K. Ott¹ and D.K. Waller²

¹USAF School of Aerospace Medicine, Wright-Patterson AFB, OH;

²University of Texas School of Public Health, Houston, TX

INTRODUCTION: Previous studies found that aircraft maintenance workers may be exposed to organophosphates in hydraulic fluid and engine oil. Studies have also illustrated a link between long-term low level organophosphate pesticide exposure and depression. We aimed to estimate exposure to organophosphate esters in U.S. Air Force aircraft maintainers and investigate the difference in depression prevalence between exposed and unexposed groups. **METHODS:** Personal air sampling for tributyl phosphate, triphenyl phosphate, and tricresyl phosphate was performed to quantify exposure for propulsion and

hydraulic workers, separated into similar exposure groups (SEGs) based on job tasks. Skin exposure was estimated using visual means for workers handling tricresyl phosphate during the air sampling period. A questionnaire was e-mailed to 52,080 aircraft maintainers (n=4,801 complete responses) to determine depression prevalence, severity, and SEG. Methods were approved by the Air Force Research Laboratory and University of Texas IRBs. **RESULTS:** No air samples were above the laboratory detection limit (0.5µg/filter), so inhalation exposures could not be calculated. Skin absorption was found to be a valid exposure route for propulsion workers. Crude prevalence of moderate or higher depression in questionnaire respondents was 6.23%. There was no significant difference between reported depression prevalence or severity between exposed and unexposed SEGs [odds ratio: 1.19; 95% CI: 0.94,1.51; p-value: 0.143]. However, dichotomous depression prevalence was associated with dichotomous self-reported exposure [odds ratio: 2.67; 95% CI: 1.25,5.72; p-value: 0.011] and with each exposure route (inhalation, ingestion, contact). Categorical depression severity was also associated with self-reported categorical exposure level when assessed using chi-squared analysis [p-value: <0.001]. **DISCUSSION:** Self-reported exposure was associated with both depression prevalence and severity. Depression risk more than doubled for workers with any perceived exposure route as compared to those unexposed by each route. An apparent dose-response relationship also exists between self-reported exposure and depression. However, causality cannot be established. Future study recommendations include estimating exposure through bioassay and investigating the relationship between self-reported vs. formal exposure measurements.

Learning Objectives:

1. Understand the sources and health effects of organophosphate ester exposure in aircraft maintenance.

[392] PSYCHOLOGICAL IMPACT OF REMOTE COMBAT OPERATIONS (RCO) IN INTELLIGENCE ANALYSTS (IA)

R. Shideler

U.S. Air Force, Beale AFB, CA

PROBLEM STATEMENT: These case reports describe the psychological nature remote combat operations has on intel analysts (IA) working stateside, in real time, supporting operations in the Middle East. **BACKGROUND/LITERATURE REVIEW:** RCO can have significant psychological impact and impairment despite being thousands of miles from the combat zone. Although the medical literature has studied Post Traumatic Stress Disorder (PTSD) rates, there are psychological impacts that do not qualify as PTSD. Furthermore, solutions center on encouraging professional interventions which are rarely sought. The psychological impact of RCOs and need for peer led interventions needs to be recognized. **CASE PRESENTATIONS:** 1) Intel Analyst (IA) was involved in routine surveillance of potential ISIS targets became delusional believing ISIS was targeting his daughter. Symptoms resolved completely with low dose SSRI and peer support. 2) IA was responsible for tracking and planning hostage rescue. Rescue forces and the hostage were killed by booby traps so IA believes he failed and deaths are result of his negligence. The guilt and sense of failure have had significant impact. 3) High value target wounded in first minutes of attack, but took over an hour to neutralize target. IA isolated himself with self-deprecating thoughts until he sought peer support. **OPERATIONAL/CLINICAL RELEVANCE:** Remote operations can cause significant, clinical impact that does not meet the current DSM-5 diagnostic criteria for PTSD. Policy promotes IAs seeking professional services for this population fearful of seeking care, despite the overwhelming preventive and therapeutic power of peer involvement. These cases illustrate the need to inoculate IAs to prevent cognitive distortions and mitigate problems through peer led support.

Learning Objectives:

1. Remote combat operations can have significant impairment despite their distance from the battlefield.
2. Remote combat Operations involved psychologic problems other than PTSD (Post Traumatic Stress Disorder).
3. Peer led support in Remote Combat Operations is effective to treating psycholocal impacts of remote combat operations.

[393] DO UK MILITARY HELICOPTER AIRCREW EXHIBIT RESILIENCE FACTORS THAT PROTECT AGAINST THE DEVELOPMENT OF OPERATIONAL STRESS?

R. Withnall¹, N. Fear² and S. Wessely²

¹Defence Professor of General Practice & Primary Care, Royal Centre for Defence Medicine, Birmingham, United Kingdom; ²King's Centre for Military Health Research, King's College, United Kingdom

INTRODUCTION: Exposure to conflict is an important risk factor for subsequent mental ill health. This study reports the first quantitative and qualitative assessment of adverse health outcomes following exposure to operational stress in UK military helicopter aircrew (UK MHA) and derives the UK military's first stress-resilience (CLEAR-LOAD) model. **METHODS:** Design. Questionnaire case-control study followed by 60 semi-structured interviews conducted in Afghanistan. Participants. 736 male UK MHA were compared with 4313 matched male non-helicopter UK military personnel. Main Outcome Measures. 1. Non-specific physical symptoms (Multiple Physical Symptoms (MPS) checklist). 2. Depressive symptoms (General Health Questionnaire (GHQ)). 3. Caseness for post-traumatic stress disorder (17-item PCL-C). 4. Alcohol use (Alcohol Use Disorders Identification Test (AUDIT)). Cut scores for caseness: MPS 18 or more; GHQ 4 or more; PCL-C 44 and 49; AUDIT 16 or more. Ethical approval by MOD Research & Ethics Committee (124/Gen/10). Statistical methods: t-tests for continuous variables; χ^2 for categorical variables; logistic regression to generate odds ratios presented with 95% confidence intervals. P-value of < 0.05 taken to indicate statistical significance. **RESULTS:** UK MHA had deployed to conflict zones more often and for longer than the comparison group, but UK MHA were about half as likely to be MPS cases (OR 0.43, 95% confidence interval 0.25-0.72), GHQ cases (OR 0.51, 0.33-0.79) or AUDIT cases (OR 0.60, 0.43-0.83). Whether a member of the UK MHA or the comparison group, an individual is about two times more likely to be a PCL-44 case (OR 2.103, 1.49-2.97) or a PCL-49 case (OR 1.924, 1.23-3.02) if they are currently single, separated or divorced compared to those in a relationship. **DISCUSSION:** No evidence was found of increased adverse health outcomes amongst UK MHA despite mandated political Leadership decisions, and heightened exposure to Operational, Administrative and Domestic stressors (LOAD). Effective Communications, good military Leadership, a supportive working Environment, effective training delivering professional Aptitude and psychological Reward (CLEAR) may have reduced the likelihood of adverse health outcomes.

Learning Objectives:

1. Learn about the UK MHA identified mandated political Leadership decisions, Operational, Administrative and Domestic factors as potential psychological stressors (LOAD).
2. Learn how Effective Communications, good military Leadership, a supportive working Environment, effective training delivering professional Aptitude, and psychological Reward helped UK MHA to develop psychological resilience (CLEAR).

[394] MULTIPARAMETRIC HIGH CONTENT ANALYSIS FOR ASSESSMENT OF NEUROTOXICITY IN PRIMARY CULTURED HIPPOCAMPAL NEURON

Y. Qi¹, X. Li² and Y. Zhou¹

¹Civil Aeromedicine Center of CAAC, Beijing, China; ²Peking University, Beijing, China

INTRODUCTION: Neurotoxicity assessment represents an important part of drug safety evaluation, as well as being a significant focus of aviation medicine to help pilots decide which medication is safe to resume flying duties. High Content Analysis (HCA) assays combine cells and detection reagents with automated imaging and powerful image analysis algorithms, allowing measurement of multiple cellular phenotypes within a single assay. This study reports the development of a robust multiparameter HCA assay for neurotoxicity screening in primary cultured hippocampal neuron. **METHODS:** Using a multiplexed detection reagent panel (nuclear stained with hoechst33342, mitotracker deep red and BOBO-3; antibodies against bIII-Tubulin, MnSOD and γ H2A.X), a multiparametric HCA assay was developed and used to characterize a test set of 10 chemicals, consisting of 7 chemicals reported to be neurotoxic and 3 chemicals considered to be non-neurotoxic. **RESULTS:** Six chemicals (Methaqualone, Doxepin, diazepam, chlorpheniramine

maleate, ephedrine and clozapine) induced cell loss, mitochondria mass changed, membrane permeability increasing, MnSOD and γ H2AX levels rising, cell shorten and round. Two chemicals (phenobarbital and amobarbital) only increased cell number or cell length. Two chemicals (aspirin and sodium valproate) had almost no effect on primary cultured hippocampal neuron. Compared with literature data, the detection accuracy of neurotoxicity is high, and the detection accuracy of general toxicity with single-parameter is lower than with multi-parameter.

DISCUSSION: This assay enables simultaneous analysis of neurotoxicity, neurite outgrowth, and neuronal morphology in primary cultured hippocampal neuron models, representing a non-subjective and high-throughput assay for drug neurotoxicity assessment, which may supply a new method for screening medications in flying.

Learning Objectives:

1. Understand how to decide which medication is safe when pilots resume their flying duties.

Wednesday, April 27

4:00 PM

Avalon 10-12

S-73: PANEL: THE 9TH ANNUAL RAM BOWL

Sponsored by American Society of Aerospace Medicine Specialists

Chair: Rebecca Blue

Syracuse, NY

Chair: Robert Johnson

Oklahoma City, OK

Chair: Allen Parmet

Kansas City, MO

Chair: Jan Stepanek

Scottsdale, AZ

PANEL OVERVIEW: The American Society of Aerospace Medicine Specialists presents the 9th Annual RAM Bowl contest for the Louis H. Bauer Trophy.

[395] THE 9TH ANNUAL RAM BOWL

J. Stepanek², R. Johnson³, R.S. Blue^{4,5}, A. Parmet¹, G.K. Anderson⁶, W.S. Silberman⁷, C. Lowry⁸ and B. Pinkston⁸

¹Viterbi School of Engineering, University of Southern California, Kansas City, MO; ²Division of Preventive, Occupational & Aerospace Medicine, Mayo Clinic, Scottsdale, AZ; ³Humana Government Business, Oklahoma City, OK; ⁴Aerospace Medicine and Vestibular Research Laboratory, Mayo Clinic, Scottsdale, AZ; ⁵Emergency Medicine, SUNY Upstate Medical University, Syracuse, NY; ⁶Defense Health Board, Washington, DC; ⁷Aviation Certification Services, Oklahoma City, OK; ⁸U.S. Air Force, Hurlburt Field, FL

The 8th Annual RAM Bowl features teams from the Air Force, Navy/Army, Mayo Clinic, Wright State and University of Texas 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. Preparation of Residents in Aerospace Medicine for the American Board of Preventive Medicine Examination.
2. Review of Aerospace Medicine for attendees seeing recertification by the American Board of Preventive Medicine.

Wednesday, April 27

4:00 PM

Avalon 15-16

S-74: PANEL: INNOVATIONS IN FLEXIBLE HYBRID ELECTRONICS FOR AEROSPACE MEDICINE

Chair: Rajesh Naik

Wright-Patterson AFB, OH

PANEL OVERVIEW: Flexible hybrid electronic materials represent a breakthrough technology with the potential to significantly impact aerospace medical applications. A new generation of soft compliant surfaces with flexible silicon-based electronics such as the "electronic skin" that can detect temperature, pressure and other stimuli have been proposed as advanced diagnostic tools, wearable sensors for human performance, sensors on surgical tools and prosthetics. This panel will highlight research activities within Air Force Research Laboratory, including the 711th Human Performance Wing, in collaboration with our national Flexible Hybrid Electronics Manufacturing Innovation Institute (FHE-MII), industrial and academic partners on developing innovative solutions and the manufacturing ecosystem to support warfighter health and performance. First, we will present the applications of flexible hybrid technologies for human performance and aerospace medicine. This will be followed by a presentation on the national flexible hybrid electronics innovation institute that is catalyzing a robust, low-cost manufacturing ecosystem for sensors for human performance and medicine. This will be followed by talks from our industrial partner on the development of technologies for clinical and human performance applications. The final talk will be by our academic collaborator on the use of flexible electronics on surgical tools and prosthetics. The panel will conclude with a question-and-answer session with a diverse group of experts.

[396] OPPORTUNITIES AND CHALLENGES FOR PERSONALIZED HUMAN PERFORMANCE SENSING

R. Naik

Air Force Research Laboratory, Wright-Patterson AFB, OH

Flexible sensors can enable long-term continuous monitoring of various physiological markers and biochemical sensing illness, neurological disorders, fitness and performance. Wearable sensors are an exciting technology space that would enable long-term continuous monitoring of various physiological markers and biochemical sensing even outside of a clinical setting. Small molecules, peptides and proteins, have been shown to be biomarkers of human performance. These small molecule targets provide information and can be collected from biological fluids such as sweat, saliva or blood, and can enable rapid and continuous personalized performance monitoring. From a wearable sensor design, biochemical sensors are complex as they require collection, ultrasensitive detection and microfluidics. In contrast to physiological wearable sensors, advancement of wearable biochemical sensors has been slow, but significant strides have been made in the last couple of years. In this presentation, we will describe some of the opportunities and challenges associated with the development of wearable sensors for detecting biochemical signatures associated with human performance.

Learning Objectives:

1. Provide a background on wearable sensors for human performance monitoring.

[397] OVERVIEW OF NEXTFLEX: AMERICA'S FLEIBLE HYBRID ELECTRONICS MANUFACTURING INSTITUTE

B. Leever

Soft Matter Materials, Air Force Research Laboratory, Wright-Patterson AFB, OH

INTRODUCTION: In 2015 the DoD announced a \$171M Cooperative Agreement to establish NextFlex, America's Flexible Hybrid Electronics Manufacturing Institute. The NextFlex mission is to catalyze a domestic FHE manufacturing ecosystem, with a focus in human performance monitoring/wearable medical devices, asset monitoring, situational awareness, and soft robotics. **METHODS:** NextFlex brings together resources from government, companies, universities, and non-profit entities to enable state of the art manufacturing technology for areas critical to both the military and commercial sectors. With a TRL/MRL entry point of 4, NextFlex leverages R&D investment at federal labs, universities, and companies by maturing select technologies to TRL/MRL 7. NextFlex also includes an education and workforce development initiative and is standing-up a hub facility in San Jose, CA, which will provide access to state-of-the-art FHE manufacturing and characterization facilities as well as the opportunity for prototyping or low-volume manufacturing services. **RESULTS:** The first NextFlex projects are expected to be awarded in Feb 2016 and will be discussed during the panel. Approx. \$5M will address manufacturing challenges related to sensors for human performance and vehicle health monitoring as well as bandages that accelerate wound healing. An update will also be provided on the Institute's Education & Workforce Development Initiative and on the status of the San Jose hub. Finally, the NextFlex roadmap process will be discussed, with a description of how NextFlex's investment strategy is determined, including upcoming project calls. **DISCUSSION:** NextFlex will facilitate a domestic manufacturing ecosystem in FHE that will enable critical manufacturing processes for affordable aerospace medicine and airman performance monitoring platforms. By bringing together government, industry, and academia in a public-private partnership, the Institute will establish a sustainable framework for advancing FHE manufacturing technology for both DoD and commercial applications.

Learning Objectives:

1. Understand the NextFlex mission and its role in addressing manufacturing challenges for airman performance monitoring and aeromedicine devices.

[398] MANUFACTURING OF WEARABLE SENSORS FOR HUMAN HEALTH AND PERFORMANCE MONITORING

S.M. Miller¹, A. Alizadeh¹, J.M. Ashe¹, A. Burns¹, N. Nagraj¹, R. Lenigk¹, Y. Lee¹, M. Misner¹, M. Yin¹, J. Brewer¹, D. Diamond², L. Florea², J. Watkins³ and J. Morse³

¹Global Research, General Electric, Niskayuna, NY; ²Department of Chemical Sciences, Dublin City University, Glasnevin, Ireland;

³Department of Polymer Science and Engineering, University of Massachusetts Amherst, Amherst, MA

INTRODUCTION: Continuous monitoring of physiological and biological parameters is expected to improve performance and medical outcomes by assessing overall health status and alerting for life-saving interventions. Low cost wearable devices with an appropriate form factor (lightweight, comfortable, low energy consuming and even single-use) are required for continuous monitoring. As part of a U.S. Army funded effort and two on-going NBMC-AFRL programs, we have developed technologies that enable low-cost wearable physiological monitoring systems, including multi-wavelength arrayed photoplethysmograph (PPG) and hydration sensors. **METHODS:** We are developing hydration monitoring technology using miniaturized, wearable electrical impedance and resonance radio-frequency (RF) sweat biochemical sensors for continuous and non-invasive measurements of fluid and electrolyte contents. We are also addressing manufacturability of novel wearable devices, such as the PPG sensors using self-assembly based approaches for large scale hybrid integration of semiconductor devices on flexible substrates. **RESULTS:** Microfluidics and RF sensor components have been integrated to develop a flexible sweat sensing device, demonstrating bulk sweat conductivity measurements and selective sodium ion detection capabilities. Magnetically directed self-assembly for heterogeneous attachment of diced semiconductor chiplets on a plastic substrate with printed interconnects has been demonstrated, as well as assessment of the manufacturing scalability. **DISCUSSION:** Wearable devices can bring a wide range of benefits. Continuous multi-wavelength PPG sensors can provide new insight about the state of wounded warfighters by non-invasive measurements of hemodynamics. Self-assembly based hybrid integration techniques provide a pathway for low cost large scale manufacturing of

single use wearable devices. Accurate assessment and management of hydration are significantly important in both military (e.g. safety, physical and cognitive performance augmentation of military personnel) and civilian (e.g., chronic patient monitoring and care as well as safety and performance enhancement of workers and athletes) sectors.

Learning Objectives:

1. Describe emerging wearable device and device manufacturing technologies to non-invasively assess human health and performance state.

[399] NEW MICRO/MESO-SCALE MANUFACTURING METHODS FOR COMPLIANT AND DEXTEROUS ENDOSCOPIC TOOLS

R. Wood

SEAS, Harvard University, Cambridge, MA

INTRODUCTION: Small complex robots — and articulated, sensor-embedded microsurgical tools in particular — present challenges for successful development and operation. These include basic questions of manufacturing, actuation, sensing, power, and control — questions that have in general been answered for larger robots. **METHODS:** All components of new robotic end-effectors for minimally invasive surgery must be developed from scratch as there is nothing off-the-shelf which can be used for mechanisms, sensors, or computation that would satisfy the extreme size constraints. Many existing microsurgical tools push the limits of conventional machining techniques to produce articulation based on discrete hinges or telescopic continuum mechanisms, and most are typically actuated proximally with pull cables or cannula rotations. We seek to expand beyond these devices and incorporate distal actuation, compliant devices for gentle tissue interaction, and haptic and proprioceptive feedback for the surgeon. **RESULTS:** With these goals in mind, this talk will present progress in the essential process technologies for the manufacture of millimeter-scale articulated and compliant endoscopic tools. These processes are inherently 2D in nature and create complex 3D structures and mechanisms through popup book-like folding.

DISCUSSION: This provides a method for automated assembly and deployability of the final devices. The talk will conclude with demonstrations of proof-of-concept microsurgical tools and discussions on relevant applications.

Learning Objectives:

1. Gain exposure to new approaches to developing medical devices through the use of novel multi-scale, multi-material manufacturing technologies.

Wednesday, April 27

4:00 PM

Avalon 17

S-75: PANEL: CLINICAL CASE PRESENTATIONS: HOW TO DECIDE ACCORDING TO THE GUIDELINES? (GERMAN LANGUAGE)

Sponsored by German Society of Aviation and Space Medicine (DGLRM)

Chair: Jörg Siedenburg

Utersen, Germany

Chair: Claudia Stern

Cologne, Germany

PANEL OVERVIEW: This panel is presented by the German Society of Aviation and Space Medicine (DGLRM). It is presented in German language with slides in English language. Speakers present different clinical cases which are discussed with the audience. The cases are discussed according to present standards and guidelines.

[400] ATRIAL FIBRILLATION – A CHALLENGE - THERAPEUTIC OPTIONS AND SPECIAL ISSUANCE – FOCUSING ON RHYTHM CONTROL AND STROKE PREVENTION

F.H. Hauer^{1,2}

¹Flugmedizin Oberkassel, Duesseldorf, Germany; ²AeMC Cologne (Aeromedical Center), Koeln, Germany

INTRODUCTION: Atrial fibrillation (AF) is the most common sustained cardiac arrhythmia occurring in 1-2% of the general population. Over 6 million Europeans suffer from AF, and its prevalence is estimated to increase by at least 2.5-fold in the next 50 years. The aeromedical requirements for special issuances of pilots with AF are published in the European regulation (EU) 1178/2011 and the AMC and GM to Part-MED, both laying down technical requirements and administrative procedures. I will demonstrate the requirements of EASA and the international guidelines regarding the management of AF.

METHODS: By giving a case report of a federal police helicopter single-pilot, I will demonstrate the therapeutic options and possible ways in obtaining a special issuance in this peculiar case. **RESULTS:** The first diagnosed episode of asymptomatic paroxysmal AF occurred in April 2015. Since flying as a single pilot an OML restriction cannot be applied, so a curative approach is postulated. In this case catheter ablation was performed to establish an adequate rhythm control, i.e. absence of AF. Documenting the lack of AF by means of an implanted reveal-recorder an unrestricted class 1 medical can be granted and no further stroke prevention therapy is necessary (VKA, NOAC). **DISCUSSION:** The prevalence of AF is very high. AF has frequent and severe consequences in affected patients. Our goal must be achieving a stable sinus rhythm and avoiding stroke. In AF patients the risk of mortality and disability as well as recurrent stroke is higher than with other strokes. Using the available options of modern stroke prevention therapy and different methods to achieve a stable sinus rhythm via catheter ablation (RFA or CRYO) are discussed. Learning to apply this sophisticated methods we will have the chance to help some of our affected pilots.

Learning Objectives:

1. Knowing the EASA requirements in pilots with AF.
2. Understand to advise your pilots properly in case of new onset of AF.
3. Learning about the different kinds of modern stroke prevention therapy regarding the actual requirements.

[401] CARDIAC ARREST IN AN ATHLETIC PILOT OF 39 YEARS

J. Siedenbueg

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An experienced co-pilot, age 39 years is physically perfectly fit. He performs until 350 W in the stress test with no abnormalities. The medical history is normal except DLP, treated with simvastatin, rare palpitations and episodes of back pain. However, he suffers from sudden cardiac arrest on the street. Other pedestrians start BCLS, followed by ACLS by emergency medicine providers. The monitor shows fast VT, after defibrillation ventricular fibrillation. Spontaneous circulation can be restored with amiodarone. In the ICU the ECG shows an MI of the posterior wall, the coronary angio shows a 2-vessel disease with high grade stenoses in LAD and D1 and several stenoses and a total stenosis of the RCA, all of which are treated with PCI and DES. After 2 days of artificial ventilation and therapeutic hypothermia he can leave the ICU with stable circulation. The echo shows slightly reduced LV function, slight posterior wall aneurysm, small posterior wall hypokinesis and slight dilatation of the left atrium, the TEE PFO and Eustachian valve. A newly diagnosed hypertension is treated by Metoprolol and Ramipril, the DLP medication is changed to Atorvastatin after an elevated lipoprotein was demonstrated, the DES require ASS and Ticagrelor. After the event his brother is diagnosed with a 3-vessel disease. After rehabilitation he can resume physical exercises up to 225 W and applies for a waiver after 6 months. However, the stress echo demonstrates an ischemia in the area supplied by the RCA, the angio CTO (chronic total occlusion) of an RCA stent near the ostium. A PCI is not successful. A month later another specialist is successful with another attempt. Despite the treatment for the DLP the Lp (a) is still elevated. After another 6 month the patient has no complaints and applies for a waiver again. The next angio demonstrates open stents. However, there are CTO and a 90 % stenosis of the RCX. All participating cardiologist agree not to continue by invasive procedures, but to continue with conservative medical treatment. Envisaging the progressive character of the CAD, aggravated by the risk factors DLP and hypertension the patient is not willing to force another waiver.

Learning Objectives:

1. The case study shows the progressive nature of CAD, particularly if aggravated by cardiovascular risk factors.
2. Persons appearing physically fit may hide severe disorders, every applicant requires meticulous history, physical, mental and technical examinations and assessments.
3. The European waiver procedures are demonstrated in general and in particular.

[402] MANUAL MEDICINE AND DIAGNOSTICS IN AVIATION AND SPACE MEDICINE: THE HEAD JOINTS IN FOCUS

L. Reichert^{1,2}

¹Branch II 3 Aeromedical Evaluation Center Section II 3 e Orthopedics, Anthropometry and Sports Science, German Airforce Center for Aerospace Medicine, Fuerstenfeldbruck, Germany; ²Military Medical Society for Chirotherapy and Osteopathy (Wehrmedizinische Gesellschaft für Chirotherapie und Osteopathie WGCO e.V.), Munich, Germany

PROBLEM STATEMENT: Functional segmental dysfunctions of the so called (atlanto-occipital and atlanto-axial) head and neck joints have in the course of aeromedical and occupational-medical complaints a considerable importance in differential diagnostics. Not only the vertebrogenic vertigo or dizziness, but also other generally ENT and neurology related symptoms are occasionally vertebrogenically triggered or caused. **TOPIC:** Possibly vertebrogenically triggered complaints of aeromedical significance and easily learned manual medical and osteopathic diagnostic and atraumatic therapeutic techniques, which can be used in everyday aeromedical assessment, are presented. Manual medical diagnostic tools are used in everyday assessment in the section Orthopedics and Anthropometry of the German Air Force Center for Aerospace Medicine. An evaluation in course of quality management shows positive cervical manual diagnostic findings in 52% of the probands (all active military pilots of the German air force, army and navy), especially of the head neck joints (32%). **APPLICATIONS:** Functional segmental dysfunctions of the atlanto-occipital and atlanto-axial head and neck joints are frequently seen findings in everyday aeromedical assessment. Aeromedical relevant complaints and diseases can be associated, triggered or caused by these dysfunctions and atraumatic manual therapeutic or osteopathic techniques can be used in differential diagnostics and therapy of frequently as idiopathic or psychogenic interpreted complaints. From the point of view of a manual physician and orthopedic surgeon, aeromedical experts and consultants should have knowledge in manual medical diagnostics and therapy. **RESOURCES:** Hülse M et al, Die obere Halswirbelsäule, Springer 2005, ISBN 9783540282501.

Learning Objectives:

1. The participant will be able to understand the importance of manual medical diagnostics and therapy in the course of aeromedical assessment. Further he will learn about generally ENT and neurology related symptoms and diseases, which are occasionally vertebrogenically triggered or caused.
2. The participant will be able to understand the manual medical examination method of segmental functional diagnostics, especially with the so called irritation and insertion points of the head neck joints and cervical spine.
3. The participant will be able to understand the manual medical therapy method of modified strain counterstrain technique, especially with the so called irritation and insertion points of the head neck joints and cervical spine, and their value in aeromedical assessment.

[403] PROBLEM STATEMENT: INTENSIVE CARE TREATMENT OF POLYTRAUMATIC PATIENT TRANSPORTED WITH A PRESSURIZED TWO-ENGINE AIRCRAFT: A CASE REPORT

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BACKGROUND/LITERATURE REVIEW: An intensive care patient after a poly-traumatic incident, that is transported by a pressurized aircraft, accompanied by a medical doctor and/or a medical assistant,

need incipient clinical and psychological attention of at least two medical crew members with appropriate skill and management levels in order to pursue a safe transportation via airway to the final rehabilitation facility.

CASE PRESENTATION: The patient was a 54-yr old polish pedestrian, who was polytraumatized by an accident with a metro "Strassenbahn" in an urbanized city in North-Rhine Westfalia in April 2015. The initial Glasgow Coma Scale (GCS) was supposed by 3/15 after seen by an emergency doctor before he was transported to an university clinic nearby, whereas the following diagnoses were stated: severe subdural hematoma, severe concussion, basilar skull fracture, multiple central mid-facial fractures including orbital blowout fractures, severe thoracic trauma with lung contusions, right-sided hemato-pneumothorax, serial rib fractures, contusion of the liver and other fractures of the hip and lower limb. The patient was treated with surgical intervention for several weeks and observed under intensive care conditions until his dismissal in a rehabilitation facility to Poland with a GCS of 9/15. **OPERATIONAL/CLINICAL RELEVANCE:** This case highlights the success of patient transportation in a modern pressurized aircraft, where intensive care treatment is needed, but also shows the potential harm that may occur. Although the patient was supplied with a dilative tracheostoma and a bladder catheter, he was in a persistent vegetative state and hemodynamic stable condition. This circumstance required immediate and consecutive attention, for e.g. using regular oral and nasal suctioning devices and procedures every 10 to 30 minutes in order to keep the upper respiration tract clear of mucus, to reduce dyspnea on exertion with consecutive fatigue and finally asphyxia or suffocation. Regular measurements of blood pressure, heart rates, and peripheral oxygen saturation were also part of the handling, allowing the patient to feel relieved and safe under extreme environmental conditions.

Learning Objectives:

1. Learn about the special medical skills required to address critical circumstances during a transportation of a patient in a persistent vegetative state under extreme environmental conditions.
2. Learn about the special management skills required to handle difficult situations for, e.g., negotiating transportation conditions between the patient, social advisor, aviation broker, medical doctors involved, fire department, and international customs services, in order to perform a safe flight.

[404] IMPLICATIONS OF IONIZING RADIATION ON FLIGHT CREWS - AN UPDATE ON THE GERMAN MORTALITY-STUDY

C. Felten², J.F. Hedtmann¹, G. Hammer¹, H. Zeeb³ and M. Blettner³

¹OSH Division, BG Verkehr, Hamburg, Germany; ²BG-Verkehr, Hamburg, Germany; ³Universität Mainz, Mainz, Germany;

⁴Laboratoire National, Dudelange, Luxembourg

INTRODUCTION: Aircrew Members are exposed to cosmic radiation as an occupational factor, potentially leading to increased cancer mortality. In a previous analysis of a large cohort of German aircrew, no increase in cancer mortality or dose-related effects were observed. With a follow-up the cohort of 6.017 cockpit and 20.757 cabin crew members was extended by 7 years to 2004. **METHODS:** The cohort includes all cockpit and cabin crew flying in the period 1960-2004. The individual radiation exposure was estimated using a job-exposure matrix. The mortality of the cohort was compared to German general population rates by standardized mortality ratios (SMR). The mortality of groups with different cumulative effective dose within the cohort were compared using mortality rate ratios (RR) by categories of time-dependent cumulative effective dose. **RESULTS:** With 931 deaths the total mortality is significantly lower than in general population. The SMR for the causes of death by cancer is lowered among Pilots (95% CI 0,49-0,79) and among flight attendants is nearby 1 in the normal range. Typical tumors caused by radiation or tobacco consumption associated tumors are decreased or occur in normal abundance. Special emphasis is placed on the results for the malignant skin melanoma with SMR of 1,27 (0,32-3,72), for the CNS with a SMR of 2,04 (0,99-3,79; 14 cases from the cockpit cohort), the SMR of 1,08 (0,69-1,65) for breast cancer from cabin cohort and a SMR of 3,93 (1,17-9,97) for the Non-Hodgkin-Lymphomas. **DISCUSSION:** The mortality from cancer is reduced with few exceptions, notably malignant skin melanoma which is slightly but not significantly increased. The increased mortality by brain cancer has to be proven. The mortality from NHL in male cockpit crew has to be interpreted in the context with the

increased mortality from AIDS. This study shows only a slightly increased risk for cancers of the central nervous system (CNS), which has been observed in other studies. There could be limited evidence that ionizing radiation is a risk factor for malignant melanoma, while the risk factor with the highest attributable fraction is ultraviolet (UV) radiation.

Learning Objectives:

1. The overall mortality in male cockpit and female cabin crew is remarkably reduced compared to the general population; the mortality from cancer is reduced with few exceptions for ex. malignant skin melanoma of cockpit crew.
2. The mortality from female breast cancer, leukaemia and brain cancer is similar to that of the general population.
3. Aircraft crews are exposed to cosmic radiation. The average effective radiation excess doses are nearby 2.1 mSv annually. As a maximum 80 -100 mSv occupational radiation dose has been reached There could be less evidence that cosmic ionising radiation is the only risk factor for malignant melanoma, while the risk factor with the highest attributable fraction is ultraviolet (UV) radiation.

Wednesday, April 27

4:00 PM

Avalon 6

S-76: PANEL: HUMAN PERFORMANCE OPTIMIZATION THROUGH AEROSPACE AND OPERATIONAL PHYSIOLOGICAL ENHANCEMENT

Sponsored by Aerospace Physiology Society and Aerospace Human Factors Association

Chair: Shawnee Williams

RAF Lakenheath, United Kingdom

PANEL OVERVIEW: This panel will present results from five United States Air Force School of Aerospace Medicine and Air Force Research Laboratory studies addressing physiological variations to sustain performance in a high-G environment, a trust based analysis of the Air Force Automatic Ground Collision Avoidance System (AGCAS), the effects of adding cognitive training to a functional agility regimen, an alternative training plan to reduce musculoskeletal injuries and a cooling mechanism to mitigate the physiological stressors caused by heat stress. The presentations will take us from the air to the ground with regard to mitigating threats to human performance for special operators. The first presentation describes alternative methods for employing the Anti-G Straining Maneuver and ultimately managing sustained G-forces. The second presentation examined the F-16 pilots' trust to the AGCAS and its ability to mitigate Controlled Flight Into Terrain. The third presentation will explore the efficacy of including an explicit cognitive training battery to a military PT regime to enhance performance in the battlefield. The fourth presentation describes alternative musculoskeletal training, via kettlebell use, to maintain cardiovascular fitness and minimize impact forces on operators with lower extremity issues. The final presentation addresses the effects of a novel cooling mechanism to reduce the physiological stressors caused by prolonged work in hot, humid environments to reduce heat stress related injuries for special operators. These studies will provide the audience with actionable concepts they can take to their warfighter to enhance human performance in austere/high-G environments as well as methodologies to sustain optimal physical fitness/performance. Mission performance is maximized through education, training, and enhanced crew survivability. These elements are integrated with our translational research which includes physiological and environmental components.

[405] VARIABILITY OF THE ANTI-G STRAINING MANEUVER WITH FULL COVERAGE MECHANICAL INTERVENTION

M. Clayton Gallo^{3,1}, T. Morgan², T. Dart³, J. Beer³, R. O'Connor³ and J. Fischer³

¹USAF School of Aerospace Medicine, Wright-Patterson AFB, OH;

²711 HPW, Wright-Patterson AFB, OH; ³Wyle Science, Technology & Engineering, Brooks City-Base, TX

INTRODUCTION: A maximum effort anti-G straining maneuver (L-1AGSM), developed for use with a conventional 5-bladder G-suit, may

waste metabolic effort when used with a modern full coverage G-suit and pressure breathing for G. Thus, we compared G-protection and energy expenditure of a modified reduced effort AGSM versus a standard L-1AGSM while wearing the newer equipment. The application aligns with the panel theme Performance Optimization through Aerospace and Operational Physiological Enhancement. **METHODS:** Ten subjects completed two centrifuge exposures consisting of 5G, 7G, and 5to9G profiles while performing a standard or modified AGSM on separate days, counterbalanced as to which AGSM was first. Light loss and perceived effort were recorded after each profile; oxygen consumption, heart rate, and blood lactate were measured before and after each exposure.

RESULTS: Straining effort reported during the modified AGSM was significantly (p -values .001-.01) less than with the standard AGSM, but there were no differences in light loss. The modified AGSM reported a significantly ($p=.02$) lower heart rate during the 5G profile, falling from 131 to 121. No significant differences in heart rate were seen for the other profiles or 2-min recovery between each exposure. Blood lactate levels for the modified AGSM were significantly lower than the standard AGSM lactate levels (p -values .002-.04) at all post-centrifuge time points. There were no significant differences in recovery oxygen consumption between the two AGSM techniques. **DISCUSSION:** The blood lactate and oxygen consumption data collected from this study add to the understanding that the AGSM is a highly anaerobic exercise. Our physiological measurements, and the fact that all subjects were able to complete the assigned centrifuge profiles without visual or cognitive impairment, suggest that the modified AGSM could be used in an operational setting to reduce exertional fatigue without jeopardizing safety in the high-G environment. The outcomes of this research effort demonstrate that the principle of consciously titrating physical effort during an AGSM can be safely taught when training aircrew in the use of full coverage G-suit and pressure breathing for G.

Learning Objectives:

1. The outcomes of this research effort demonstrate that the principle of consciously titrating physical effort during an anti-G straining maneuver (AGSM) can be safely taught when training high-G aircrew in the use of a full coverage G-suit and pressure breathing for G.

[406] A TRUST-BASED ANALYSIS OF THE AIR FORCE AUTOMATIC GROUND COLLISION AVOIDANCE SYSTEM

J. Lyons¹, W. Fergusson¹, N. Ho², G. Sadler³, S. Cals⁴, C. Richardson⁴ and M. Wilkins⁵

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²California State University, Northridge, Northridge, CA; ³NASA Ames, Mountainview, CA; ⁴416 Flight Test Center, Edwards AFB, CA; ⁵SOSD, Washington, DC

INTRODUCTION: This research examined pilot trust (i.e., one's willingness to be vulnerable) to the Air Force recently-fielded Automatic Ground Collision Avoidance System (AGCAS). The AGCAS system was fielded on the F-16 platform as a method to mitigate Controlled Flight Into Terrain (CFIT) due to spatial disorientation or gravity-induced loss of consciousness. The AGCAS technology operates based on a time-based algorithm that triggered an automated maneuver when a collision with the ground is detected, thus it represents a complex form of automation. Research on trust in automation is typically lab-based with little actual evaluation of automated systems in the field. The AGCAS implementation offered a valuable opportunity to study the process of trust development among real operators, with a real form automation, that has high personal relevance given the high stakes involved in its execution. **METHOD:** Interviews were conducted with operational F-16 pilots ($N = 180$) at 10 different Air Force or Air National Guard bases. The interview focused on the following issues in relation to AGCAS: initial trust level, antecedents to trust, change in trust, performance perceptions, perceptions of the business case for why the system was developed, perceived reputation, awareness of positive/negative stories, and information related to AGCAS activations. **RESULTS:** The primary trust enablers identified included: evidence of good performance in operational environments, nuisance-free performance, strong business case, transparency in the form of HUD indicators, pedigree of the test community, and the attribution of early system errors on hardware limitations versus software. The primary trust detractors involved: the occurrence of nuisance activations, non-intuitive error displays, data

limitations for system sensing capabilities, and lack of overall system knowledge/understanding. **DISCUSSION:** The current study identified the antecedents of trust and distrust of the AGCAS among operational pilots in the Air Force. The set of factors has a strong link to theories of trust in automation which adds value to the field given the applied and relevant nature of this automated technology.

Learning Objectives:

1. The learner will take away an understanding of what trust is, why it is important in the context of the Air Force, and what some of the drivers of trust are for the AGCAS system.

[407] FUNCTIONAL ADAPTIVE TRAINING PLUS EXPLICIT COGNITIVE TRAINING

E. Eveland

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INTRODUCTION: Our research investigates combined physical and cognitive training to prepare Airmen for the battlefield and mitigate injuries. A recent study asked if addition of explicit working memory and decision-making training to a functional agility regimen (F+C) would enhance active duty Airman performance on the cognitive portion of a simulated battlefield obstacle course compared to traditional Air Force physical training (AFPT). **METHODS:** A total of 40 active duty Airmen (19 – 40 y) participated in the study, and completed all tests (training, $n=27$, controls, $n=13$). Training group participants underwent 8 weeks of agility-based physical training. Exercises were done in a circuit manner. Different exercise combinations were presented twice weekly. Agility, balance, and strength components were included. Explicit working memory or decision-making training was included in every exercise set. The control group did their normal Air Force PT and reported their training activities weekly. Both groups were evaluated with a standard battery of 35 physiological, anthropometric, and cognitive tests pre- and post-training. Post 8 weeks of training or traditional PT, the pilot obstacle course was completed. This protocol was approved by the AFRL Institutional Review Board. **RESULTS:** Both groups were similar on key physiological variables before and after training, replicating past experiments showing both standard military and alternative training types produce similar results in the physiological domain. Performance in the battlefield obstacle course showed both groups performed similarly on the physiological components, but the F+C group significantly outperformed AFPT participants on unpracticed cognitive tasks at exhaustion: M4 rifle assembly, and recall of a battlefield map of installations and troop locations. **DISCUSSION:** These results suggest military PT which includes explicit cognitive training may better prepare warfighters to meet unpredictable battlefield cognitive demands, even when physically exhausted. Further studies asking if traditional military PT combined with explicit cognitive training would produce the same results are warranted. Validation of the pilot obstacle course should be undertaken.

Learning Objectives:

1. Learn whether explicit working memory and decision-making training enhance active duty Airman performance on the cognitive portion of a simulated battlefield obstacle course.
2. Learn whether modified military PT can improve performance for actual unpredictable battlefield scenarios.
3. Learn whether a member needs high performance in agility, balance, and strength components to benefit from the cognitive/working memory training.

[408] PHYSIOLOGIC RESPONSES TO 10 WEEKS OF KETTLEBELL SWING TRAINING IN UNITED STATES AIR FORCE PERSONNEL

M. Wade², R. O'Hara², D. Bryant², J. Ordway¹ and L. Caldwell²

¹FHC, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; ²Aeromedical Research, Wright-Patterson AFB, OH

INTRODUCTION: Optimal physical performance of military operators during periods of high operational tempo may be difficult to maintain due to time constraints, limited exercise facilities, and excessive amounts of high-impact activities such as running and heavy load carriage. The purpose of this study was to compare the physiological responses of 10 weeks of one-arm continuous kettlebell (KB) swing training to traditional United States Air Force (USAF) physical training

(PT) according to Air Force Instruction 36-2905. **METHODS:** Twenty trained male (n=10) and female (n=10) USAF subjects volunteered and were selectively assigned to one of three groups: (1) KB swing training, (2) KB swing training plus high-intensity running, and (3) traditional USAF PT. The following measurements were made before and after 10 weeks of training: 1.5-mile run, 1-minute maximal push-ups, 1-minute maximal sit-ups, vertical jump, 40-yard dash, and percent body fat (%BF). Subjects attended 3 supervised exercise sessions per week for 10 weeks. During each session, all groups performed a 10-minute dynamic warmup followed by either (1) 10 minutes of continuous KB swings, (2) 10 minutes of continuous KB swings plus 10 minutes of high-intensity running, or (3) 20 minutes of moderate-intensity running plus push-ups and sit-ups. Paired t-tests were conducted to detect changes from pre- to post-testing within each group and analysis of variance was used to compare between-group variability ($p \leq 0.05$). **RESULTS:** There were no statistically significant changes in 1.5-mile run time between or within groups. The 40-yard dash significantly improved within the KB swing group ($p=0.006$) and KB plus run group ($p=0.003$); however, there were no significant changes in the traditional PT group ($p=0.081$) or between groups. All groups significantly increased 1-minute maximal pushups. **DISCUSSION:** This study provides evidence that continuous KB swing training may be used by military operators as a high-intensity, low-impact alternative to traditional USAF PT to maintain aerobic fitness, improve speed, and improve maximal pushups in periods of high operational tempo.

Learning Objectives:

1. The audience will learn how to implement novel physical training techniques.

[409] EFFECTS OF A NEW COOLING TECHNOLOGY ON PHYSICAL PERFORMANCE IN U.S. AIR FORCE MILITARY PERSONNEL

R. O'Hara

Aeromedical Research, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH

INTRODUCTION: Heat stress is a viable concern for Air Force Special Forces Operators (SOF) as it severely limits the ability of SOF personnel to adequately sustain and satisfactorily complete specified duties required during sustained operations (SUSOPS) missions, thus affecting human performance optimization. The purpose of this investigation was to determine the effects of a novel cooling shirt on core body temperature in highly trained U.S. Air Force personnel. **METHODS:** Twelve trained ($\geq 80^{\text{th}}$ percentile for aerobic fitness according to the American College of Sports Medicine, $\geq 90\%$ on the U.S. Air Force fitness test), male Air Force participants (mean age 25 ± 2.8 years; height 178 ± 7.9 cm; body weight 78 ± 9.6 kg; maximal oxygen uptake $57 \text{ mL/kg/min} \pm 1.9$; and body fat $10 \pm 0.03\%$) completed this study. Subjects performed a 70-minute weighted treadmill walking test and 10-minute, 22.7-kg sandbag shuttle test under two conditions: (1) "loaded" (shirt with cooling inserts) and (2) "unloaded" (shirt with no cooling inserts). Order of conditions was counterbalanced with a 72-hour recovery period between trials. Core body temperature, exercise heart rate, capillary blood lactate, and ratings of perceived exertion were recorded. **RESULTS:** Core body temperature was lower ($p=0.001$) during the 70-minute treadmill walking test in the loaded condition. Peak core temperature during the 70-minute walking test was also significantly lower ($p=0.038$) in the loaded condition. No other statistically significant differences were observed for ratings of perceived exertion or blood lactate in either the treadmill or 10-minute sandbag shuttle tests. **DISCUSSION:** Traditional cooling technologies are limited by the need for a power supply, the added weight of the product, and the cooling duration. This lightweight (471 grams) passive cooling technology offers multiple hours of sustained cooling, reduced core and peak body temperature during a 70-minute, 22.7-kg weighted vest walking test, which will enhance overall human performance for SOF personnel.

Learning Objectives:

1. Learn whether traditional cooling technologies are sufficient for use in current operating environments.
2. Learn what the limitations to the current cooling mechanisms are.
3. Learn what are the effects of the lightweight cooling technology are.

THURSDAY, APRIL 28, 2016

Thursday, April 28

8:00 AM

Avalon 1-3

51ST ANNUAL HARRY G. ARMSTRONG LECTURE

Arnaud Desjardin

"BEA's Safety Investigation into the German Wings Accident - Findings and Lessons Learned"

Learning Objectives:

1. Enrich aviation medical doctors' best practices with the lessons learned from safety investigations.
2. Increase awareness of aviation medical doctors about the impact of the psychiatric risk on flight safety.
3. Show the safety benefits of provisions allowing and controlling the use of anti-depressant medication for pilots.

Thursday, April 28

10:00 AM

Avalon 1-3

S-77: SLIDE: AEROSPACE MEDICINE: THEN, NOW, AND THE FUTURE

Chair: Leon Hrebien

Philadelphia, PA

Chair: Theron Toole

FPO, AP

[410] ONE OF THE GREATEST FLIGHT SURGEON STORIES, 1ST LIEUTENANT THOMAS R. WHITE M.D., FLIGHT SURGEON FOR THE DOOLITTLE TOKYO RAID

A.C. Marchiando

Free Agent, Poquoson, VA

INTRODUCTION: On April 18, 1942, just 4 months after Pearl Harbor, the United States bombed Japan with 16 U.S. Army Air Corps B-25 bombers launched off the U.S. Navy carrier Hornet, led by aviation pioneer, Lt. Col. James "Jimmy" Doolittle. The flight surgeon who volunteered for the top secret raid was 1st Lt. Thomas White M.D. Harvard 1937, post graduate training Johns Hopkins. His position on the five-man crew was as a fully trained gunner, as there was no extra room for a doctor. On plane #15, they bombed military installations in Kobe, Japan. Running low on fuel, they had to ditch in the sea off a Japanese occupied island in China. The crew got out unharmed and hidden by a friendly Chinese family and linked them with Chinese guerillas who kept them one step ahead of Japanese troops looking for them. On day six they met up at a poorly supplied, primitive Chinese hospital with the crew of plane #7, four of whom were badly injured ditching their plane. The pilot, Ted Lawson, author of the book *Thirty Seconds Over Tokyo*, was injured the worst. Dr. White, suffering from malaria and with Japanese in the area, stayed behind to care for his patients. Lawson's badly infected and gangrenous leg was eventually amputated by Dr. White using spinal anesthesia and an 1890's surgery set. Dr. White even twice transfused Lawson with his own Type O blood! Lawson improved after surgery and made a slow recovery. Two weeks after surgery and with Japanese troops closing in, Dr. White and his four patients moved ten days in hand-carried sedan chairs and vehicles to get an airfield and were flown to Kunming, then to India. In New Delhi, Dr. White talked their way onto a TWA Boeing Stratoliner for a six day trip to the USA. They flew into Bolling Field, Washington, DC, and sent the patients to Walter Reed Army Hospital. Dr. White met privately with the Air Surgeon, Maj Gen David Grant. White and the other Raiders were presented the Distinguished Flying Cross by Gen Hap Arnold. Lt. White was awarded the Silver Star for his bravery caring for his patients. He remained on duty during WWII, left the service, and practiced in Hawaii and California, until his death in 1992.

Learning Objectives:

1. Learn about 1st Lieutenant Thomas R. White M.D., a flight surgeon in WWII on the Doolittle Tokyo Raid.