**Learning Objectives:**
1. This lecture will acquaint the attendees with Aeromedical evacuation as it was accomplished during the 14 years of conflict in Iraq and Afghanistan (2001-2015).
2. The presentation will provide an overview of the key lifesaving advances in Aeromedical Evacuation during the conflicts in Iraq and Afghanistan.

***Tuesday, April 26*** ***10:30 AM***
***Avalon 18-19***

## S-27: POSTER: A. AVIATION MEDICINE; B. AEROSPACE HUMAN FACTORS

**Chair: Marvin Jackson**
*Chicago, IL*

**Chair: Gordon Landsman**
*Aurora, CO*

### [159] A FALSE MEDICAL HISTORY INFORMATION RELATED PRIOR MYOCARDIAL INFARCTION IN A COMMERCIAL PILOT: A CASE REPORT

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**PROBLEM STATEMENT:** This case report describes a commercial pilot who has a cardiovascular disease problem. **BACKGROUND/ LITERATURE REVIEW:** Civilian pilots are required to have a medical certificate to exercise safely the privileges of the applicable license. During aeromedical health examinations pilots have to give complete and correct information related their medical conditions. **CASE PRESENTATION:** The pilot was a 54-yr old commercial pilot. He applied for the Class-1 medical certificate to the Aeromedical Center in a university hospital. During examination, abnormal ECG findings inverted T waves in the inferior leads (II, III, and aVF), inverted T waves in the lateral leads (V5 and V6) and pathological Q waves usually indicate prior myocardial infarction was found. After talking with the pilot, he gave information about his prior myocardial infarction and PTCA history. But the pilot did not give any information to the Aeromedical Examiner (AME) or tick boxes related his heart problem before the examination. Echocardiogram was performed and the results are concentric left ventricular hypertrophy, left-ventricular systolic dysfunction, mitral valve regurgitation (mild) and left atrial dilation. At the Gated Tc-99m sestamibi SPECT was reported with irreversible perfusion defect at the inferior wall and inferolateral wall, also hypokinesia (severe) at the inferior wall and midventricular portion of the lateral wall. Angiography results were interpreted as coronary disease including ventricular apical dyskinesia, inferior and posterolateral akinesia, posterobasal akinesia and three lesion around obtuse marginal coronary arteries (40-50%, 40-50% and 40%). An unfit decision for flying was given about the pilot and final denial of medical certificate also was given by the Turkish Directorate General of Civil Aviation. **OPERATIONAL/CLINICAL RELEVANCE:** This case highlights the AME's role during aeromedical examinations. AME's should remind to the pilots to provide a complete medical history for improving flight safety. Pilots read and sign application form about having made any false or misleading statements in connection with their application and its possible results including withdrawal of medical certificate.
**Learning Objectives:**
1. Understand the Authorized Aeromedical Examiner's role related missing information about medical history and pilots responsibilities giving correct information about their medical conditions.

### [160] REVIEW OF PERMANENT MEDICAL DISQUALIFICATION OF CIVILIAN TURKISH PILOTS DURING JANUARY 2012–JULY 2015

A. Akin[1], T. Cakmak[1], S. Metin[1], S. Gokkusu[2], K. Eren[2] and H. Dogan Yedikardaslar[2]
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**INTRODUCTION:** Currently, 19 Aeromedical Centers (AMC), designated and authorised at the discretion of the Directorate General of Civil Aviation-Aeromedical Section (DGCA-AMS), perform the civil aviator medical examinations according to the medical requirements issued by the International Civil Aviation Organization (ICAO) and Joint Aviation Authorities (JAA) Requirements for Flight Crew Licensing (JAR-FCL3) in Turkey. We aimed to document the total number and categories of medical conditions causing permanent disqualification of Turkish civilian pilots and candidates. **METHODS:** We analyzed the causes of permanent medical disqualification in civilian Turkish pilot and pilot candidates applying for medical examinations to AMCs for the period January 1st, 2012–July 7th, 2015 by reviewing medical records kept by DGCA-AMS where all the files finally submitted to. The identified cases were stratified by age and subdivided into clinical categories and disease groups. **RESULTS:** Out of 21,388 medical examination, 88 pilots (82 male, 6 female) with a mean age of 38.6±18.26 were permanently disqualified. The average disqualification rate was found as 4.11 per 1,000 pilot-years. Most frequently disqualified people is found in age over 50 group (n=32; 36.36%) and in age under 19 group (n=20; 22.7%). Most frequent clinical category responsible for disqualification was ophthalmology n=29 (32.96%), followed by cardiology (n=15; 17.05%) and otorhinolaryngology (n=11; 12.5%). Most frequent medical diseases were hearing loss (n=12; 13.64%), decrease in visual acuity (n=11; 12.5%), dyschromatopsia (n=10; 11.36%), coronary artery diseases (n=6; 6.82%) and bipolar personality disorder (n=4; 4.55%). **DISCUSSION:** The overall disqualification rate we found is almost the same with the USAF study reported in 1984. Highest disqualification rate is in group over 50 because of cardiovascular diseases particularly coronary ischemia. Almost all dyschromatopsia cases were seen among age under 19 (candidate group) which leads the group to be the second group with most disqualified person. But still lower than general population probably due to the fact that people who have this illness do not apply for pilot certification.
**Learning Objectives:**
1. The audience will learn the clinical categories and disease groups that cause permanently disqualification in Turkish civilian pilots.

### [161] BILATERAL MIDDLE EAR BAROTRAUMA WITH HEMOTYMPANUM FOLLOWING COMMERICAL AIR TRAVEL: A CASE REPORT

K. Hillenbrand
*U.S. Navy, FPO*

**PROBLEM STATEMENT:** This case report describes a U.S. Navy sailor who experienced a bilateral barotrauma during commercial air travel despite no prior upper respiratory symptoms. **BACKGROUND:** Middle ear barotrauma is a result of a pressure differential across the tympanic membrane between the middle ear and the environment. Although the pressure changes are greater and at a faster rate when SCUBA diving or in high performance aircraft, physicians need to be aware that this condition can be seen in commercial aviation even with no to minimal risk factors. **CASE PRESENTATION:** The patient was a 21 year old male U.S. Navy sailor stationed in Italy with no prior medical or significant surgical history. He had no diving and no vocational aviation experience. Over the course of four commercial flights over eight days the patient noted progressive muffled hearing, difficulty equalizing and aural pressure culminating in intense sharp pain on his fourth and final flight during descent. Patient did not seek medical care between flights but two days after his travel was seen in shipboard sick bacy for persistent fullness and muffled hearing. He was noted on exam to have bilateral hemotympanum consistent with a middle ear barotrauma despite no history of allergies, an upper respiratory infection, or previous difficulties

in equalizing. On follow up one month later the patient's symptoms and exam findings had resolved. **CLINICAL RELEVANCE:** This case represents a uncomplicated case of bilateral middle ear barotrauma. Although typically associated with SCUBA diving or high performance aircraft, this case demonstrates that even patients with no or minimal risk factors are at risk. This patient had a benign and uncomplicated clinical course but physicians need to be aware of the potential for more serious, and sometimes permanent, pathology including ossicular chain disruption, vertigo, and fistula formation.

**Learning Objectives:**

1. To understand the pathophysiology, risk factors, prevention options, indications for referral and treatments for middle ear barotrauma.

### [162] POST EJECTION STRESS DISORDER CASE AFTER BIRD STRIKE

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**INTRODUCTION:** We report a case of a bird strike that shattered the canopy of a fighter jet, followed by an ejection, which lead to Post-Traumatic Stress Disorder (PTSD) in a WSO. Bird strikes are a signification threat to flight safety and have caused a number of accidents with human casualties. **CASE REPORT:** A young male WSO ejected from a fighter jet at high speed, low altitude after a bird strike shattered the canopy. The pilot didn't eject and managed to return the damaged aircraft to the base. After the WSO was picked up by the Rescue Team, he presented at the hospital with loss of consciousness (of unknown duration), amnesia, and headache, as well as shoulder and neck pain. He was admitted and a CXR and a CT of the brain and neck were done. CXR showed multiple lines on the 2nd left rib. The CT of the brain showed a suspicion of intracranial bleeding and he was held for observation. After stabilization he was discharged. He later returned to the flight surgeon complaining of headaches, disturbed sleep and anxiety. Extensive medical investigations were done. The clinical reports from the treating facility show that he has PTSD. He was started on conservative medical management. The aeromedical decision made in this case was that he was unfit for all flying duties. **DISCUSSION:** Generally, bird-aircraft collisions pose a major threat to aviation safety. Additionally, PTSD is a complex and debilitating condition that can affect every aspect of an aircrew's life. Traumatic events such as these which involve an individual being exposed to an extraordinary situation(usually life-threatening, or believed to be life-threatening depending on the circumstances), are perceived with a varying degree of fear, horror and / or helplessness. Moreover, egress from fighter jet by ejection seat can lead to serious injuries. The aircrew in this case ejected after the bird strike. The ejection made his situation worse. As complications of the ejection, he developed PTSD. Furthermore, he was not motivated to make any effort to return to flying. The medical board recommends that he is unfit for all flying duties.

### [163] AEROMEDICAL DISPOSITION OF TURKISH CIVILIAN PILOTS AND CANDIDATES WHO UNDERWENT REFRACTIVE SURGERY

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*[1]Aerospace Medicine, Gulhane Military Medical Academy, Eskisehir, Turkey; [2]Aeromedical Section, Directorate General of Civil Aviation, Maltepe, Turkey*

**INTRODUCTION:** A refractive error is present when the optical power of the eye produces an object image that is focused anterior (myopia) or posterior (hyperopia) to the retina, or in various axes which create more than one focal point (astigmatism). Additionally a difference in the refractive power between the two eyes, called anisometropia, is also included in this group. Refractive surgery (RS), a method for correcting or improving the vision, entails unfitness. A fit assessment may be considered by Directorate General of Civil Aviation-Aeromedical Section (DGCA-AMS) provided that: pre-operative refraction was no greater than +5 or -6 diopters for Class 1 and no greater than +5 or -8 diopters for Class 2; examination of the eye shows no postoperative complications and stability of refraction has been achieved; glare sensitivity is within normal standards; mesopic contrast is not impaired as indicated in International Civil Aviation Organization (ICAO) and Joint Aviation Authorities (JAA) Requirements for Flight Crew Licensing (JAR-FCL3). **METHODS:** The AMS files were reviewed to quantify the number of civilian pilots and candidates who underwent RS between 2003 and 2015. TFR periods and the outcomes are also documented. **RESULTS:** We identified 16 cases (14 male, 2 female) that underwent RS (2 PRK and 14 LASIK). Their mean age was 31.2±4.87. The mean duration of temporary flight restriction (TFR) before the final disposition was pronounced was 116±37.12 days. In addition to the RS 1 case had keratoconus and 1 case underwent phacoemulsification cataract surgery which extended the duration of TFR to 180 days. Only 1 case received unfitness for flight operations due to perifoveal leakage found on 2 consecutive fundus fluorescein angiography examinations 1 year later after the RS. **DISCUSSION:** After RS, stability of refraction should be achieved and maintained for a period of at least 3 months which is the minimum standard for Turkish DGCA-AMS. It should be kept in mind that even though 1 year later after RS there can be late side effects which can affect the disposition and lead to unfitness for flight.

**Learning Objectives:**

1. The audience will learn the outcome of Turkish civilian pilots who underwent refractive surgery.

### [164] MALIGNANT MELANOMA OF THE SKIN IN AN EXPERIENCED MALE AVIATOR

E.J. Prochazka
*Consultant, San Diego, CA*

A 36-yr-old male USAF pilot and civilian airline pilot has been diagnosed with malignant melanoma of the right leg in March 2013. He has about 2400 hours military flight experience as instructor and evaluator pilot. In the civilian aviation area he is an airline transport rated pilot for a large domestic carrier with about 3900 hours flown. Upon initial diagnosis his lesion was 0.85 mm thick, extending into the deep margins. 1/4 superficial inguinal lymph nodes positive. Family history was positive for metastatic disease. Laboratory testing reveals Stage III B melanoma, included multiple MRIs, PET scans, without evidence of metastatic disease. Laboratory testing reveals strong positivity for Melan- A and S- 100, supportive of the diagnosis. Therapy included wide excision with lymphatic mapping and induction interferon, lymphadenectomy with Sartorius transposition flap. Completed 20 treatment cycles of induction interferon. Almost 30 months after initial diagnosis completely disease free and without any residuals, completely asymptomatic. Waiver submission to U.S. Air Force MAJCOM resulted in disqualification from air force aviation duties due to stage III B, retention as officer with ALC -C3. Under FAA medical certification fully qualified as command pilot, class I - with special issuance.

**Learning Objectives:**

1. Increased awareness for malignant melanoma in aviators even without excessive sun exposure. High index of suspicion especially in aircrew with a positive family history.
2. Different retention and disposition standards for U.S. Air Force pilots and FAA medical standards for pilots in command medical certification.
3. Discussion of feasibility and possible deviation from U.S. Air Force Air Crew Waiver Guide in exceptional cases, such as this case presentation.

### [165] HYPERTROPHIC CARDIOMYOPATHY ON MILITARY PILOT: ISSUES OF AVIATION AND PUBLIC SAFETY

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**PROBLEM STATEMENT:** Hypertrophic cardiomyopathy (HCM) is a relatively common pathology with direct impact of flight safety. It has a difficult decision in aeromedical medicine. To discuss the expert management in this situation, we report a case of HCM in a Moroccan military pilot evaluated in Aeromedical Center (AMC) of Rabat.

**BACKGROUND / LITERATURE REVIEW:** HCM is a disease at risk of sudden death paradigm of sudden incapacity in flight. In aviation medicine, HCM presents features such heart murmurs and ECG abnormalities. In case of repolarization abnormalities, normalization of ST-segment or T-Waves in stress test is not able to exclude a cardiomyopathy. Cardiovascular magnetic resonance imaging (MRI) is pivotal in screening and evaluation of HCM. Recent guidelines of the European Society of Cardiology (ESC), taking into account the HCM Risk-SCD score, may help the expert in the evaluation of sudden death at 5 years. **CASE PRESENTATION:** A 37 years old military pilot, with 1840 hours of flight on military transport aircraft, presented repolarization disorders during his periodical annual medical examination. He was clinically asymptomatic, practicing sports with any antecedent or cardiovascular factor. Clinical examination was normal, and EKG showed a Left Ventricular Hypertrophy (Sokolov=39mm) and diffused negative T-Waves. Echocardiography suspected nonobstructive apical hypertrophic cardiomyopathy (IV septum thickness: 13.6mm) confirmed by MRI. Then, he was declared temporary unfit. Stress test and 24H-Holter were reassuring and the HCM Risk-SCD computed at 1.5%. Given these results derogation is granted provided to flight with, a second experienced pilot, and biannual medical check and unfitness for external operations. **OPERATIONAL / CLINICAL RELEVANCE:** If HCM is diagnosed unfitness is the rule in all military or civilian pilot. Favorable asymptomatic cases, except for fighter pilot, including HCM Risk-SCD score under 4% and no major or minor factors of sudden death according to European and American recommendations, can allow the ability to fly by derogation, but always under restrictions.

**Learning Objectives:**

1. If HCM is diagnosed unfitness is the rule in all military or civilian pilot. Favorable asymptomatic cases, except for fighter pilot, including HCM Risk-SCD score under 4% and no major or minor factors of sudden death according to European and American recommendations, can allow the ability to fly by derogation, but always under restrictions.

## [166] INCIDENTALLY DIAGNOSED THICKENED RIGHT ATRIAL CHIARI NETWORK IN A JET PILOT; A POTENTIAL SOURCE OF EMBOLISM

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**INTRODUCTION:** We present the case of a jet pilot who had right atrial thickened chiari network with potential source of embolism in his right atrium. **METHODS:** A 22 year-old asymptomatic male jet pilot visited our center to have aircrew periodic medical examination which consists of physical exam, chest x-ray, ECG, transthoracic echocardiography (TTE), pulmonary function test and biochemical analysis of blood. **RESULTS:** Physical exam, biochemical analysis and chest X-Ray were normal. ECG showed regular sinus rhythm with no abnormality. TTE demonstrated thickened right atrial chiari network. The right heart volumes were also normal. There was no significant tricuspid insufficiency. The pulmonary artery pressure was also normal. A chiari network extending from right atrial free wall to the right lateral wall was detected and the thickening at the end of the network was 7x3 mm. Left ventricle systolic and diastolic functions were normal. In order to obtain detailed information, we performed 2D and 3D transoesophageal echocardiography (TEE) and it revealed the same findings and in addition patent foramen ovale. **DISCUSSION:** Aberrant chiari network localized in the right atrium is generally silent but sometimes they can be a focus of embolism if it is thickened. Sometimes they may lead to arrhythmia. If there is not a development of arrhythmia it doesn't need an intervention. His clinic may become symptomatic due to the difficult and challenging environmental stresses of flight such as hypoxia, anti G maneuver. The thickened chiari network may have risk of potential source of embolism to the pulmonary and systemic circulation that may lead to acute incapacitation. TTE and 2D-3D TEE are an indispensable diagnosis tool to detect the potential source of embolism as in our case for periodic medical examination of military aircrew.

**Learning Objectives:**

1. To learn the detection of pilots with chiari network and potential source of embolism with TTE and TEE.

## [167] LONG TERM IMPACT OF POSITIVE PRESSURE BREATHING FOR G PROTECTION (PBG) ON RESPIRATORY FUNCTION: ITALIAN AIR FORCE PILOT STUDY

A. Scagliusi[1], C. Condoluci[2], P. Trivelloni[1], P. Verde[1], P. Perelli[3] and F. Morgagni[3]
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**INTRODUCTION:** High-performance fighter aircrafts expose pilots to forces that can adversely affect performance and induce G-LOC. To improve +Gz countermeasure for aircrew, PBG has been developed. PBG has been shown to maintain cerebral perfusion by raising the systemic arterial pressure, so increasing the overall level of G-tolerance. The goal of this study was to determine the incidence of long term adverse respiratory effects in pilots using PBG. **METHODS:** According to American Thoracic Society/European Respiratory Society guidelines, measurements of FEV1, FVC, FEV1/FVC ratio, FEF25–75% and PEF were carried out. ANOVA test was used. **RESULTS:** Data from 34 male Italian military pilots (400 to 1200 hrs of flight time on specific aircraft, no known allergy, no smoking) were recorded. 21 pilots were selected from one F-2000 squadron (PBG users) and 13 were selected from an air transport squadron (control group, non-PBG users). Mean age was: 36 years (PBG users) and 30,7 years (control group)($p<0,002$). FVC, PEF, FEV1/FVC ratio and FEF25-75% were quite similar showing non-significant differences (NS). Mean FEV1 was a little lower in PBG users than in control group (4,19 vs 4,29 l), but NS. **DISCUSSION:** Our data show that there are non-significant differences among the studied parameters. Although the small number of pilots and the age difference between the two groups limit the significance of the study, it's worthwhile to try to explain if the lower FEV1 could represent an indication of early stage deterioration of respiratory function. FEV1 declines with age; whether our data reflect the PBG use and/or physiological age related decline, it's hard to say. Predicted values percentage (age-adjusted) shows overlapping results, thus indicating a likely absence of negative respiratory effects of PBG. Further studies are required to stratify pilots in subgroups according to flight time, adding total lung capacity, reserve volume, functional residual capacity and diffusion lung CO measurement, in order to obtain an accurate examination of peripheral airways and alveolar capillary interface. Chest CT scan could be performed to detect early subtle signs of lung injury.

**Learning Objectives:**

1. To understand that PBG use is safe for high performance aircraft pilots, according these preliminary data.

## [168] NAVAL AVIATION SYPHILIS SURVEILLANCE POLICY COST BASIS ANALYSIS AND RECOMMENDATIONS FOR FUTURE UTILIZATION

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**INTRODUCTION:** Syphilis has historically been the one sexually transmitted infection (STI) that has accounted for the greatest loss of personnel and person-hours. Studies have shown that morbidity caused by STIs have become operationally insignificant. This study evaluates current U.S. Navy syphilis surveillance policy of aviation personnel. **METHODS:** A retrospective cohort study of Naval personnel on flight status was performed to conduct a cost basis analysis of U.S. Navy syphilis surveillance policy. The U.S. Department of Defense Armed Forces Health Surveillance Center's Defense Medical Epidemiology Database (DMED) was used to obtain 2004 to 2013 counts of U.S. Navy and Marine Corps personnel with first occurrence syphilis diagnoses, ICD-9 codes 091 – 097. Counts for personnel on flight status with the same diagnoses were also produced to form exposed group data. The cost of syphilis serology testing was obtained from Naval Hospital Pensacola laboratory and used to determine the cost of the current U.S. Navy syphilis surveillance policy. **RESULTS:** Over the ten-year period, 1,285 cases of syphilis occurred in

U.S. Navy and Marine Corps personnel representing 5,248,921 person-years (PY). Personnel on flight status had 30 of those cases representing 221,587 PY. Syphilis rate of U.S. Navy personnel on flight status was 0.15 per 1000 PY compared to a syphilis rate of 0.30 per 1000 PY for U.S. Navy personnel not on flight status. Syphilis rate of Marine Corps personnel on flight status was 0.10 per 1000 PY compared to a syphilis rate of 0.16 per 1000 PY for Marine Corps personnel not on flight status. These rate differences were significant for the combined U.S. Navy and Marine Corps with a relative risk of 0.5424 (95% CI 0.3776, 0.7790; p-value 0.0009). Navy spends $41,845 per case of syphilis diagnosed but surveillance only finds 17% of cases. **DISCUSSION:** Our results suggest that Naval personnel on flight status have a significantly lower rate of acquiring syphilis than their non-flight status peers. These results also indicate that the U.S. Navy's health maintenance policy of syphilis testing for flight status personnel should be discontinued. Also, U.S. Navy STI surveillance policy should be reviewed with a focus on at risk populations.

**Learning Objectives:**

1. Understand the current CDC and USPSTF recommendations regarding syphilis surveillance and the definition of an at risk population.
2. Recognized the differences between treponemal and non-treponemal serology tests and when it is appropriate to use each.
3. Be aware that U.S. Navy and Marine Corps personnel in a flight status are not an at risk population regarding syphilis.

## [169] PROCESS FOR U.S. NAVY AEROMEDICAL REFERENCE AND WAIVER GUIDE REVISION FOR PERIMESENCEPHALIC SUBARACHNOID HEMORRHAGE

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*Residency, Naval Aerospace Medical Institute, Pensacola, FL*

**MOTIVATION:** U.S. Navy Aeromedical Policy as specified in the Aeromedical Reference and Waiver Guide (ARWG) indicate the diagnosis Subarachnoid Hemorrhage (SAH) is disqualifying. Prior to requesting a waiver, an aviator must be asymptomatic and without recurrence for two years after the initial event. Recent waiver requests from aviators with non-traumatic, non-aneurysmal SAH, specifically perimesencephalic subarachnoid hemorrhage (PM-SAH) have illustrated that one-size-fits-all policy may be overly restrictive. **OVERVIEW:** A senior designated Naval Flight Officer experienced a PM-SAH with full recovery and no residual deficit. His flight surgeon requested a waiver six months after the event. Review of the literature indicated that the chance of recurrence of this event was low and appeared to meet acceptable aeromedical risk. However, the ARWG section on Subarachnoid Hemorrhage, which underwent periodic review in 2014, does not address any specific guidance for PM-SAH. Thus, the case was managed under the general guidelines for SAH, possibly delaying the aviators return to flight unnecessarily. This is likely not an isolated case, as PM-SAH represents 5% of SAH, so breaking it out to offer specific guidance is indicated. This has impact on operational support, as several other cases have been presented to NAMI in recent history. A literature review was conducted to find primary, peer-reviewed publications for review and to be presented to the Aeromedical Advisory Council (AAC) for consideration. The principal consideration in any AAC is risk mitigation relative to severity, likelihood and unknown outcomes to develop recommendations and waiver submission requirements. This publication will present the finding of the AAC conducted for PM-SAH. **SIGNIFICANCE:** Aeromedical Advisory Councils translate updated research concerning aerospace medical topics into operational recommendations. This is necessary to ensure current medical knowledge is used to support operational needs of agencies tasked with global security missions. This process is also used to align the U.S. Navy ARWG with sister services of the U.S. Armed Forces to maintain consistency in the application of aeromedical risk mitigation to the operational environment.

**Learning Objectives:**

1. The participant will be able to understand the process of how the U.S. Navy review and modify the Aeromedical Reference and Waiver Guide.
2. The participant will be able to understand epidemiology, diagnosis and prognosis of perimesencephalic subarachnoid hemorrhage and the aeromedical risks it presents.

## [170] CANCER INCIDENCE IN MOROCCAN AIRCREW, 2005-2014

M. Zerrik[1], C. Abdelkhirane[2], H. Echchachoui[1], C. Elmhadi[1] and M. Chemsi[1]
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**BACKGROUND:** Flight personnel are exposed to several agents including ionizing radiation and chemical combustion that may be associated with an increased risk of cancer. Previous studies regarding cancer incidence and mortality in aircraft pilots have not shown a consistent pattern. The aim of this study was to describe the cancer incidence in commercial pilots and other crew member considering flight hours and aviation specialty. **METHODS:** In this sectional study, all civil aviation people regularly reviewed in aeromedical expertise center during 2005 – 2014 (609 airline pilots and 1469 of other aircrew) were studied regarding cancer incidence using their medical file archives. Only cases of invasive cancer with pathological confirmation were be included. The cancer incidence and other epidemiological and clinical aspect will be compared with that of the general population referring to the last Rabat cancer register by comparing observed and expected number of cases through standardized incidence ratios (SIR). **RESULTS:** The SIR for cancer was: 1.00 (95%CI 0,86-1,14) For airline pilots, 0.97 (95%CI 0,93-1.10) for cabin crew and 0.98 (95%CI 0.87-1.09) for airline controller. The average age was 43 year. We had heterogeneous localizations (brain, breast, stomach, rectum, prostate...), thyroid carcinoma was the most frequent one in its papillary form (SIR=2.4). **DISCUSSION:** Moroccan aviator had an overall cancer incidence similar to the general population. But the average age was lower (56,2 years) may perhaps be related to their young age and frequency of medical surveillance. Unlike literaturedata our airline pilots had not an increased incidence of malignant melanoma maybe because of our skin type (phototype IV, V). Actually there is no study accused UV radiation to higher incidence of thyroid cancer but this result can be explained by systematic gland examination and genetic factors.

**Learning Objectives:**

1. Morrocan aviator had an overall cancer incidence similar to the general population.

## [171] CASE STUDY: FLYING HIGH-PERFORMANCE AIRCRAFT WITH ATRIAL SEPTAL DEFECT (ASD) AND AMPLATZER™ OCCLUDER DEVICE?

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**PROBLEM STATEMENT:** This case report describes the safe return of a military jet pilot after treatment of a hemodynamic relevant atrial septal defect (ASD) which was found accidentally. As a German requirement, he retrieved his medical certificate after thorough testing in the long-arm human centrifuge (laHC) and high altitude chamber (HAC) before regaining his aeromedical certificate. **BACKGROUND/LITERATURE REVIEW:** Worldwide, there has never been a case of an AeMC declared a patient with an implanted AMPLATZER™ septal occluding device (ASOD) fit to fly for high-performance aircrafts. **CASE PRESENTATION:** A Tornado pilot who had suffered from syncope was diagnosed with ASD II with hemodynamic relevance and right heart dilatation. He had no medical history and held a valid aeromedical certificate. On the basis of the diagnosis, a German AeMC grounded the patient. An ASOD was implanted. After a year of good tolerance, the question was whether the pilot would be able to fly a jet again. Based on the examinations by the AeMC, tests in the long-arm human centrifuge (laHC) and in the HAC were planned. After cardiologic assessment, the patient took the laHC test (+2.5, 3.5, 4.5 Gz; 3 g/sec; plateau 20 sec; one min break). Before and after this test, ECG and echocardiography (ECHO) checks were undertaken. Afterwards he underwent a long-term ECG and took the HAC test on the following day, where he experienced acute hypoxia (25,000ft). During all tests, 12-channel ECG monitoring was conducted continuously

and showed sinus rhythm and no arrhythmia. No clinical abnormalities were found; heart frequency and blood pressure were normal. There were also no abnormalities in the overnight Holter monitoring between the two tests. The ECHOs revealed that the ASOD was still in the correct position, with no evidence of flow across the bulging disc (shunting). **CLINICAL RELEVANCE:** After the surgery the patient showed good clinical conditions. The responsible AeMC still decided to conduct another simulated acceleration and hypoxia test to examine the patient for his medical fitness for flying duties. Thorough testing in the laHC and HAC is mandatory. He passed and was granted an aeromedical certificate limited to two years (re-evaluation).

**Learning Objectives:**

1. Worldwide there has never been a case of an AeMC declared a patient with an implanted AMPLATZER™ septal occluding device (ASOD) fit to fly for high-performance aircrafts.
2. On human centrifuge runs it could be shown that a jet pilot after ASOD surgery is be able to fly in a jet again with limitations.

## [172] FREQUENCY OF RELATION BETWEEN COMMON BAROTRAUMAS AND UPPER RESPIRATORY INFECTIONS AMONG CIVILIAN PILOTS IN IR.OF.IRAN

K. Soleimani
*Air Medical Section, Civil Aviation Organization Air Medical Center, Tehran, Iran*

**INTRODUCTION:** Acute viral respiratory illnesses are among the most common of human diseases, accounting for one-half or more of all acute illnesses. Acute infections will normally necessitate a period of temporary "unfitness" for an aviator. This period is likely to resolve quickly, so that return to normal duties is not delayed. The purpose of this study was to evaluate a relationship with ENT barotrauma during flight among commercial pilots with or without upper respiratory infections. **METHODS:** There were 1745 commercial flight crew (men) in Islamic Republic of Iran visiting in Aeromedical Center (AMC) during a 12-mo period who answered a questionnaire regarding signs and symptoms of upper respiratory infections (URI) and barotraumas frequency of relation to flying with a common cold. **RESULTS:** On ordinary, most of flight crew practiced one to two URI per year. Approximately 1162 (66.5%) of the flight crew informed themselves unfit, until 583 (33.5%) went on with their flying duties in spite of signs and symptoms of a URI. The second group the 344 (59.0%) informed taking antihistamine medication. Approximately 583 (33.5%) of all flight crew informed having practiced one or more events of ear barotrauma, essentially during going down (86%), because 6.5% informed sinus barotrauma incidents during their flying professional. **DISCUSSION AND CONCLUSION:** In civil aircraft the cabin pressure at a cruising altitude of 30,000 to 40,000 ft is usually kept at a pressure comparable to an altitude of approximately 6000ft to 8000 ft. Furthermore, when level flight is performed for several hours in a dry environment and with a URI, one feels the pressure changes quite quickly when starting descent. The effects show that not all flight crew and airline companies express URI a valid reason for unfitness to fly in spite of the risk for acute incapacitation. Immediate consideration this actuality and to the risk factors caused by URI are forcefully recommended.

**Learning Objectives:**

1. The purpose of this study was to evaluate a relationship with ENT barotrauma during flight among commercial pilots with or without upper respiratory infections.

## [173] ASSESSMENT OF A PROTOTYPE APACHE FLIGHT EYEWEAR

D.V. Walsh[1], G.M. Jurek[1], W. McLean[1], J. Statz[2] and R. Allen[1]
*[1]Vision Protection and Performance Division, United States Army Aeromedical Research Laboratory, Fort Rucker, AL; [2]Oak Ridge Institute for Science and Education, Oak Ridge, TN*

**INTRODUCTION:** Currently, Apache pilots needing refractive correction are issued the modified HGU-4/P Apache aviator spectacles. Although Apache pilots can wear contact lenses in flight, multifocal contact lenses are not authorized for flight duty forcing presbyopic Apache pilots to wear the modified HGU-4/P spectacles. However, a recently published survey found dissatisfaction with pilots' Field of View (FOV) while wearing the current aviator spectacle frame. FOV is vital to Apache pilots when using their Helmet Display Unit (HDU) that is over their right eye. An Air Force frame (AFF-OP) was modified in-lab, and the purpose of the study was to evaluate the FOV with the current Apache flight frame vs. the modified flight frame. **METHODS:** Twenty-one Apache pilots were recruited to assess FOV under three conditions: (1) wearing the current Apache frame; (2) wearing the modified Apache frame; and (3) having no-frame condition. The Apache community is implementing a new helmet (Echo) and subjects were encouraged to bring in both helmets for testing, if applicable. All pilots were tested with the current Apache helmet and 10 with both helmets. The main outcome measure was total FOV of the 4 quadrants tested: superior left (45°); superior right (135°); inferior right (225°); and inferior left (315°). The study was approved by the U.S. Army Medical Research and Materiel Command Office of Research Protection. **RESULTS:** No significant differences in FOV were seen between the two frames tested while wearing the current Apache helmet ($p=0.74$) and the new Apache Helmet ($p=0.64$). However, there were significant differences in FOV between the no-frames condition and the two frames tested with both helmets ($p<0.001$). **DISCUSSION:** No significant differences in FOV were seen between the two frames tested while wearing either Apache helmet. However, with both helmets there were significant differences in FOV between the no-frame condition and the two frames tested. This suggests that wearing no frames is still the best option in integrating the HDU device. With advances in contact lens technology, future research can study the viability of the latest generation of multifocal contact lenses with Apache aviators.

**Learning Objectives:**

1. The participant will be able to understand the issues Apache pilots have with the current Army issued Apache spectacle frame.
2. The participant will learn about an alternative Apache spectacle frame developed and tested at USAARL.

## [174] INCREASING UTILITY OF HUMAN PATIENT SIMULATORS IN AN OPERATIONAL ENVIRONMENT FOR MILITARY MEDICINE

A. Camden, K. Barrera and S. Conwell
*711 Human Performance Wing, Wright-Patterson AFB, OH*

**INTRODUCTION:** Human patient simulators (HPS's) are sophisticated manikins that are becoming popular in medical education. They are typically used in a clean, laboratory-like setting (e.g., a simulated emergency room) to teach students how to diagnose and treat a patient. Most commercial HPS's create their own wireless internet and rely on a nearby operator for control, making high-fidelity training for prehospital trauma (i.e., field medicine) unrealistic. Further, the costs of a specialist to control the HPS's can become prohibitively high. **METHODS:** This proof-of-concept study connected two HPS's to an external wireless network at Angel Thunder, the world's largest personnel recovery exercise for Air Force Pararescue Jumpers. Although the exercises took place in the remote test ranges of Playas, NM, a deployable wireless network consisting of three towers allowed for remote control of the HPS's from afar, increasing realism of the training exercise. **RESULTS:** The deployable network was found to successfully cover a five mile radius from each tower. Operators located in San Antonio and Toledo were able to create a virtual private network to control the HPS's located in Playas. Initial results found no noticeable lag in operations. Further, when asked to rate the overall effectiveness of the training exercise incorporating HPS's as injured patients, 84% of 32 respondents rated the training exercise as "Effective" or "Very Effective". **DISCUSSION:** The use of a deployable wireless internet network was demonstrated for pararescue training; however, such technology could be applied in a variety of military exercises where other network options are difficult or infeasible, such as in remote ranges or even at sea. Future efforts should focus on increasing the range, altitude, and mobility of the network to increase the effective exercise training area. The ability to remotely control an HPS within a deployable network in an operational training environment can increase the training realism for students. This capability could be a cost-effective method to control HPS's to improve the military medical training in a variety of environments.

**Learning Objectives:**

1. Understand methods to improve utility of human patient simulators and its relation to military medical training.

## [175] UPDATE ON THE ABSORPTION AND SIDE-EFFECT PROFILE OF LOW-DOSE INTRANASAL SCOPOLAMINE SPRAY

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*Naval Medical Research Unit Dayton, Wright-Patterson AFB, OH*

**BACKGROUND:** Motion sickness (MS) continues to be a problem for the modern military across the Services. The anticholinergic scopolamine is the most efficacious anti-MS medication, though the oral and transdermal administrative routes have drawbacks compromising utility, including delayed onset of action and dose-related side effects. A 2011 pilot study (n=6) showed an intranasal mist formulation of scopolamine (INSCOP) was rapidly absorbed without the significant side effects or cognitive deficits seen in the oral and transdermal routes. INSCOP plasma levels were detectable in all subjects by 15 minutes post-dose ($M$ = 73.0 pg/ml) and an average maximum plasma concentration of 158.4 pg/ml. These results were presented at the 2013 AsMA conference. In this update, those results have been combined with 13 additional subjects creating a more comprehensive view of the impact of INSCOP. **OBJECTIVE:** Evaluate absorption, dosing accuracy, and cognitive side-effect profiles of a low-dose INSCOP spray. **METHODS:** Nineteen volunteer active duty members received a 0.2 mg INSCOP dose. Blood was collected prior to dosing and at 0:05, 0:15, 0:30, 0:45, 1:00, 2:00, 3:00, 4:00, 6:00, and 8:00 hours post-dose. Vitals were assessed concurrently with blood draws. Cognitive performance and subjective fatigue levels were assessed prior to dosing and at 0:20, 1:20, 2:05, 3:05, and 6:05 hours post-dose. Scopolamine plasma concentrations were determined using Liquid Chromatographic-Mass Spectrometric analysis. **RESULTS:** INSCOP plasma levels were detectable in all 19 subjects by 15 minutes post-dose. Peak plasma concentrations were reached by 1 hour post-dose. Cognitive performance data had small but significant decreases post-dose and subjective fatigue levels increased throughout the assessment period. Decreased cognitive performance data and increased fatigue levels may be due to length of study day, boredom, and Circadian rhythms. **CONCLUSIONS:** Low-dose INSCOP is rapidly absorbed and lacks the larger cognitive deficits and side effect profiles seen in other administrative routes of scopolamine. A comparison of cognitive performance data and subjective fatigue levels in a double-blind placebo vs. INSCOP trial will further validate results.

**Learning Objectives:**

1. The audience will gain an understanding of the current routes of administration for the anti-motion sickness agent scopolamine.
2. The audience will learn about the absorption characteristics and side effects profile of scopolamine administered in a novel dosage form at a lower than conventional dose.

## [176] COMPARISON OF PILOT VISUAL SCAN PATTERNS IN GLASS VS ANALOGUE COCKPITS

S. Pingali[1,2], T. McMahon[2] and D.G. Newman[1]
[1]*Department of Aviation, Griffith University, Nathan, Australia;*
[2]*Department of Aviation, Swinburne University, Hawthorn, Australia*

**INTRODUCTION:** Scanning flight instruments is an important skill pilots must learn and maintain, particularly when flying aircraft with either digital ("glass") or analogue instrument displays. Understanding how pilots monitor the instruments in different cockpit types is crucial, particularly in terms of transition training and flight safety. The aims of this study were to find out if there are any differences between visual scan patterns in glass and analogue cockpits, and what operational performance issues any differences might reveal. **METHODS:** Twelve fixed-wing pilots, 9 male and 3 female, participated in this study, which received institutional ethics approval. The study was conducted in a reconfigurable fixed-wing flight simulator. Each subject flew 2 navigation flights under visual flight rules conditions, one using a glass display and the other using an analogue display. During the final approach the heading indicator was also failed, without the subject's knowledge. Visual scan data was recorded using a head-mounted eye tracker. Visual fixation time was expressed as a percentage of the total flight time. Analysis of variance was used for the statistical analysis of the data. **RESULTS:** In a glass cockpit pilots scanned the instruments 70% more than in the analogue cockpit. During take-off, climb, approach and landing phase this difference was significant ($p<0.05$). In an analogue cockpit pilots looked at the outside world 11% more than in the glass cockpit. This difference was significant ($p<0.05$) during take-off, climb and approach phase. The results also showed that failure detection was significantly dependent on cockpit type ($p<0.05$), with only one subject detecting the failure in an analogue cockpit compared with 100% detection in the glass cockpit. **DISCUSSION:** The results of this study show that there is a significant difference in visual scanning patterns between glass and analogue cockpits. The fact that pilots were unable to detect the same failed instrument in both cockpits highlights the importance of transition training. Further research is required to determine if operational performance deteriorates when pilots transition to an analogue cockpit from a glass cockpit.

**Learning Objectives:**

1. Participants will learn about the differences in pilot visual scanning patterns between digital and analogue flight displays.

## [177] HUMAN PERFORMANCE AUGMENTATION IN REMOTELY PILOTED AIRCRAFT OPERATIONS

M.R. Hoepf[1] and M.S. Middendorf[2]
[1]*Applied Neuroscience, Air Force Research Laboratory, Beavercreek, OH;* [2]*Neuralphysiology, Air Force Research Laboratory, Medway, OH*

**INTRODUCTION:** The current research follows a program of research structured around the sense-assess-augment framework. The objective is to assess operator cognitive state in remotely piloted aircraft (RPA) operations, and provide augmentation to assist the operator in times of high workload. In previous experiments, physiological measures were identified that demonstrated sensitivity to workload. The assessment is accomplished by sensing physiological signals from the operator, extracting features from the signals using algorithms, and processing the features with a model to measure workload. The current research investigates human performance augmentation in a realistic RPA simulation. **METHODS:** Thirteen persons (7 female) were recruited from a Midwestern university to participate in the experiment. The participants were trained to perform a surveillance task and a tracking task using RPAs. There was also a secondary task in which participants were required to answer cognitive probes. A within subjects factorial design was employed. There were two workload factors per task (surveillance and tracking). Augmentation was the third factor, and was unique to each task type. Subjective workload estimates were acquired using the NASA-TLX. Performance data was calculated using a composite scoring algorithm. **RESULTS:** Results indicated that augmentation significantly improved performance and reduced workload in both tasks. The data suggests, however, that augmentation was more beneficial in high workload conditions than low workload conditions. This notion is also consistent with evidence gathered during structured debriefing sessions with the participants. **DISCUSSION:** The increase in performance and decrease in workload associated with augmentation is an important and expected finding. There were, however, indications of negative effects of automation in some conditions. Many participants voiced complaints about being bored when augmentation was provide in low workload conditions. These findings are consistent with an adaptive automation framework. This research suggests that augmentation should only be provided when it is truly needed, especially if the augmentation requires additional assets and/or resources.

**Learning Objectives:**

1. The learning objective of this presentation is to acquire knowledge of the augment component of the sense-assess-augment taxonomy.
2. Automation may not be helpful in low workload situations.
3. Improving operator performance and reducing workload is the goal of the sense-assess-augment framework.

## [178] A PROCESS IMPROVEMENT APPROACH TO MUSCULOSKELETAL PAIN AMONG A-10 PILOTS IN A DEPLOYED LOCATION

E. Grieser[2] and M. Seyffert[1]
[1]*Aerospace Medicine, Michigan Air National Guard, Ann Arbor, MI;*
[2]*USAF, San Antonio, TX*

**INTRODUCTION:** There is a persistent medical problem of musculoskeletal pain and neurological symptoms in pilots of a local fighter squadron. Acute to subacute ailments (insomnia, extremity numbness, tingling, occasional loss of sensation) are likely brought about by sitting for extended sorties. Immediate negative consequences of pain may include

fatigue, reduced attention to detail, and potential mission cancelation. Chronic problems may include chronic pain and long-term disability. Due to this negative impact to combat operations and overall readiness, we engaged in data gathering to identify pilots' perceptions of somatic and cognitive symptoms, and process improvement steps at a local squadron level. **METHODS:** A 2 page locally-developed questionnaire was distributed among the 107th Expeditionary Fighter Squadron and its replacement. The questionnaire asks about perceived impact of pain on sleep, mobility, concentration, etc. and also includes open-ended, qualitative fields to capture individual flyers' suggestions for future interventions. **RESULTS:** Data collection is still ongoing and projected to be completed by Dec 2015. Preliminary results suggest aviators lose a significant amount of sleep per week due to pain and frequently take NSAID pain relievers to cope with sortie-related pain, yet do not perceive pain negatively impacts their ability to focus and concentrate while flying. Qualitatively, aviators cite confined cockpit and non-reclined seat as contributory to pain, and use exercise and non-medical interventions (i.e., cockpit modifications, stretching, massage, soft tissue manipulation) to alleviate pain. **DISCUSSION:** Quantitative and qualitative information will aid in prevention and management of sortie-related pain in aviators engaged in extended combat missions. Potential interventions include: education in the form of health bulletins to inform flyers of sleep hygiene, relaxation techniques and cognitive-behavioral self-management of pain, massage chair for symptom relief, medical provider trained in massage and musculoskeletal manipulation.

**Learning Objectives:**

1. The participant will be able to understand the utility of process improvement within the deployed setting.

### [179] HUMAN PERCEPTION OF LEGACY GAUGES VERSUS MODERN GLASS DISPLAYS IN AIRCRAFT INSTRUMENTATION

T. Smeddal and B.S. Bradke
*Mechanical Engineering, Norwich University, Northfield, VT*

**INTRODUCTION:** Throughout the evolution of manned flight, the layout and appearance of primary flight displays have also evolved in order to show pilots critical flight data faster and with greater accuracy. The most important of these displayed flight parameters monitored during all phases of flight is altitude because it is the primary means of separation between aircraft and obstacles. The purpose of this research project is to investigate how pilots are able to perceive and interact with both main styles of aircraft instruments. **METHODS:** Pilot perception was defined as the accuracy with which test subjects reported the altitude they saw on the computer screen. Following the computer based testing phase; values reported by each subject was compared to the actual values displayed by the instruments. This data was analyzed, and charts of response correctness were made. These charts directly compared the number of correct then compared to the flight experience of each subject to conclude which of the two instrument styles is the most effective for the widest variety of pilots and aviation applications. **RESULTS:** As expected, the vertical tape altimeter performed better for perceiving exact altitude, and both gauge types had similar results for trend recognition. But, tape altimeters had a significant difference between fast and slow climb/dive rates suggesting that round-dial altimeters may be better for displaying insidious rates of climb or descent. **DISCUSSION:** This study was a preliminary attempt to objectively determine which altimeter type was better suited for pilot performance. Unexpectedly, a large number of incorrect answers were recorded during benign test conditions. This suggests that unfamiliarity with the specific instruments (e.g. three-needle vs. two-needle) used in the study was a factor. Despite this, the results showed that tape-type altimeters may be inadequate for showing pilots slow rates of climb or descent, a common factor in aircraft mishaps.

**Learning Objectives:**

1. Vertical-tape-style altimeters may be inadequate for displaying insidious climb/descent rates.

### [180] EFFECTS OF WHOLE-BODY VIBRATION ON NECK AND TRUNK PROPRIOCEPTION AND POSTURAL STABILITY

T. Nagai[1], H.M. Bansbach[1], M. Faherty[1], J.P. Abt[2], T.C. Sell[1] and S.M. Lephart[2]
*[1]Neuromuscular Research Laboratory, University of Pittsburgh, Pittsburgh, PA; [2]College of Health Sciences, University of Kentucky, Lexington, KY*

**INTRODUCTION:** Prolonged exposure to whole-body vibration (WBV) is considered a risk factor for neck pain (NP) and low back pain (LBP) in aircrew. Decreased trunk proprioception following WBV exposure has been previously reported. Proprioceptive feedback from the neck and trunk plays an important role in maintaining proper postural stability; therefore, it was hypothesized that WBV exposure would negatively affect both neck/trunk proprioception and postural stability, potentially exposing aircrew to a greater risk of NP/LBP. The purpose of this study was to examine the effects of WBV on neck and trunk proprioception and postural stability. **METHODS:** A total of 15 healthy subjects (6 males and 9 females) participated (age: 25.4±4.5yrs, height: 169.0±7.8cm, weight: 69.9±10.9kg). Subjects performed one of three testing protocols before and after a 30-minute seated WBV exposure: 1) neck rotation joint position sense (JPS); 2) trunk flexion JPS and threshold to detect passive motion; 3) single leg dynamic postural stability and eyes-open/closed static postural stability. Neck/trunk JPS was calculated as an absolute difference between the guided and replicated trials. The standard deviation of the center of pressure (CoP) in anterior-posterior (x) and medial-lateral (y) directions during a 10-second static balance was used for static postural stability. Dynamic postural stability index was used for dynamic postural stability. Paired t-tests or Wilcoxon Signed Ranks tests were used to examine the difference before and after the WBV exposure ($p<0.05$). **RESULTS:** The trunk JPS was significantly improved (pre: 2.45±1.37, post: 1.62±0.70, $p=0.029$) following WBV. The CoPx during eyes-closed static balance was also improved (pre: 8.57±2.39, post: 7.53±2.03, $p=0.023$). Contrarily, the CoPx and CoPy got worse during eyes-open static balance (CoPx pre: 3.99±0.70, post:4.61±0.99, $p=0.031$; CoPy pre:3.50±0.52, post:4.01±0.75, $p=0.020$). **DISCUSSION:** Mixed results in CoP between eyes-open (worsened) and eyes-closed (improved) may suggest a potential interaction effect between the visual system and static postural stability after the WBV exposure. Future studies should examine exposure time and changes on proprioception during WBV.

***Tuesday, April 26*** ***10:30 AM***
***Avalon 1-3***

## S-28: PANEL: AIRSHOW PERFORMERS; ARE THEY DANGEROUS, UNDISCIPLINED RISK TAKERS?

**Chair: Arnold Angelici**
*College Park, GA*

**Chair: John Hyle**
*Peachtree City, GA*

**PANEL OVERVIEW:** With the perceived recent rash of air show crashes and fatalities, many regulators and the general public view airshow performers as dangerous, undisciplined risk takers. This panel will 1) explain the process of becoming and maintaining certification as a U.S. civilian airshow demonstration pilot, 2) a discussion of airshow pilot demographics, 3) a review of several high visibility accidents focusing on the medical and human factors, and 4) inappropriate use of medications among the airshow demonstration pilot population. The presenters will be: Captain John Hyle, Arnold Angelici, MD, and Tom Faulkner, MD.

### [181] AIRSHOW DEMONSTRATION PILOT REQUIREMENTS

J. Hyle
*JMatt Aviation, Peachtree City, GA*

This presentation will provide information on the process of obtaining a Statement of Aerobatic Competency in order to perform low level aerobatics. The overriding FAA Regulations and Orders that affect the airshow performer will be discussed. The typical day of an airshow demonstration pilot will be reviewed highlighting activities and requirements to preserve flight safety and the safety of the spectators. The Good Operating Practices of the International Council of Airshows will be reviewed and their practical implementation discussed. Procedures for maintenance and, if necessary, termination of the Statement of Aerobatic Competency will be explained. Finally, it will briefly touch on non-aerobatic formation flight and the process to obtain a FAST card allowing that activity.

**Learning Objectives:**
1. Better understanding of obtaining a Statement of Aerobatic Competency.
2. Steps taken in the airshow community to limit the effects of human and physiological factors on demonstration pilots.
3. The regulatory environment the airshow demonstration pilot works within.

### [182] AVIATION MEDICAL EXAMINER'S RESPONSIBILITIES AND THEIR PLACE IN THE CHAIN OF EVENTS PRIOR TO AN AIRCRAFT ACCIDENT

A.A. Angelici
*Aerospace Medicine, Federal Aviation Administration, College Park, GA*

**PROBLEM STATEMENT:** Aviation Medical Examiners (AME) are physicians designated by the Federal Air Surgeon to perform Aviation Medical Examinations necessary to determine qualifications for the issuance of medical certificates under 14CFR67. Designation as an AME is a privilege that conveys responsibilities to serve the needs of the FAA in fulfilling its safety mission. AME's are physicians with varying levels of aerospace medical expertise, who are expected to demonstrate continued competence in knowledge of FAA Medical Certification Standards and Procedures, and in Clinical Aerospace Physiology. They are the usually considered by the airman as the FAA's representative who stands in between their ability to fly or remain on the ground. **BACKGROUD:** Aircraft accident data were obtained from the National Transportation Safety Board database, the International Council of Airshows, and the Civil Aerospace Medicine Institute autopsy database. Information on the number of airmen with current statements of acrobatic competency was obtained from ICAS. **CASE PRESENTATION:** A review of accident data resulted in a selection of four accidents where the airman failed to report or omitted medical condition(s) and medications and were determined by the NTSB for be a contributing or causal factor in the accident. **OPERATIONAL/CLINICAL RELEVANCE:** Review of the accident events and the NTSB reports revealed two events in the chain of events that led up to the accidents; the failure to disclose by the airman and the AME failing to perform an adequate history and physical exam. The history is limited to what the airman provides on the FAA Form 8500-8 through the MedXpress. The AME has the responsibility to review the history and perform a physical exam to determine if the airman meets aeromedical standards set forth in the Federal Aviation Regulations (FAR). If the airman does not meet these standards, the airman's medical is deferred to the AMCD for determination. The Federal Air Surgeon may grant the airman a Special Issuance. A Statement of Demonstrated Ability (SODA) may be granted if the disqualifying condition is static or non-progressive and has been found capable of performing airman duties without endangering public safety.

### [183] ROLE OF THE AEROSPACE MEDICINE SPECIALIST IN AIRSHOW PLANNING AND EXECUTION

J. Hyle[2], A.A. Angelici[1] and T. Faulkner[3]
*[1]Aerospace Medicine, Federal Aviation Administration, College Park, GA; [2]JMatt Aviation, Peachtree City, GA; [3]Medical Direction, LLC, Atlanta, GA*

**PROBLEM STATEMENT:** The Role of the Aerospace Medicine specialist in the planning, execution, and after action evaluation of public airshows. **TOPIC:** Advanced planning, scheduling, and communication and coordination have greatly improved the quality of air shows while maintaining safety and the effective management of medical events involving massive public gatherings. The Aerospace Medicine specialist serves a strategic role in the planning and implementation of airshows for the performers and general public. This presentation will review the responsibilities of Aerospace Medicine specialists involved in these massive public events; addressing common problems with related solutions to the variety of planning and execution challenges of Airshows. Further, it will address the importance of post-event assessments which can serve to improve such events in the future. **APPLICATIONS:** Aerospace medicine professionals are sought out to advise and support airshows, particularly in the areas of prevention and public health. An understanding of the importance of advanced planning and onsite coordination with visiting performers and local medical and safety resources serves not only to prevent problems, but effectively respond the myriad of illnesses and injuries to mass casualties in the event of an accident.

**Learning Objectives:**
1. Review the pertinent parties, leadership hierarchy, and timeline to consider when planning an airshow.
2. Understand the fitness for flight criteria that airshow performers must meet at these events.
3. Discuss the relevant topics to consider in a post-event review to improve future airshows.

***Tuesday, April 26*** ***10:30 AM***
***Avalon 7-9***

## S-29: PANEL: AEROSPACE MEDICINE CONSULTATION DILEMMAS - CASES FROM THE USAF AEROMEDICAL CONSULTATION SERVICE

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

**Chair: Christopher Keirns**
*Wright-Patterson AFB, OH*

**Chair: John Lynch**
*Wright-Patterson AFB, OH*

**Chair: Tighe Richardson**
*Wright-Patterson AFB, OH*

**PANEL OVERVIEW:** Since the inception of the United States Air Force (USAF), the Aeromedical Consultation Service (ACS) has used evidence based medicine to disposition aviators with medical issues that may impact safety of flight. A waiver guide is published and updated regularly utilizing published literature as well as our own data which includes over 280,000 aviators and over 2 million studies followed for over 60 years. The ACS both in person evaluation and case review consultation for all aviators in the United States Air Force, Air Force Reserve, and Air National Guard. These in depth consultations are most commonly necessary when pathology exists that is not clearly defined in our waiver guide. This panel will look at 5 such cases. Panelists include the Chief of the Aeromedical Consultation Service as well as the chief of each specialist branch within the ACS. The panel will conclude with an open question answer session for these world experts in Aeromedical Consultation.

***NOTE: Due to a computer error the abstracts in Panel S-29 and S-30 have the same numbers. We have added A and B to the abstracts to differentiate them. We apologize for this error.***

### [184-A] SPONTANEOUS PNEUMOTHORAX IN A U.S. AIR FORCE PILOT: A RECURRING PROBLEM

J.M. Sill[1,2] and D. Regn[2]
*[1]Eastern Virginia Medical School, Norfolk, VA; [2]Pulmonary Medicine, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH*

**PROBLEM STATEMENT:** This case describes a USAF pilot who developed a spontaneous pneumothorax in-flight. **BACKGROUND / LITERATURE REVIEW:** The annual incidence of spontaneous pneumothorax is up to 37 per 100,000 in males and 15.4 per 100,000in females. Risk factors include male gender, smoking, tall stature, and family history. Symptoms can be suddenly incapacitating and include dyspnea, chest pain, and hypoxemia. Recurrence is common, and the risk increases with each occurrence. Recurrence rates are 50%, 62%, and 83%, after a first, second, or third episode. One large study found the 4-year recurrence rate to be 54.2% (13.6% per year). **CASE:** A 29-yr-old male F-16 pilot presented with acute chest pain and dyspnea that began while performing air combat maneuvers. He admitted to similar symptoms in-flight the month before, but did not seek medical attention. A chest x-ray revealed a moderate, left-sided pneumothorax, requiring tube thoracostomy. A high-resolution CT revealed the presence of a left-sided bleb, not seen on chest x-ray. He underwent video-assisted thoracoscopic surgery, with bleb resection and pleurodesis. He made a full recovery and has returned to flight status, with no recurrence.

**OPERATIONAL / CLINICAL RELEVANCE:** Spontaneous pneumothorax can be suddenly incapacitating and has high relapse rates. Those with bullae and those with a recurrent pneumothorax are required to undergo surgical pleurodesis, prior to returning to flight status. The rapid pressure/volume changes associated with flight may increase the relapse rate for aviators above that of the general population. Many experts and medical societies advocate pluerodesis in aviators after a first incidence of spontaneous pneumothorax, regardless of the CT findings. Current Air force policy does not require this. However, this case highlights the importance of close monitoring and appropriate imaging after an initial episode.

**Learning Objectives:**

1. Describe the incidence of spontaneous pneumothorax and the frequency of recurrence.
2. Understand the aeromedical risks involved with a spontaneous pneumothorax.
3. Review the appropriate workup for an aviator who develops a spontaneous pneumothorax.

### [185-A] COMMON VARIABLE IMMUNODEFICIENCY AND PROTEIN WASTING IN A USAF REMOTELY PILOTED AIRCRAFT OPERATOR

L.M. Bridge and C.J. Keirns
*Aeromedical Consult Service, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH*

**PROBLEM STATEMENT:** A 30-year old, active duty, U.S. Air Force MQ-1B (a remotely piloted aircraft, or RPA) pilot presented to the flight medicine clinic with chronic diarrhea and was ultimately diagnosed with common variable immunodeficiency (CVID). In order to control his diarrhea and protein-losing enteropathy, oral budesonide was initiated. **BACKGROUND/LITERATURE REVIEW:** CVID is a genetic syndrome of impaired immunity marked by both insufficiencies in at least two of the serum immunoglobulins and recurrent upper respiratory infections. Thus, it is disqualifying for aviation duties in the USAF. Approximately 50% of those affected will develop chronic diarrhea and malabsorption, often requiring treatment with oral corticosteroid analogues. When administered as an oral capsule, budesonide is a high-potency systemic steroid with a binding affinity at the glucocorticoid receptor that is greater than both cortisol and prednisolone. However, a high first-pass metabolism of 80-90% limits its systemic bioavailability, and evidence indicates that it may convey fewer corticosteroid side effects compared to other systemic steroids at equivalent doses. Nevertheless, given the multiple organ systems affected and high risk of adverse events associated with all systemic corticosteroids, USAF policy currently prohibits use of this class of medications in all aviators. **CASE PRESENTATION:** The member's persistent diarrhea and protein wasting precluded discontinuation of corticosteroid therapy. After a period of titration, he was eventually stabilized on a lowest possible dose of oral budesonide at 3 mg daily. **OPERATIONAL/CLINICAL REVELANCE:** After establishment of disease stability and symptom control, an evidence-based literature review was performed to determine the unique aeromedical risks associated with this member's diagnoses and treatments. The emerging field of RPAs allows a novel conceptualization of aeromedical risk, as in this case. Medications and conditions that are disqualifying for manned flight may be acceptable for RPA controllers, provided there is evidence in the medical literature supporting the decision to adjust the risk determination.

**Learning Objectives:**

1. Understand the multisystem side effects of systemic corticosteroids and the aeromedical risks associated with their use.
2. Identify and describe the differences between the side effect profile of systemic low dose budesonide, high dose budesonide, and other corticosteroids at comparable therapeutic doses.
3. Apply evidence based medicine and the principles of aeromedical risk assessment to aeromedical decision-making with respect to an RPA pilot with a rare condition requiring chronic medical therapy.

### [186-A] POLYCYSTIC KIDNEY DISEASE IN A C-130 LOADMASTER PRESENTING WITH FLANK PAIN

K. Alford
*U.S. Air Force, Wright-Patterson AFB, OH*

**PROBLEM STATEMENT:** A case is presented of a USAF, C-130 Loadmaster with polycystic kidney disease to highlight the USAF Aeromedical Consultation Service approach to aeromedical disposition for service members with chronic, multi-system disease processes. **BACKGROUND / LITERATURE REVIEW:** Autosomal dominant polycystic kidney disease (ADPKD) affects nearly 1 in 500 Americans. The characteristic finding in ADPKD is the development of numerous fluid-filled cysts in the kidneys. Patients with ADPKD are susceptible to several acute renal complications such as painful hemorrhage into cysts, infections of cysts, gross hematuria and recurrent nephrolithiasis. Chronic renal insufficiency that often progresses to end stage renal disease is common in ADPKD. However, ADPKD can also impact several extra-renal organ systems with the development of valvular heart disease and an increased prevalence of intracranial aneurysms (ICA) the most aeromedically relevant. **CASE PRESENTATION:** The patient was a 23 year old C-130 Loadmaster who presented to his flight medicine clinic with several weeks of flank pain, hematuria, and dysuria. Empirical antibiotics for possible urinary tract infection were ineffective. A CT scan of the abdomen revealed multiple bilateral simple cysts consistent with a diagnosed of polycystic kidney disease. Due to a strong family history of ICA, he underwent MRI/MRA of the brain, which was negative for aneurysm. The patient's case was reviewed at the USAF Aeromedical Consultation Service. He was granted a waiver for continued flying duties but was restricted from high performance aircraft duties. **OPERATIONAL / CLINICAL RELEVANCE:** ADPKD has both acute and chronic, multi-system manifestations of potential aeromedical impact. The USAF Aeromedical Consultation Service's evaluation of the member focused on accurately defining his risk for sudden incapacitation and on monitoring requirements and best practice recommendations for reducing the risk for disease progression and aeromedically relevant clinical events such as subarachnoid hemorrhage or acute nephrolithiasis.

**Learning Objectives:**

1. Identify the aeromedically relevant complications of autosomal dominant polycystic kidney disease.
2. Discuss the indications for screening for intracranial aneurysms in aircrew members with autosomal dominant polycystic kidney disease.
3. Evaluate the USAF Aeromedical Consultation Service's process for considering aeromedical disposition in patients with chronic, multisystem diseases.

### [187-A] A CASE OF RECURRENT TRAUMATIC EPITHELIAL INGROWTH STATUS POST-LASIK

T.C. Richardson
*Aerospace Ophthalmology, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH*

**PROBLEM STATEMENT:** The U.S. Air Force 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. After extensive Department of Defense research and observed stability, intrastromal procedures (e.g., laser-assisted in situ keratomileusis [LASIK]) were deemed safe in aviators and were approved for aircrew in 2007. To date, approximately 400 stromal procedures have been accomplished. Aviator LASIK complication rates during the perioperative period are rare. The majority of complications are the result of traumatic LASIK flap dislocation with associated complications. When an aviator has a traumatic dislocation and related complications, how is his/her condition assessed? What is the natural history of treatment and follow-up in the setting of recurrent epithelial ingrowth? **TOPIC:** This case report will focus on an Air Force helicopter pilot who suffered a traumatic LASIK flap dislocation and the resulting progression of recurrent epithelial ingrowth. We will review his medical and administrative journey from duties not including flying to return to flying status. **APPLICATIONS:** Current aeromedical guidelines will be reviewed related to a history of corneal refractive surgery in aviators and special focus will be made on those with perioperative or trauma-related complications.

**Learning Objectives:**

1. To become familiar with operationally oriented complications of LASIK.
2. To become familiar with the requirements for treatment and follow-up as related to LASIK injuries.
3. To learn about how to better facilitate care for those with refractive surgery related injuries.

### [188-A] AN UNUSUAL CORNEAL TOPOGRAPHY: THE BIRTH OF THE USAF ACS REACT STUDY

T.C. Richardson, D. Rousse and S. Wright
*Aeromedical Consultation Service, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH*

**PROBLEM STATEMENT:** Abnormal corneal architectural indices (such as maximum keratometry, I-S difference, etc.) can be used to demonstrate the existence of or estimate the risk of corneal dystrophy and ectasia. In the U.S. Air Force, these indices (historically based on the Rabinowitz criteria) were evaluated as an indicator of possible early keratoconus (KCN) and prompted the Topographical Pattern Suggestive of Keratoconus (TPSK) Study. Data for this study were collected between 1998 and 2005 and demonstrated a 35% rate of progression of abnormal anatomy with the development of KCN. However, with advances in corneal imaging and evaluation, the predictive reliability of earlier criteria is being reinvestigated by the additional inclusion of newer technology parameters and indices (now based on Rabinowitz and Belin). This new study is known as the Re-Evaluation of Abnormal Corneal Topographies (REACT) Study. **TOPIC:** This case report will focus on a U.S. Air Force aviator applicant who had an abnormal corneal topography that was consistent with TPSK criteria for progression risk, but demonstrated stability and was evaluated by the world's foremost expert Dr. Yaron S. Rabinowitz. Dr. Rabinowitz determined that the applicant did not have KCN or any evidence of early keratoconus based on these newer technology parameters and indices. This case led to the development of the REACT Study, using newly developed corneal imaging indices and measurements to fully evaluate those individuals with topographical patterns that are suspicious for early keratoconus. **APPLICATIONS:** Current aeromedical guidelines will be reviewed and related to a history of TPSK and the newly implemented REACT studies.

**Learning Objectives:**

1. To become familiar with the history of USAF ACS abnormal corneal topography evaluation.
2. To become familiar with the diagnosis and natural history of keratoconus (KCN).
3. To become familiar with the REACT study and what it means for USAF aviators.

***Tuesday, April 26*** ***10:30 AM***
***Avalon 10-12***

## S-30: PANEL: RESIDENT RESEARCH PANEL--PART 1

**Chair: Richard Allnutt**
*Beavercreek, OH*

**Chair: Patrick Storms**
*Dayton, OH*

**PANEL OVERVIEW:** This panel will consist of aerospace medicine residents presenting the findings from their scholarly activity. During their residency practicum years, residents develop and execute a research project on a topic of aeromedical importance and prepare a presentation to report the results of their research. Residents will present the findings from their research projects. Engaging in scholarly activity advances resident learning and produces information that contributes positively to the body of knowledge relevant to aerospace and operational medicine.

***NOTE: Due to a computer error the abstracts in Panel S-29 and S-30 have the same numbers. We have added A and B to the abstracts to differentiate them. We apologize for this error.***

### [184-B] USAF C-130 CLASS A MISHAPS, 1980-2014: A DESCRIPTIVE ANALYSIS

A. Duong
*FEER, USAF School of Aerospace Medicine, Dayton, OH*

**INTRODUCTION:** The C-130 is the most versatile and numerous tactical air lifter in the military. There have been no previous studies of C-130 mishaps. The purpose of this study is to describe injuries and fatalities to recommend interventions for preventing injuries and preserving lives and equipment. **METHODS:** A descriptive analysis of all 42 U.S. Air Force C-130 Class A mishaps occurring from FY 1980 through FY 2014 inclusively was conducted. Chi-square and Fisher's exact tests (for small numbers) were used to analyze associations. This study reviewed the original Safety Investigation Board's reports to prevent future mishaps and fatalities and to mitigate injuries. The records of all passengers (N=314) and crew (N=278) aboard the aircraft during the mishaps were systematically reviewed and coded to investigate associated factors. **RESULTS:** Lack of restraint is associated with increased risk of fatalities (odds ratio 4.9, 95% confi dence interval 3.1-7.8), p-value < 0.0001) and increased risk of injuries (odds ratio 26.5, 95% confi dence interval 11.8-59.5, p-value < 0.0001). There is no statistical diff erence in outcomes between pilot or crew or passenger seats. **DISCUSSION:** The use of restraints on C-130 aircraft saves lives and reduces injuries. Crashworthy (pilot) seats are not signifi cantly diff erent from non-crashworthy seats onboard the C-130 in terms of mishap fatalities and injuries. Patterns of injuries, causes, and recommendations from mishap investigations may suggest mitigation strategies to reduce future mishaps. In addition, this research will assist the Air Force Life Cycle Management Center in providing advice on seating design and specifi cations for the next production requirements for the C-130 and operational protocols that ensure the best possible safety for aircrew and passengers in terms of seating and restraint.

**Learning Objectives:**

1. Characterize injuries and their causes.
2. Look for associations between injuries/fatalities and seat types, with or without restraints (seat belts).
3. Classify C-130 mishaps by cause after stratifying for human factor vs. non-human factor.
4. Provide recommendations to minimize injuries, fatalities, and equipment losses.

### [185-B] G-FORCE TOLERANCE OF ACUPUNCTURE ASP NEEDLES

T. Duffy
*711 HPW USAF, Wright-Patterson AFB, OH*

**INTRODUCTION:** This study determines the G-force tolerance of auricular ASP acupuncture (AP) needles. The aeromedical application of auricular AP may provide a medication-free approach to treating various problems in fighter pilots from musculoskeletal pain to motion sickness. **METHODS:** Using the vertical impact device (VID), determine the G-force necessary to dislodge ASP needles with and without an adhesive cover using the established 5-needle Battlefield Acupuncture pattern in a cadaver ear. An impact time of 25 ms was used to approximate an ejection sequence and a linear progressive impact force was delivered. Two cadaver ears were mounted to a composite head form that was mounted to the foot pan, which was part of a seat configuration mounted to the top of the VID drop carriage. A two-layer configuration of 2-in-thick sections of felt (16S1, 16 lb/ft$^2$) was used as the impact programmer between the VID drop carriage and the reaction base. Ten impact tests were conducted at drop heights from 2.5 to 60 in. **RESULTS:** The maximum shock level of 107 G with a velocity change of approximately 24 ft/s did not dislodge any of the ASP needles with or without adhesive covers from the cadaver ears on the test head form. **DISCUSSION:** The high G-forces experienced by fighter pilots subject them to musculoskeletal disorders. ASP needles may relieve their discomfort and enhance aviation safety. These 3-mm ASP AP needles stay in the ear for 2-28 d at 1 Gz. The concern is if dislodged in flight they could present a foreign object debris hazard in the cockpit. This research indicates it takes significant force to remove these needles and the foreign object debris risk is low.

**Learning Objectives:**

1. Battlefield Acupuncture (BFA) was developed by Dr. Richard C. Niemtzow in 2001. It is an auriculotherapy system using five ASP acupuncture needles for the relief of pain.
2. ASP acupuncture needles are not easily dislodged and can tolerate a maximum shock level of 107 G with a velocity change of approximately 24 ft/s.
3. ASP acupuncture needles stay in the ear for 2-28 days at 1 G.

### [186-B] ARE CARDIAC ARRHYTHMIAS IN AVIATORS ASSOCIATED WITH STRENUOUS PHYSICAL ACTIVITY?

J.M. Hatfield, E.D. Davenport, J. Voss and R.H. Gallavan
*USAF School of Aerospace Medicine, Wright-Patterson, OH*

**INTRODUCTION:** Recent literature suggests a reverse "J" or even "U" shaped association between all-cause mortality and levels of physical

activity, such as jogging or running, potentially due to arrhythmias (e.g., atrial fibrillation). The goal of this study was to determine the association between runtime on the Air Force fitness test and arrhythmia waiver among aircrew. **METHODS:** Cases consisted of individuals in the Aeromedical Consultation Service database with a waiver indicating arrhythmia; controls were randomly selected from those with normal electrocardiograms. Runtime was determined from initial recorded fitness test on or before the waiver year and subjects were excluded for implausible runtime (<2 min for 1.5 mi, n=8) or if runtime was unavailable. LOWESS analysis characterized the association between runtime and case status throughout the range of runtimes. Logistic regression was used for step-wise model building to identify potential confounders. **RESULTS:** The total number of subjects was 282 (94 cases): age 21 – 62 (mean 35) yr; height 62.5 – 79.0 (mean 70.8) in; runtime 7.7 – 16.5 (mean 11.8) min. In the fully adjusted model, the odds ratio (OR) for arrhythmia was 1.18 (95% confidence interval [CI] 1.05-1.33) per inch of height, OR=1.13 (95% CI 1.09-1.18) per year of age, OR=1.29 (95% CI 1.09-1.53) per unit of body mass index, and OR=0.77 (95% CI 0.64-0.93) per inch of waist circumference. There was no association between runtime and arrhythmia case status (OR=0.97 per minute, p=0.72) after adjustment for these confounders. **DISCUSSION:** In this relatively small case-control study among aircrew, arrhythmia cases had higher body mass index but lower waist circumference and were older and taller as compared to unmatched controls. Although cases also had a better fitness test score on the run component (data not shown), most conclusions about strenuous activity from our observational data are subject to limitations, particularly because fitness standards changed during the study period.

**Learning Objectives:**

1. Understand the potential for cardiac arrhythmias with vigorous physical activity.
2. Better understand the purposes of Locally Weighted Scatterplot Smoothing (LOWESS) biostatistical analysis.
3. Understand the benefit of using A Body Shape Index (ABSI), as compared to Body Mass Index (BMI).

### [187-B] LONGITUDINAL OUTCOMES OF AIRCREW AND AIRCREW APPLICANTS WITH LATTICE DEGENERATION

M.R. Brown, D.R. LaMothe and S.T. Wright
*[1]USAF School of Aerospace Medicine, Wright-Patterson AFB, OH*

**INTRODUCTION:** Vision is the most critical of the higher senses in aviation and any decrement may threaten mission success. Lattice degeneration of the retina, the most common vitreo-retinal degeneration, is of significant concern because it is one of the most clinically recognizable precursors of retinal tears and detachments. These can occur suddenly and result in significant visual compromise. The objective of this research was to determine the course of progression to retinal complications in U.S. Air Force aircrew with lattice degeneration. An understanding of complication rates in this age- and occupation-specific group with lattice degeneration allows for greater accuracy in developing risk assessments, which can help shape future aeromedical policy. **METHODS:** Two hundred sixty-eight aviators and special operators were identified based on their enrollment in the Lattice Degeneration Management Group. Evaluated metrics included age, gender, diagnosis code, age at time of evaluation, age at time of diagnosis, symptoms, refractive status, presence of high risk features for progression (i.e., retinal holes, sub-retinal fluid, and/or vitreo-retinal traction), treatment required, post-treatment results, and current aeromedical waiver status. **RESULTS:** Data analysis showed 268 subjects were tracked (254 male and 14 female) over an average period of 4.5 years (max 16.58, min 0.2). The average age of entry was 30.8 years (max 57.25, min 19.7). Six aviators experienced retinal complications while being followed in the management group. The average presentation to event was 2.6 years. The incidence of retinal complications was then found to be 1.33% per year. **DISCUSSION:** Lattice degeneration is disqualifying for all classes of USAF aviation. This study analyzed USAF data with the goal of assessing progression risk over the course of an aviation career as opposed to lifetime risk. Given that subjects were only followed for an average of 4.5 years, more data must be collected in the future to definitively determine aviation career risk. Data analyzed from this study suggests the risk of progression during an aviation career may be lower than published for lifetime risk which is currently used to set aeromedical policy.

**Learning Objectives:**

1. Understand the aeromedical risks of aviators with retinal detachment.
2. Identify risk factors for the development of a non-traumatic retinal detachment.
3. Gain an understanding of the current aeromedical policy for flyers and applicants identified with lattice degeneration.

### [188-B] THE PREVALENCE OF STRESS RELATED CONDITIONS AND SUICIDAL IDEATION AMONG USAF SPECIAL OPS COMMAND SUPPORT AIRMEN

E.R. Anderson-Doze[2], W. Chappelle[3], L. Prince[4] and T. Goodman[1]
*[1]Neurostat Analytical Solutions, LLC, San Antonio, TX; [2]Residency in Aerospace Medicine, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; [3]Aerospace Medicine Consult Division, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; [4]FECN Occupational Health Stress Screening USAF School of Aerospace Medicine, Aerospace Medicine Consult Division Prince Research and Analytic Solutions, LLC, Birmingham, AL*

**INTRODUCTION:** The purpose of this study is to assess impacts of occupational stress on Air Force Special Operations Command maintenance and support airmen. The study will seek to identify levels and symptoms of stress to include aspects of burnout (high emotional exhaustion, cynicism, low professional efficacy), high psychological distress (including high social role distress and interpersonal relationship distress), high role conflict/overload, as well as rates and demographic and occupational risk factors of suicidal ideation. **METHODS:** Participants completed a standardized survey questionnaire (AF15-016SGP) to identify sources of occupational stress and emotional and psychological distress. The survey was designed to be fully anonymous and was administered via the internet using Survey Monkey. Measures included the Maslach Burnout Inventory-General Survey, the Outcome Questionnaire-45, which assesses psychological distress, and the Sharon Glazer Role Scale. **RESULTS:** Preliminary findings are based on a 19% response rate to the survey (346 respondents). Maslach Burnout Inventory-General Survey responses revealed that 18.7% endorsed high Exhaustion, 16.4% endorsed high Cynicism, and 9.0% endorsed low Professional Efficacy. On the Outcome Questionnaire-45, 10.5% endorsed high Psychological Distress, 17.1% endorsed high Interpersonal Relations Distress, and 28.9% endorsed high Social Role Distress. Suicidal ideation was endorsed by 3.5% of participants. Based on the Sharon Glazer Role Scale, 13.2% endorsed high Role Overload and 17.3% endorsed high Role Conflict. **DISCUSSION:** Findings of this study will be used by Air Force leadership to better understand the challenges faced by special operations aircraft maintainers and support personnel. High levels of occupational stress can affect the general health and performance of these airmen, thus having an impact both directly and indirectly on aviation and crew safety. There is also particular concern for risk of suicide in this setting. Recommendations resulting from this study will be geared toward effective force management and the cultivation of strategies to improve the overall well-being of the Air Force Special Operations Command maintenance and support force.

**Learning Objectives:**

1. To become familiar with several different questionnaire tools to assess for risk of suicidal ideation.

***Tuesday, April 26*** ***10:30 AM***
***Avalon 13-14***

## S-31: SLIDE: OBSERVATIONS IN SPACE MEDICINE

**Chair: Volker Damann**
*Cologne, Germany*

**Chair: Casey Pruett**
*Cologne, North Rhine-Westphalia, Germany*

### [189] ESA'S FIRST COMPLETE DIRECT RETURN POST LANDING OPERATIONS

C. Pruett[1,2], S. Vaquer[1,2], S. Ghiste[3], F. Merzbach[2,4], U. Straube[2] and V. Damann[2]

*[1]Wyle GmbH, Cologne, Germany; [2]Space Medicine Office - European Astronaut Centre, European Space Agency, Cologne, Germany; [3]Astronaut Pre-Assignment Training, European Space Agency, Cologne, Germany; [4]Klinik für Anästhesiologie und operative Intensivmedizin Universitätsklinikum Köln (AöR), Cologne, Germany*

**MOTIVATION:** As each space fairing nation looks to optimize resource allocations with decreasing available funds, novel ideas are being implemented to maximize the return on expenditures. **OVERVIEW:** The European Space Agency had the unique opportunity with the 2015 short duration mission of one of its astronauts to the ISS to design and implement a direct return of the astronaut post landing from Kazakhstan to Cologne, Germany. This mission involved one Russian, one Kazakh and one Danish astronaut. **SIGNIFICANCE:** This situation allowed ESA to implement new ways to bring its astronaut back, similar to how NASA brings its astronauts back to the USA via its Direct Return program. Bringing the astronaut back to Cologne as quickly and safely as possible after landing enabled faster access to him for baseline data collection testing and medical evaluation. It also avoided the costly process of sending the full medical and scientific team to Russia for a three-week post flight testing and rehabilitation program at the Gagarin Cosmonaut Training Center. Furthermore, it afforded the astronaut to return quickly to his family, familiar work environment and begin his post flight rehabilitation and physiotherapy program. Numerous key elements needed thorough preparation for this mission including the following: plane selection, identification of medical equipment needed, outfitting the plane, simulation practicing with the equipment and aircrew, flight path investigation, research of health care facilities along different flight paths, arrangement with customs officials, travel logistics and coordination with the Russian Search and Rescue Forces. A dedicated physician coordinated all medical aspects for this activity, in coordination with many others to successfully implement this novel approach.

**Learning Objectives:**

1. In the European context, in order to develop and implement a direct return flight mission, several important challenges need to be overcome. Major challenges included, vertical and horizontal cooperation within ESA, route selection, aircraft medical outfitting, international collaboration and international law.

## [190] FIRST EXPERIENCES OF A COMMERCIAL SPACEFLIGHT FAMILIARIZATION PROGRAM

M. Kuypers
*XCOR, Mojave, CA*

**INTRODUCTION:** XCOR plans to perform suborbital spaceflights to an altitude of 105 km with the Lynx spacecraft in the near future. The pilot and one commercial spaceflight participant (SFP) will be exposed to alternating G-forces. XCOR has introduced a familiarization program (FP) to accustom the SFP with G-forces and to monitor their performance. **METHODS:** We prospectively collect demographic, psychological and physical data of our SFPs during the program. The FP consists of a G-simulator training (ST) exposing the subjects to maximum of +3.0 Gz, an aerobatic flight and/or a high-performance jet-trainer flight (FT) exposing the participants to +4.0 Gz. The flight profile consists of a parabolic flight maneuver mimicking 0 G for 5 seconds followed by a pullout maneuver with +4.0 Gz for 20 seconds. We monitor for G-force induced loss of consciousness (G-LOC) and symptoms of vertigo and vomiting. The SFP completes a questionnaire before and after each training session. **RESULTS:** Thus far, 35 SFPs have completed a total of 56 training sessions. All of the SFPs volunteered to participate in this research. The SFPs are predominantly male (80%), age 23-74 years with a mean of 50 years. 34% of the SFPs have a medical history of a mild chronic disease, mostly mild-moderate hypertension or stable endocrine disease. The vast majority (89%) reported no susceptibility to motion sickness and had low anxiety scores (4/10). There were two (3,6%) cases of G-LOC and only one case of vomiting (1,9%). Other reported symptoms were; mild nausea 67%, slight vertigo 44%, palpitations 48% and light-headedness 12%. **DISCUSSION:** This study population consists of actual SFPs, a new diverse group of space pioneers. They appear to be predominantly male with a mean age of 50 years, about one-third have a mild chronic disease. Self-selection bias may partly explain why anxiety levels, susceptibility to motions sickness and G-LOC are low in this group. More research needs to be done to enhance adequate training and monitoring of SFPs on commercial suborbital spaceflights.

**Learning Objectives:**

1. The participant will be able to get a better understanding on the demographic background of current commercial space flight participants (SFP).
2. The participant will learn how SFPs perform during a familiarization program, exposing them to G-forces that mimic a suborbital spaceflight.

## [191] THE REDUCTION OF MIR-33-5P INHIBITS OSTEOBLAST DIFFERENTIATION BY TARGETING HMGA2 IN SIMULATED MICROGRAVITY

H. Wang, Z. Hu, S. Zhang and X. Cao
*The Key Laboratory of Aerospace Medicine, Ministry of Education, The Fourth Military Medical University, Xi'an, China*

**INTRODUCTION:** miRNAs interfere with the translation of specific target mRNAs and are thought to thereby regulate many cellular processes. But the role of miRNAs in bone loss induced by microgravity remains unclear. **METHODS:** The differentially expressed miRNAs in femur tissue of hindlimb unloading rats were detected by miRNA microarrays. The microgravity environment of cells was stimulated by clinostat. The mRNA and protein levels of osteoblast differentiation markers, Runx2 and Osx, were tested by qRT-PCR and western blot. Bioinformatics analysis and luciferase reporter assay were used to predict and identify the target genes of miRNA. **RESULTS:** The miRNA microarray data and further qRT-PCR data showed that the expression of miR-33-5p was significantly down-regulated under stimulated microgravity environment. And the expression of miR-33-5p notably increased during the induction process of osteogenic differentiation. Both mRNA and protein level of Runx2 and Osx significantly increased following transfection with the mimic of miR-33-5p. Then, mimic of miR-33-5p was transfected into MC3T3-E1 cells prior to subjecting the cells to clinorotation. The result showed that overexpression of miR-33-5p partially attenuated the inhibition of MC3T3-E1 cells differentiation induced by simulated microgravity. Furthermore, Hmga2 was proved to be a target gene of miR-33-5p by means of luciferase reporter assay. And both mRNA and protein level of Runx2 and Osx significantly increased after transfection of siRNA-Hmga2, indicated that Hmga2 could inhibit the osteoblast differentiation. To further confirm that the induction of osteoblast differentiation by miR-33-5p depends on Hmga2, inhibitor of miR-33-5p and siRNA-Hmga2 were co-transfected into MC3T3-E1 cells. The result showed that co-transfection partially blocked the inhibitor-33-induced reduction of osteoblast differentiation. **DISCUSSION:** Our study showed that a specific mechano-sensitive miRNA, miR-33-5p, senses microgravity environment in osteoblasts and subsequently modulates osteoblast differentiation in vitro. Specifically, miR-33-5p functions by inhibiting its direct target, Hmga2, at the post-transcriptional level to negatively affect osteoblast differentiation.

**Learning Objectives:**

1. To increase knowledge of the molecular mechanism of osteopenia induced by microgravity.
2. To understand the role of miR-33-5p in osteoblasts mechanotransduction under microgravity environment.

## [192] EFFECTS OF SIMULATED MICROGRAVITY ON THE MORPHOLOGY AND GENE EXPRESSION OF HUMAN SKIN FIBROBLASTS - PRELIMINARY RESULTS

P.L. Bellicanta[1], M.A. dos Santos[2], T. Russomano[3], J. Costa da Costa[4], M. Zanini[5] and D.R. Marinowic[6]
*[1]Pharmacy School, PUCRS, Porto Alegre, Brazil; [2]Pharmacy, PUCRS, Porto Alegre, Brazil; [3]John Ernsting Aerospace Physiology Lab Microgravity Center PUCRS, PUCRS, Porto Alegre, Brazil; [4]Brain Institute, Sao Lucas Hospital PUCRS, Porto Alegre, Brazil; [5]Chemical School, PUCRS, Porto Alegre, Brazil; [6]IPB Institute of Biomedical Research, São Lucas Hospital, Porto Alegre, Brazil*

**INTRODUCTION:** The inherent characteristics of plasticity of human fibroblast cells makes it an important tool for evaluating the

effects of microgravity at a cellular level. This study analyzed the behavior of human skin fragment fibroblasts in a simulated microgravity environment. **METHODS:** Human fibroblast cells in the 8th and 17th passage, cultured under standard incubator conditions at 37°C with 5% CO2, were submitted to simulated microgravity in a 3D-clinostat for a period of 24h and 40h. After exposure, both passage cells were analyzed and compared with the control group (1G) in population doubling assays, tests of passage and microscopic analysis, as well as PCR analysis for detection of variations in the gene expression related to the cell cycle (p21, p16). **RESULTS:** Before microgravity exposure, cells belonging to the 17th passage presented characteristics of cells in an apoptotic state. After 24h and 40h of microgravity, the cells of both groups showed themselves to be more confluent and elongated. PCR analysis demonstrated that p21 expression was decreased while p16 increased. In addition, PCR analysis showed a difference in expression of p21 and p16 genes between the 24h and 40h samples. **DISCUSSION:** The present research showed cells to be more confluent and elongated after microgravity exposure, a characteristic of cells with fewer passages, suggesting alterations in their cytoskeleton. This result was confirmed by PCR analysis where a decrease in p21 expression was demonstrated. This result corroborates previous findings that among 588 genes tested, the p21 gene presented a negative expression. Conversely, the p16 gene showed a positive expression. Since both the p21 and p16 genes are related to the cell cycle, these results suggest the hypothesis of important changes having occurred in the cellular cytoskeleton and, consequently, a probable alteration in the production of cell cycle regulatory proteins (cyclins). Furthermore, RT-PCR analysis demonstrated a difference in p21 and p16 gene expression between the 24h and 40h samples, indicating the need for a more detailed comparison between the exposure times.

**Learning Objectives:**

1. The participants will be able to have a better comprehension about the effects of simulated microgravity on the morphology and gene expression of human fibroblasts skin cells. Since, in order to find evidences that could explain the morphological changes on these cells, this research comprises genetic and microscopic analysis.

### [193] IMPORTANCE OF ROTATIONAL AXIS POSITION ON CARDIOVASCULAR RESPONSE TO SHORT-ARM HUMAN CENTRIFUGATION

C. Laing[1,2], D.A. Green[2], N. Goswami[3], E. Mulder[1] and J. Rittweger[1]
*[1]Institute of Aviation Medicine, German Aerospace Center (DLR), Cologne, Germany; [2]Centre for Human & Aerospace Physiological Sciences (CHAPS), King's College London, London, United Kingdom; [3]Gravitational Physiology and Medicine, Medical University of Graz, Graz, Austria*

**INTRODUCTION:** Exposure to microgravity causes a head-ward fluid shift that current spaceflight countermeasures fail to fully ameliorate. Artificial gravity (AG) through short-arm human centrifugation (SAHC) has been proposed as a possible countermeasure. Whilst the responses to increasing g-levels have been well characterized, the effects of a shift in rotational axis position (RAP), independent of g-level, are not known. **METHODS:** Twenty (10 male; 10 female) healthy participants underwent passive SAHC in profile periods of 10 min. Each randomized profile consisted of one of three centers of rotation (above head – P1; apex of head – P2 or heart-level – P3) at one of three different g-levels (1.0, 1.7 or 2.4 $g_z$ at the feet; G1, G2 and G3 respectively). Cerebral perfusion (cerebral near-infrared spectroscopy, cTSI), central volume loss (strain gauge plethysmography for calf circumference, CC) and heart rate (HR) were all continuously measured. Data obtained were analyzed using a linear mixed effects model with written informed consent from all participants; adhering to the declaration of Helsinki and approved by the Ethics Committee of the North Rhine Medical Association. **RESULTS:** Overall, ΔCC and ΔHR increases were significantly attenuated as were ΔcTSI decreases at P3 compared to P1. In the last minute at 2.4 $g_z$, ΔCC increases were attenuated from P1 (5.02 ± 0.24 mm) to P3 (2.72 ± 0.13 mm, $p < 0.05$) and ΔHR increases were attenuated from P1 (41 ± 2 bpm) to P3 (9 ± 1 bpm, $p < 0.05$). Together, RAP at heart-level (P3) attenuated ΔCC and ΔHR increases, a measure of reduced central hypovolemia and cardiovascular response, respectively. At 2.4 $g_z$ in the final minute of centrifugation, ΔcTSI decreases were attenuated from P1 (-4.14 ± 0.31 %) to P2 (-1.56 ± 0.17 %, $p < 0.05$) and P3 (-1.03 ± 0.13 %, $p < 0.05$).

**DISCUSSION:** Currently within the literature, magnitude of centrifugation as an index of g-stress is quantified by g-level experienced at the feet only. However, within this present study we show that g-level alone is an insufficient method to classify degrees of AG and that minute changes in RAP have a significant effect on the cardiovascular response. Results of this study clearly demonstrate that placement of RAP during centrifugation deserves more attention than previously thought.

**Learning Objectives:**

1. Rotational axis position (RAP) has an influencing factor on cardiovascular response similar to characterized g-level effects. Specifically, RAP shift towards the heart being comparable to reducing g-level. Thus, future centrifuge studies would benefit from considering RAP in addition to g-level.

### [194] MOBILITY AND AGILITY: PILOT STUDY EVALUATION OF LOCOMOTION IN THE MIII SPACE SUIT ASSEMBLY

C.R. Cullinane[2], R. Rhodes[1] and L. Stirling[2]
*[1]Advaced Spacesuit Development Lab, NASA, Houston, TX; [2]Health Sciences and Technology, Massachusetts Institute of Technology, Cambridge, MA*

**INTRODUCTION:** Manned spaceflight uses spacesuit assemblies (SSAs) to maximize human performance and efficiency, while preventing injury. The Mark III Planetary SSA implements a multi-bearing, hard-material hip brief assembly (HBA). While the HBA reduces the work to change suit volume, it requires movements inconsistent with natural biomechanics. We hypothesize that the HBA alters normal gait (as measured by speed, step length, stride length, cadence, and dynamic base). **METHODS:** A subject (suited and unsuited) performed two planetary tasks—walking forwards and backwards. Motion capture and ground reaction forces were recorded. The suited tasks were performed in a tethered configuration at nominal 4.3 psi suit pressure. An analysis of variance (ANOVA) was used to examine effects of task type and suited/unsuited configuration. Post-hoc T-tests were performed where relevant. This experiment was authorized under the NASA IRB for human subjects testing. **RESULTS:** An ANOVA found a significant interaction effect of planetary task and suited configuration ($p<0.0005$). When comparing the suited with the unsuited operator ($n = 1$) during both forward and backward walking, there was a statistically significant difference found for all gait parameters $p<0.05$). When comparing the dynamic base while suited, there was no difference between walking forwards and backwards ($p=0.069$). **DISCUSSION:** The suit diminished subject mobility and stability through a decrease in speed, stride length, and step length, and increase in dynamic base. When pooling suited conditions, they dynamic base increased to 0.20 m ± 0.03 m, which is a physical limitation in the HBA. While walking forwards, the suited configuration had a reduction in cadence; however, when walking backwards, teh suited configuration had an increase in cadence. This may be a function of the interaction between the natural hip biomechanics with the operational motion envelope of the HBA.

**Learning Objectives:**

1. Understand how spacesuit design decisions impact gait and the role it plays in accomplishing mission tasks safely.

***Tuesday, April 26*** ***10:30 AM***
***Avalon 15-16***

## S-32: PANEL: UNMANNED AIRCRAFT SYSTEMS (UAS) IN SUPPORT OF CIVILIAN AND MILITARY OPERATIONS

*Sponsored by AsMA Science and Technology Committee*

**Chair: Melchor Antunano**
*Edmond, OK*

**Chair: Annette Sobel**
*Lubbock, TX*

**PANEL OVERVIEW:** This panel will give an overview of research and operational advances and current aeromedical policy in the field of UAS

platforms. The overview will provide a baseline for aeromedical decision making in this field.

### [195] UNMANNED AIRCRAFT SYSTEMS (UAS) IN SUPPORT OF AUSTERE ENVIRONMENTS

A. Sobel[2], M.J. Antunano[1], K. Williams[1] and L. Cifuentes[3]
*[1]Civil Aerospace Medical Institute, Federal Aviation Administration, Edmond, OK; [2]Medical Education, TTUHSC, Lubbock, TX; [3]VP Commercialization, Texas A&M Corpus Christi, Corpus Christi, TX*

**INTRODUCTION:** UAS and associated technologies include RPVs, drones, and UAVs, and, as such, represent a significant class of aviation platform versatility and infrastructure requirements. This presentation will address the history of platform and capabilities development and operational considerations and emerging capacity and challenges for UAS support a broad spectrum of medical operations. **METHODS:** The author will provide a historical overview of R&D in the field to include specialization that have led to new opportunities to support field medicine. **RESULTS:** Remote environments with austere infrastructure provide an important backdrop for the deployment of UAS platforms. The full span of humanitarian and disaster assistance may also benefit for this technology suite of tools. The aerospace medicine and human performance communities have a pivotal role to play integral to the development of these broadly integrated missions. **DISCUSSION:** Aviation safety and performance optimization of human-in-the-loop systems and opportunities for medically-oriented missions continue to evolve. It is anticipated that improved patient outcome, decision-support options, and logistics support to care will some of the results observed.

**Learning Objectives:**

1. Provide an overview of the components of Unmanned Aircraft Systems.
2. Identify examples of potential applications of Unmanned Aircraft Systems to medical operations.
3. Describe significant human factors issues requiring consideration in Unmanned Aircraft Systems.

### [196] CURRENT FAA REGULATORY APPROACH FOR UNMANNED AIRCRAFT SYSTEMS (UAS)

M.J. Antunano
*Civil Aerospace Medical Institute, Federal Aviation Administration, Edmond, OK*

The design and production of basic and advanced Unmanned Aircraft Systems (UAS) for civilian use is showing an exponential trend due to the efforts of many individuals, private companies, universities and government organizations in the U.S. and worldwide. A wide variety of domestic users that include industry, private citizens, and federal, state, local governments are using or expect to use UAS, could play a transformative role in fields as diverse as emergency medical support, search & rescue, disaster monitoring & response, commerce, farming, public safety, border patrol & coastal security, environmental & climate monitoring, wildlife monitoring, identification and protection of natural resources, aerial photography and video for public media use, etc. As UAS are integrated into the National Airspace System (NAS), the federal government must take the necessary steps to ensure that such integration considers not only economic competitiveness and public safety, but also the privacy, civil rights, and civil liberties concerns these systems may raise. The FAA has the responsibility to establish and ensure compliance with operational safety regulations among civilian users of UAS in the NAS. The FAA issues *Experimental Airworthiness Certificates* (EAC) for civilian UAS to do research and development (R&D), training and flight demonstrations. An EAC is currently the only way civil UAS operators are accessing the NAS. EAC regulations preclude carrying people or property for compensation or hire but do allow operations for R&D, flight and sales demonstrations, and crew training. The FAA issues a *Certificate of a Waiver or Authorization* (COA) for public aircraft used for law enforcement, firefighting, border patrol, disaster relief, search and rescue, military training, and other government operational missions. A COA allows an operator to use a defined block of airspace and includes special provisions unique to the proposed operation. Most COAs require coordination with an appropriate air traffic control facility and a transponder on the UAS to operate in certain types of airspace. The FAA has submitted to the DOT for approval a Small UAS Rule. In the meantime, exemptions are being granted by the FAA.

**Learning Objectives:**

1. Understand the FAA regulatory approach to allow the safe operation of civilian unmanned aircraft systems in the National Airspace System.

### [197] ERGONOMICS CONSIDERATIONS FOR UAS HUMAN FACTORS RESEARCH

K. Williams
*FAA CAMI, Oklahoma City, OK*

**INTRODUCTION:** Human factors research for UAS has mostly focused on control station displays and controls and problems caused by the lack of control station user-interface design standards. While these are certainly important issues, they fail to include broader ergonomic issues that have relevance to the health and safety of not only the UAS crewmembers, but also the general public who might come into proximity with UAS operations. The purpose of my discussion will be to highlight UAS human factors areas that also relate to potential medical issues and to suggest potential research topics for those issues. **METHODS:** I will identify several ergonomics-related topics that might have an effect on health and safety and will suggest ways to address these topics through research, training, or the development of guidelines. **RESULTS:** These topics will include the role of control station design in the development of repetitive motion disorders and other types of strain-related injuries, the potential for UAS launch operations to contribute to shoulder injuries, dangers to the public caused by small UAS operations, and dangers to UAS pilots from small UAS operations. **DISCUSSION:** Mitigations for these problems include the redesign of control stations, the use of visual observers for certain operations, the development of launch and recovery protocols, and the development of operational protocols for small UAS operations. The continued growth of the UAS market will be determined, at least partially, by the prevention of serious injuries or deaths related to their operation. Addressing these issues now is critical to that growth.

**Learning Objectives:**

1. Provide an overview of UAS ergonomics research areas that relate to potential aeromedical issues.
2. Identify ergonomics related topics in UAS research.
3. Describe medical conditions that may be mitigated by UAS ergonomics research.

### [198] A MODEL FOR USING FAA TEST SITES TO RESEARCH, DEVELOP, TEST AND VALIDATE CIVILIAN AND MILITARY UAS MEDICAL OPERATIONS

L. Cifuentes
*VP Commercialization, TAMUCC, Corpus Christi, TX*

**INTRODUCTION:** Our presentation will offer the value proposition for using FAA Test Sites to research, develop, test and validate current and future UAS activities supporting civilian and military medical operations. Additionally, we will provide a synopsis of the features and benefits offered today via the Lone Star UAS Test Site for review and validation of operational and safety procedures for UAS operators. **METHODS:** Mechanisms for developing federal and state agency, academic and industry partnerships will be addressed. **RESULTS AND DISCUSSION:** Lastly, we will provide an overview of the Beyond Visual Line of Sight (BVLOS) road map for civilian and military medical operations in the National Airspace.

**Learning Objectives:**

1. Describe testbed capabilities relevant to real-world UAS operations.
2. Identify operational and safety procedures required for UAS operators.
3. Describe a National Airspace roadmap for medical UAS operations.

***Tuesday, April 26*** ***10:30 AM***
***Avalon 17***

## S-33: PANEL: GUARDING THE 24/7/365 REMOTE WEAPON STRIKE WARRIOR: OPERATIONAL MEDICINE CHALLENGES AND VALUE-DRIVEN SOLUTIONS

**Chair: Brig Gen Christopher Knapp**
*Freeburg, IL*

**Chair: James McEachen**
*Lackland AFB, TX*

**Chair: Paul Young**
*Lackland AFB, TX*

**PANEL OVERVIEW:** This panel offers a Total Force (Active Duty, Air National Guard, and Air Force Reserve Command) look at the state of the remote weapon strike warrior, their operational challenges, and value-driven solutions for operational medicine support. The integrated combination of Remotely Piloted Aircraft (RPA) and the Distributed Common Ground System (DCGS) embodies an approach to warfare that has redefined doctrine. Mission execution is Total Force by design. The capabilities brought to bear by this weapons system is in high demand with a global impact that has driven the community to sustain 24/7/365 operations for more than a decade. Unfortunately, measures of burnout and psychological distress have risen to levels rivaling those of the military's most demanding specialties. This panel will explore these challenges along with value-driven solutions to enhance operational medical support for these key frontline warriors. The first presentation provides an overview of RPA and DCGS, their operational environment, and overarching operational medicine challenges. A series of three linked presentations will then follow with results drawn from comprehensive occupational health assessments conducted across multiple RPA and DCGS squadrons. This includes a presentation analyzing Total Force data concerning the sources and levels of medically significant psychological distress within the community. Next will be a presentation elucidating the prevalence of problematic health-related behaviors affecting readiness (such as sleep, exercise, alcohol consumption, caffeine/energy supplemental usage) and the associated challenges to aeromedical support. This will be followed by a presentation that analyzes cutting-edge data regarding the emotional reactions to killing reported by RPA operators engaged in weapon strike operations. The final panel presentation leverages the findings from the previous presentations to help assess the value of an embedded operational medicine support team in enhancing warfighter effectiveness within this unique environment. Rounding out this panel will be a discussion forum led by senior medical cadre with direct ties to the remote weapon strike warrior community.

### [199] WHAT YOU NEED TO KNOW ABOUT THE REMOTE PILOTED AIRCRAFT (RPA) AND THE DISTRIBUTED COMMON GROUND WEAPONS SYSTEM (DCGS) OPERATING ENVIRONMENT

C.M. Thurman[1], J.C. McEachen[2], C. Young[3] and R.M. Shideler[4]
*[1]SG, 480 ISR Wing, Hampton, VA; [2]25th AF/AG, Beavercreek, OH; [3]25th AF, San Antonio, TX; [4]U.S. Air Force, Beale AFB, CA*

**PROBLEM STATEMENT:** The RPA/DCGS community represents a formidable high demand, global impact weapons system that has been engaged in 24/7/365 operations for more than a decade. With a 2300% increase in workload over 13 years, they have been operating at near 100% capacity for over a decade. Medical evidence clearly supports that shift workers have increased rates of cardiovascular disease, diabetes, depression, and cancer. The challenge to operational medicine and a key tenet of this panel is identifying best practices to promote these frontline warriors' health and performance within their operational environment. **TOPIC:** RPA/DCGS operators are the remote equivalents of the "front end" and "back end" of a flying platform. They engage in wartime operations on a daily basis. Contrary to popular belief, this form of warfare is one of the most personal ever seen. Operators often know more about their targets than they know about their own neighbors. The decisions they make can directly impact who lives and dies on the battlefield. Further, the rapid juxtaposition of wartime decisions and home life make compartmentalization much more difficult. There are several isolating barriers encountered by RPA/DCGS operators. They are isolated by shift schedules, which limit formation of social networks proven to help promote resiliency. Operators are isolated by the classification of the work. They frequently cannot share events which may be causing them emotional distress with friends and family, nor their biggest successes. Many sites are geographically isolated. In remote areas, operators have limited access to medical services, food options and housing. Further, long commutes quickly turn 12 hour work days into 15 hours. **APPLICATIONS:** The RPA and DCGS operational environment represents a challenging and worthy arena for ensuring adequate medical/psychological support. The problems outlined above cannot be solved within the confines of the traditional medical system. Multiple studies have shown the effects of this type of warfare on RPA/DCGS operators. A new form of warfare needs a new way to care for its warfighters.

**Learning Objectives:**
1. The RPA/DCGS operational environment is isolating as well as emotionally and cognitively challenging.

### [200] SOURCES AND LEVELS PSYCHOLOGICAL DISTRESS AND POST-TRAUMATIC STRESS DISORDER IN USAF REMOTELY PILOTED AIRCRAFT OPERATORS

E. Skinner[2], W. Chappelle[3], T. Goodman[1], W. Thompson[1] and L. Prince[4]
*[1]Neurostat Analytical Solutions, LLC, San Antonio, TX; [2]USAFSAM, Wright-Patterson AFB, OH; [3]USAFSAM, WPAFB, OH; [4]Prince Research and Analytic Solutions, LLC, Birmingham, AL*

**INTRODUCTION:** USAF Predator /Reaper remotely piloted aircraft (RPA) have emerged as critical assets to intelligence, surveillance, reconnaissance and close air support operations. The increased requirement for mission support has created a rapidly expanding need for Predator/Reaper operators to keep pace with the surge in operations. Research assessing the psychological impact of balancing around-the-clock war fighter roles with domestic/personal lives on a daily basis is limited. The purpose of this study was to assess for main sources of occupational stress, the prevalence of aeromedically significant levels of psychological distress, and symptoms of post-traumatic stress disorder (PTSD) among the airmen. **METHODS:** A total of 1796 (88% male; 12% female) RPA operators (pilots, sensor operators and mission intelligence coordinators) from three USAF major commands participated in the study. Participation in the anonymous survey was coordinated by the USAF School of Aerospace Medicine and granted exemption by the Wright-Patterson Air Force Base IRB. The estimated response rate was 34%. Participants completed a demographic and occupational questionnaire in addition to the Outcome Questoinanaire-45.2 (measuring clinical distress) and the PTSD Checklist-5 (measuring the prevalence of PTSD). Group means and standard deviations were calculated, as well as logistic regression and chi-square analyses to identify occupational and demographic predictors of aeromedically significant psychological distress. **RESULTS:** Qualitative analysis revealed the top sources of occupational stress to be low manning, long hours, shift work, and excessive workload. Overall, 14% of RPA operators met the cutoff for high levels of clinical distress, and 5% met PTSD symptom criteria. Key operational, demographic, and behavioral health predictors were identified. **DISCUSSION:** Sources and levels of aeromedically significant psychological distress among RPA operators provide insightful knowledge for operational medicine providers, integral to precision-based healthcare and for targeting key areas affecting performance in this unique and constantly evolving aviation platform.

**Learning Objectives:**
1. Identify the top sources of stress, levels of clinical distress, and prevalence rate of PTSD in the RPA community.

### [201] OCCUPATIONAL HEALTH SCREENING OF USAF REMOTELY PILOTED AIRCRAFT OPERATORS

K.A. Traut[3], W. Chappelle[3], E. Skinner[3], T. Goodman[1], W. Thompson[1,3] and L. Prince[2]

*[1]Neurostat Analytical Solutions, LLC, San Antonio, TX; [2]FHOH, USAF School of Aerospace Medicine, Birmingham, AL; [3]USAF School of Aerospace Medicine-Aeromedical Research, Wright-Patterson AFB, OH*

**INTRODUCTION:** U.S. Air Force Predator /Reaper remotely piloted aircraft (RPA) have emerged as critical assets to intelligence, surveillance, and reconnaissance missions for delivering weapons on targets for close air support and precision strike operations. The health and wellness of RPA operators are critical to sustaining performance readiness; therefore, the purpose of this study was to conduct a field survey to assess for general areas of health-related behaviors. **METHODS:** A total of 1,796 (88% male, 12% female) RPA operators completed the anonymous, web-based survey. Participation in the survey was coordinated by the U.S. Air Force School of Aerospace Medicine and granted exemption by the Air Force Research Laboratory Institutional Review Board. The estimated response rate was 34%. Statistical analyses were performed to assess for between-group major command differences to quantitative and qualitative items assessing sleep, exercise, tobacco, alcohol and caffeine use, medical conditions worsened by occupational stress, healthcare utilization, and medication utilization. **RESULTS:** RPA operators in this study reported the following: getting less sleep than national averages and sleep patterns that may put them at elevated risk for accidents and/or illness; getting less exercise than recommended standards; and rates of alcohol and tobacco use less than or equal to the American adult population. Problematic caffeine/energy drink usage was endorsed by 22% of RPA operators. Prescription and OTC medication use increases were endorsed by 9% and 17% of operators, respectively, for reasons reported to be stress management, sleep management, and pain management. Above normal alcohol consumption per occasion was reported by 26-27% of male and female RPA operators, with 7% reporting monthly binge drinking. Overall, health-related behaviors were predominantly attributed to occupational environment across all three major commands. **DISCUSSION:** Recommendations are provided for line and medical leadership for optimizing the health of RPA operators. The results provide key areas to target for mitigating the prevalence of problematic health behaviors and health-related problems affecting readiness and performance conditions.

**Learning Objectives:**

1. Gain understanding about current reported levels of occupational stress among USAF RPA operators.

## [202] PRE-POST WEAPON STRIKE EMOTIONAL REACTIONS TO KILLING AMONG USAF REMOTELY PILOTED AIRCRAFT PREDATOR-REAPER OPERATORS

W. Chappelle[2], E. Skinner[1], K.A. Traut[1] and J. Campo[3]
*[1]USAF School of Aerospace Medicine-Aeromedical Research, Wright-Patterson AFB, OH; [2]Aeromedical Operational Psychology, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; [3]Headquarters Air Force, Pentagon, DC*

While the demand for USAF Remotely Piloted Aircraft (RPA) weapon strike missions has increased over the last decade, the emotional impact on pilots and sensor operators bearing the responsibility of carrying out such missions remains unclear. The purpose of this study is to identify the range and impact of emotional reactions among RPA operators who have employed weapons and killed via remote-combat. Participants included USAF Predator/Reaper pilots and sensor operators (n = 150+) from 13 separate squadrons engaged in around-the-clock operations and who employed weapons and killed enemy combatants. Individual interviews were conducted and a range of self-reported responses were identified pre-post weapon strikes. Negative self-reported responses were further categorized according to: acute vs. chronic, disruptive vs. non-disruptive, and resolved vs. unresolved. The results of this study revealed operators simultaneously experience a wide range of both positive and negative emotional reactions following weapon strikes with confirmed killing of enemy combatants. Approximately 41 - 44% of operators reported disruptive, negative emotional reactions that led to noticeable changes in their demeanor and 10 - 14% reported having unresolved emotional difficulties and/or internal conflict following a weapon strike. Demographic (e.g., age, marital status, gender) and operational variables (e.g., duty position, high definition video feed, civilian/military casualties, deployment experience, etc.) were assessed for elevating the risk for disruptive emotional reactions. The results of the study identify the salient and complex emotional reactions that operators experience in response to weapon strike missions. The implications of the study findings include, but are not limited to: the expansion of proactive measures to psychologically prepare and support RPA aircrew, reprioritizing flight medicine and mental health support requirements to focus on the highest risk areas, increasing post-mission socialization following weapon strikes, and improving post-kill leadership engagement and support.

**Learning Objectives:**

1. Understanding the breadth and depth of emotional reactions that RPA weapon strike pilots and sensor operators experience prior to, during, and following weapon strike missions.
2. Understanding how to categorize and evaluate the impact and potential for disruptive post strike emotional reactions among RPA pilots and sesnor operators.
3. Understanding demographic and operational variables, as well as mission outcomes (i.e., collateral damage, civilian or military casualties) that elevate the risk for disruptive and unresolved emotional reactions if untreated.

## [203] THE VALUE OF EMBEDDED OPERATIONAL MEDICAL SUPPORT FOR 24/7/365 REMOTE WEAPON STRIKE OPERATIONS

J.C. McEachen[1], W. Chappelle[2], L. Prince[3], E. Skinner[2] and C. Young[1]
*[1]25th AF/SG, Lackland AFB, TX; [2]USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; [3]USAF School of Aerospace Medicine, Birmingham, AL*

**MOTIVATION:** Integrated Remotely Piloted Aircraft (RPA) and Distributed Common Ground System (DCGS) 24/7/365 operations have redefined military doctrine. As exemplified by the U.S. Air Force School of Aerospace Medicine (USAFSAM) survey results presented in this panel, a growing Total Force need exists within the RPA/DCGS community to help enhance warfighter effectiveness within their operational environment. **OVERVIEW:** Over the past five years, operational support teams comprising medical and/or behavioral health experts with appropriate security clearances have been embedded in select locations to provide continuous, direct support to Total Force RPA and/or DCGS operators. Based on a composite examination of USAFSAM surveys completed over the past 5 years, unit-wide incident rates of key measures of distress decreased by up to 52% in locations where a dedicated, full-time operational medical/psychological support team had been integrated. There was also evidence of improved service member availability based on Air Force Individual Medical Readiness results as well as supportive comments from RPA/DCGS commanders and operators describing enhanced mission support. **SIGNIFICANCE:** Addressing human performance optimization is at the heart of effective operational medicine. This is evidenced by the vision set forth by the Department of Defense Consortium on Health and Military Performance (CHAMP) of enhancing warfighter performance within the operational environment as well as the emergence of transformational Air Force Medical Service CONOPS forging a new era in health and human performance. Current data suggests that an embedded operational medical/psychological support team offers a value-driven solution for helping better address key human performance needs amongst an identified at-risk population working 24/7/365 RPA and DCGS operations. As remote weapon strike operations continue to evolve, these results help inform operational medicine professionals who are looking for effective solutions to better enhance human performance in demanding operational environments.

**Learning Objectives:**

1. Assess the value of an embedded operational medical/psychological support team for enhancing warfighter health and human performance within the RPA & DCGS operational environment.

***Tuesday, April 26*** ***10:30 AM***
***Avalon 6***

## S-34: PANEL: LINKED IN TO HISTORY: INTRIGUING FIGURES IN AEROSPACE MEDICINE

*Sponsored by the Aerospace Physiology Society*

**Chair: James Davis**
*Shaw AFB, SC*

**Chair: Troy Faaborg**
*Washington, DC*

**PANEL OVERVIEW:** This panel will explore the colorful figures who contributed to the study and practice of aviation medicine, through educational and entertaining biographical sketches. Many historical figures have shaped the field into what we know today - some names you may recognize, and some you may not. Either way, their stories define the history of aerospace physiology, so sit back and enjoy these presentations that will get you "Linked In to History."

### [204] WILEY HARDEMAN POST: FAMED AVIATOR, ENTREPRENEUR, AND RESEARCHER

S. Williams
*U.S. Air Force, Department of Defense, APO*

**INTRODUCTION:** Wiley Post might be one of the most unassuming aviation pioneers as he only managed to complete the sixth grade, was a construction worker, served as a "roughneck" in the Oklahoma oilfields and was a parachutist for a flying circus. This presentation will take you through the incredible journey of Wiley Post and how his unwavering drive aided in several contributions to aerospace medicine, such as being the first pilot to fly solo around the world, discovering the jet stream and helping develop the first functional pressure suit.

**Learning Objectives:**
1. Understand the life and contributions of a pioneer of aviation's Golden Age, Wiley Post.
2. List the contributions Wiley Post made to aerospace medicine.

### [205] DR. EARL WOOD: PHYSICIAN, RESEARCHER, AMERICAN PATRIOT

J. Harvey
*Safety Issues Division, AF Chief of Safety, U.S. Air Force, Alexandria, VA*

During the height of World War II, Dr. Earl Wood and his colleagues at the Mayo Clinic Aero Medical Unit embarked on a quest to discover the limitations of the human body by developing the first civilian human centrifuge in the United States. It is often underappreciated that he and his colleagues awoke every morning and risked their lives in the service of their nation by being their own guinea pigs in the name high-G and high altitude physiological research. Their "Top Secret" research commissioned by the Army Air Corps laid the foundation for the science behind high-G flight and is credited with saving the lives of many American military pilots contributing greatly to the outcome of the war. Accredited with such first as: the anti g-suit, M-1 straining maneuver, arterial blood pressure gauge, and human diagnostic cardiac catheterization, this presentation will highlight Dr. Earl Wood's discoveries in aerospace physiology how these discoveries live on in medical care today.

**Learning Objectives:**
1. Understand the contributions of Dr. Earl Wood to modern aerospace physiology and aviation.

### [206] HISTORICAL FIGURES: JOSEPH W. KITTINGER, COL, USAF (RET)

M.M. Metzler
*Aerospace & Operational Physiology, United States Air Force, Tyndall AFB, FL*

**INTRODUCTION:** In 1997, Joe Kittinger was enshrined in the National Aviation Hall of Fame in Dayton Ohio for his record-setting free fall on 16 August, 1960. On that day, he jumped from 102,800 feet, setting four world records. He was also the capsule communicator during Felix Baumgartner's historic free fall on 12 October 2012, assisting the Austrian skydiver in breaking his own record that stood for over 50 years. Though most well-known for his jump in 1960, Col Kittinger is also a decorated Vietnam veteran and former POW. Col Kittinger joined the U.S. Air Force in 1949, and earned his pilot wings at Goodfellow AFB in 1950. Volunteering for three tours of duty in Vietnam, Kittinger logged 483 combat missions, shooting down a Vietnamese MiG-21. He and his WSO were later shot down in an F-4D in 1972, were captured, and spent 11 months at the Hanoi Hilton. Kittinger was promoted to full bird Colonel while in captivity. He retired from the USAF in 1978, having earned two Silver Stars, two Legions of Merit, six Distinguished Flying Crosses, three Bronze Stars, and two Purple hearts, among many other achievements. Currently he serves as an aviation and aerospace consultant, and has recently been barnstorming in a 1929 New Standard bi-plane, built for the Gates Flying Circus.

**Learning Objectives:**
1. Recognize the outstanding achievements of Col Kittinger and his contributions to broadening the horizons of aerospace knowledge.

### [207] ROBERT BOYLE: THE FIRST EXPERIMENTS ON HYPOBARIC HYPOXIA AND DECOMPRESSION SICKNESS

N. Sevilla
*U.S. Air Force, Alexandria, VA*

Robert Boyle (1627-1691) was a leading intellectual physiologist of the 17th century and most famous for his "Boyle's Law" that reveals the inverse relationship between the pressure and volume of gas at constant temperature. Along with his assistant, Robert Hooke, Boyle designed the first air pump to witness and experiment on the deleterious effects of hypobaric hypoxia on different animals. In one of his observations, Boyle and Hooke gave the first description of the gas bubbles of decompression sickness. These foundations of exposure to partial vacuum eventually led to the creation of "a vessel for extracting the air, so large that a man might fit in it;" thus directly leading to the invention of the first human decompression chamber. The understanding of respiration within the understanding of Boyle's Law is the foundation of aerospace physiology training and the development of high-altitude life support equipment.

**Learning Objectives:**
1. List the influences Robert Boyle made to understanding high-altitude physiology.
2. Describe the impact of "Boyle's Law" to aerospace physiology training.

### [208] BRILLIANT LEADER AND SCIENTIST: THE ACHIEVEMENTS OF CAROLYN LEACH HUNTOON

A. Fox-Lippert
*Naval Air Systems Command, U.S. Navy, Patuxent River, MD*

Carolyn Leach Huntoon (b. 1940) is perhaps best known for having been the first woman Director of NASA's Johnson Space Center. However, this Aerospace Medical Association Fellow has also pioneered research in fields involving man's adaptation to weightlessness, and the human body in the space flight environment. In addition to writing and editing text within some of the most widely used books in the field of Aerospace Medicine, her many academic publications have paved the way for astronauts to successfully navigate the wildly dynamic surroundings of space. Her leadership acumen stretched beyond her career with NASA, to include a noteworthy position with the United States Department of Energy and numerous prestigious awards within the aerospace community.

**Learning Objectives:**
1. List the leadership influences Carolyn Leach Huntoon made on women in the fields of aerospace medicine and astronautical science.
2. Describe the impact of Carolyn Leach Huntoon's research in the human body's adaptations to the space environment.

***Tuesday, April 26*** ***2:00 PM***
***Avalon 1-3***

## S-35: PANEL: PERFORMANCE ENHANCING DRUG USE BY AIRCREW

*Sponsored by the AsMA Air Transport Medicine Committee*

**Chair: Nadia Bastaki**
*Dubai, United Arab Emirates*

**Chair: Ries Simons**
*Soesterberg, Netherlands*

**PANEL OVERVIEW:** The utilization of performance enhancing drugs by aircrew in commercial aviation operation has direct impact on flight safety. The panel will discuss the epidemiology of the utilization of those drugs as well as the clinical and safety implications of their use.

### [209] PERFORMANCE ENHANCING DRUGS FOR PILOTS: WHY NOT?

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

**PROBLEM STATEMENT:** Job stress and social demands of pilots are increasing. Mismatch between job demands and social demands are an important cause of stress. The impact of life stressors on someone's life is difficult to objectify and shows huge inter-individual variation in effects. Pilots are often reluctant to seek help for these problems. There is evidence that life stress can impair performance and may disrupt sleep. This leads to increased levels of fatigue, which in turn impairs cognitive and social performance (e.g., decreased response accuracy, narrowing of attention, social withdrawal). There is an increase of atypical employment of pilots and some pilots fly while sick or severely fatigued because they are paid per hour flown. There is anecdotal evidence that some of these pilots use alertness and performance enhancing drugs. The question is what consequences above developments may have for flight safety. **TOPIC:** This presentation will discuss life stresses of pilots and the aeromedical considerations regarding flight safety of pilots using psychostimulants ('smart drugs' or 'neuroenhancers'), or anti-depressants. In that context, the properties and effects of various neuroenhancers that are used in Europe will be discussed. **Discussion:** Aeromedical Examiners should give their pilots guidance concerning professional life style, preventive health measures, use of medication, and coping strategies. In case a pilot (occasionally) uses smart drugs to improve alertness and performance, it is recommended to discuss with him/her how one can cope without using drugs and consider an 'anti-skid' or 'wingman' approach.

**Learning Objectives:**

1. The participant will be able to learn what the consequences of using neuroenhancing drugs can be for aircrew and what the considerations are in the context of flight safety.

### [210] THE ROLE OF PHARMACEUTICAL ENHANCEMENT IN AVIATION: FACT VERSUS FANTASY

J.A. Caldwell
*Coastal Performance Consulting, Key West, FL*

**INTRODUCTION:** The fast-paced 24/7 nature of modern aviation operations poses significant challenges for human physiological capabilities. As a result, aircrew members often suffer from fatigue due to sleep and circadian disruptions. Stimulant and hypnotic medications can be highly beneficial fatigue countermeasures, but unfortunately, the utility of these compounds is often questioned due to misinformation, political factors, and media hype. **METHODS:** A review of select studies on the efficacy and safety of alertness-enhancing and sleep-promoting compounds, along with a review of myths and facts surrounding the use of these medications has been examined. **RESULTS:** Substantial evidence exists that current U.S. military use of performance-enhancing medications is both safe and effective. Placebo-controlled, systematic investigations support the favorable cost/benefit analysis of alertness aids such as caffeine, modafinil, and dextroamphetamine for the sustainment of pilot performance in situations devoid of adequate sleep opportunities. Similarly, well-controlled investigations also fully support the utility of hypnotics such as zolpidem and temazepam for the preservation of pilot performance in circumstances where sleep opportunities exist but are compromised due to circadian or environmental factors. **DISCUSSION:** The "Just Say No to Drugs" mentality may be culturally correct, but is contrary to the peer-reviewed scientific data on this topic. Properly utilized alertness-enhancing and sleep-promoting medications can offer a significant safety and performance benefit in aviation operations.

**Learning Objectives:**

1. Separate the myths and facts surrounding the utility of pharmacological compounds for optimizing safety and performance in aviation operations.

***Tuesday, April 26*** ***2:00 PM***
***Avalon 7-9***

## S-36: PANEL: MAINTENANCE OF CERTIFICATION: EPIDEMIOLOGY/BIOSTATISTICS AND REVIEW OF RESPIRATORY AND METABOLIC DISEASES

*Sponsored by the American Society of Aerospace Medicine Specialists*

**Chair: Cheryl Lowry**
*Alexandria, VA*

**Chair: Kimberly Toone**
*Alexandria, VA*

**PANEL OVERVIEW: PROBLEM STATEMENT:** The American Board of Preventive Medicine (ABPM) has four distinct requirements for maintenance of certification (MOC): **Part 1: Professional Standing -**Diplomates must hold an active, valid and unrestricted medical license in all States, US territories, or Canadian Provinces in which the diplomate is licensed to practice medicine. **Part 2: Lifelong Learning and Self-assessment (LLSA) -** A total of 250 hours of Continuing Medical Education (CME) over the 10-year span of certification is required. **Part 3: Assessment of Cognitive Expertise -** Diplomates holding time-limited certificates will be required to take and pass a cognitive exam. **Part 4: Assessment of Practice Performance -** Diplomates are required to complete two practice performance assessments during their 10 year certification cycle. TOPIC: This panel, sponsored by the American Society of Aerospace Medicine Specialists (ASAMS), will address Part 2 of the MOC requirements by providing a lecture series on topics within the core competencies of Aerospace Medicine. This panel will provide a review of Epidemiology and Biostatistics as well as discuss Respiratory and Metabolic Diseases including their epidemiology, screening requirements, and preventive strategies. **APPLICATIONS:** As stated by the ABPM, "Aerospace medicine focuses on the clinical care, research, and operational support of the health, safety, and performance of crewmembers and passengers of air and space vehicles, together with the support personnel who assist operation of such vehicles." In order to provide care to such a diverse and complicated population, continuing education is a vital tool that must be addressed throughout the 10 year certification period and not simply relegated to a few weeks prior to the examination. This series is intended to supplement other continuing education procedures and should not be used as "stand alone" course for MOC. **RESOURCES:** Additional information on MOC can be found at https://www.theabpm.org/moc/requirements.cfm, https://www.theabpm.org/public/studyguide.pdf. Information about ASAMS can be found at http://www.asma.org/about-asma/constituents/american-society-of-aerospace-medicine-specialists.

### [211] MAINTENANCE OF CERTIFICATION: EPIDEMIOLOGY/ BIOSTATISTICS AND REVEIW OF RESPIRATORY AND METABOLIC DISEASES

K. Toone[2,1]
[1]*U.S. Navy, Virginia Beach, VA;* [2]*ASAMS, Alexandria, VA*
(See Overview for details)

**Learning Objectives:**
1. The purpose of this panel is to provide information on Aerospace Medicine core competencies and comply with the requirement for lifelong learning as a vital component of maintenance of certification.

***Tuesday, April 26*** ***2:00 PM***
***Avalon 10-12***

## S-37: PANEL: RESIDENT RESEARCH PANEL--PART 2

**Chair: Richard Allnutt**
*Beavercreek, Ohio*

**Chair: Patrick Storms**
*Dayton, Ohio*

**PANEL OVERVIEW:** This panel will consist of aerospace medicine residents presenting the findings from their scholarly activity. During their residency practicum years, residents develop and execute a research project on a topic of aeromedical importance and prepare a presentation to report the results of their research. Residents will present the findings from their research projects. Engaging in scholarly activity advances resident learning and produces information that contributes positively to the body of knowledge relevant to aerospace and operational medicine.

### [212] RETROSPECTIVE COHORT STUDY OF PREDICTIVE RISK FACTORS FOR CORONARY ARTERY DISEASE BY ANGIOGRAPHY IN U.S. AIR FORCE AVIATORS WITH CORNARY CALCIFICATION

M.S. Lee[2,1], E.D. Davenport[2,1] and R.H. Gallavan[2,1]
*[1]Aerospace Medicine, 711 Human Performance Wing, Wright-Patterson AFB, OH; [2]USAF School of Aerospace Medicine, Wright-Patterson AFB, OH*

**INTRODUCTION:** Advances in computed tomography (CT) technology have enabled coronary calcium scoring as a risk stratification tool for coronary artery disease (CAD). Literature also indicates that the type of plaques involved in acute coronary events may be related to soft plaques with or without significant luminal blockage or calcium deposition, thus coronary angiography is currently the gold standard for assessing risk in aviators in the United States. We hypothesize that calcium scores can be used as a predictive risk factor in assessing the severity of CAD in USAF aviators. **METHODS:** The Air Force Research Laboratory Institutional Review Board approved the study. We reviewed 524 cases from the USAF Aeromedical Consult Service (ACS) CAD working group from January 1978 to December 2014. To analyze outcomes, we used linear regression comparing calcium scores to aggregate CAD blockage and Student's t-tests to compare mean calcium scores to significant outcomes using varying cutoffs for USAF ACS CAD classifications as defined by luminal disease (<10%), minimal disease (aggregate block <50%), moderate disease (aggregate block ≥50% and <120%), significant disease (aggregate block ≥120% or >70% maximum lesion), or percutaneous intervention. **RESULTS:** Forty cases had positive coronary CT calcium scores. Cases with endovascular procedures prior to calcium scoring and those without follow-up angiography were excluded. We identified 19 aviators with positive CT calcium scores who then completed coronary angiography. Student's t-test analysis did not show significant differences in calcium scores related to CAD classification on angiography. Linear regression analysis showed statistically significant positive correlation between aggregate CAD percentages and CT calcium scores. **DISCUSSION:** Coronary calcium scoring showed statistically significant correlation with aggregate percent blockage on coronary catheterization and a trend towards ACS CAD classification in USAF aviators. Further research in coronary risk stratification using non-invasive imaging options for aviators with CAD using coronary calcium burden, lesion location, and evaluation of intraluminal disease is needed.
**Learning Objectives:**
1. Understand CT calcium score's role in assessing CAD risk for aviators.

### [213] A VALIDATION STUDY OF A NOVEL METHOD TO IDENTIFY AND QUANTIFY THE STRUCTURAL ISOMERS OF TRICRESYL PHOSPHATE

B. Park[1], J. Martin[2] and C. Grabinski[2]
*[1]USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; [2]711th HPW, Wright-Patterson AFB, OH*

**INTRODUCTION:** The *ortho* isomer of tricresyl phosphate (ToCP) is a well-described toxicant known to induce delayed neurotoxicity in experimental models. ToCP and its *meta* and *para* structural isomers are used in commercial jet engine oils as an anti-wear additive with potential for exposure to passengers and aircrew in times of fume events. A liquid extraction and inject method was previously developed for gas chromatography/mass spectrometry that was able to characterize and quantify aircraft maintenance fluid mixtures. This is a validation study of this analytic method in detection and quantification of ToCP. **METHODS:** TCP and its individual isomers were purchased as standards for quantification. Calibration curves were created using the known standards mixed with an internal standard of d26-dodecane (1 µg/mL final). Calibration curves were created with a sample of aircraft engine oil used in the Boeing C-17 aircraft for qualitative and quantitative method validation. Known quantities of TCPs were then spiked onto glass fiber filters and subjected to airflow in a custom manifold simulating a pumped flow sampling environment used for real world air sampling. The filters were extracted with solvent, and the results were compared with the standards for quantitation and extraction efficiency estimates. Samples were run utilizing a triple quadrupole gas chromatography/mass spectrometry system. **RESULTS:** Lower limits of detection for known standards of TCP and isomers ToCP, TmCP, and TpCP were 4.5e-2+-0.003 µg/mL, 3.72e-2+-0.002 µg/mL, 2.01e-2+-0.001 µg/mL, and 4.76e-2+-0.007 µg/mL, respectively. The coefficient of determination ($R^2$) was above 0.98 for a 5-point curve for TCP mixture and all individual isomers. **DISCUSSION:** Our results show detection limits of the separate isomers of TCP to be as sensitive as methods previously described. The utility of this method is evident in times of exposure to unknown aircraft maintenance fluid mixtures ranging from low molecular weight such as jet fuel and high molecular weight such as engine oil. This can make both experimental and operational exposure studies more efficient.
**Learning Objectives:**
1. Validate a novel method to identify and quantify the structural isomers of tricresyl phosphate.

### [214] COOLING SYSTEM TO TREAT ELEVATED CORE BODY TEMPERATURE

K. Hettinger[3], R. O'Hara[2], E. Eveland[4], R.H. Gallavan[1] and L. Tripp[5]
*[1]USAFSAM/FHS, 711th Human Performance Wing, Wright-Patterson AFB, OH; [2]FHC, USAF School of Aerospace Medicine, Wright-Patterson AFB , OH; [3]USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; [4]RHCP, 711th Human Performance Wing, Wright-Patterson AFB, OH; [5]711th Human Performance Wing, Wright-Patterson AFB, OH*

**INTRODUCTION:** Air Combat Command has designated non-invasive cooling of trauma patients to prevent hypothermia from point of injury to role 4 facilities and temperature maintenance among aeromedical evacuation patients to be a research priority. This presentation discusses findings from a study designed to determine the effectiveness of a cooling pump based patient thermal management system on lowering core body temperature after temperature elevation caused by physical activity. **METHODS:** Ten active duty Air Force volunteers between the ages of 19 and 45 ingested a CorTemp core body temperature sensor. Subjects exercised on a treadmill for 60 min or until core temperature elevated 1°C above baseline. Subjects then rested supine on a standard NATO litter for 60 min or when core temperature returned to subjects' baseline. Subjects repeated the exercise-then-rest regimen a second time, except resting occurred on a litter cooling pad. A reduction in cooling time to baseline by half for each subject using the cooling pad compared with cooling naturally was determined to be a level of significance. **RESULTS:** Each of the 10 subjects showed a decrease in cooling time to baseline core temperature using the thermal management system when compared to cooling naturally. However, the majority of subjects failed to achieve a cooling reduction of 50%, which was the a priori determined level of significance. **DISCUSSION:** This thermal

management system may have a role in the prevention of hypothermia among trauma patients or with temperature maintenance among aeromedical evacuation patients as it did demonstrate the ability to cool subjects faster than ambient conditions. However, the system may not be effective as a treatment modality for patients with hyperthermia.

**Learning Objectives:**

1. Understand the challenges surrounding treatment of heat related injuries in the current deployed environment.
2. Understand how one cooling pump based patient thermal management system may be used for temperature maintenance among deployed troops with heat related injuries and aeromedical evacuation patients.

### [215] ASESSMENT OF OPERATIONAL HEALTH IN B-1 LANCER AIRMEN

J.M. Nelms and W. Chappelle
*USAF School of Aerospace Medicine, Wright-Patterson AFB, OH*

**INTRODUCTION:** This study was to assess occupation-related changes in health among B-1B Lancer aircrew and associated airmen in support of B-1 operations. The investigators sought to identify sources of occupational stress and situational stressors specific to B-1 operations that impact health and performance, levels and symptoms of stress, self-reported utilization of medical and mental health care services and medication to manage health-related conditions, self-reported changes in lifestyle habits and relationships, and recommendations from such personnel on systemic changes to improve health and morale. Largely identical studies and consultations have been conducted previously on different groups, and the results of these studies raised situational awareness to operational demands and needs for improving health and performance among these groups. The intent of the investigators was to implement this manner of health assessment and improvement in the B-1 community. **METHODS:** The intent of the study was to obtain responses from airmen functioning in B-1B operations duty positions (N~430). Potential subjects were invited to participate in an anonymous survey. Consent was implied by completion of the survey, and the study was approved under the Institutional Review Board exemption protocol. **RESULTS:** There was reduced participation in the entire operations group, and only 41 surveys were completed by B-1 aircrew. While this sample was not enough to reflect on the health of the entire group, it was sufficient for a squadron-level unit health assessment. Several sources of increased occupational stress were identified. Clinical distress scores and evidence of increased post-traumatic stress were also assessed. **DISCUSSION:** The results from this study will be used for training medical and mental health practitioners providing care to B-1 aircrew and developing force management recommendations for line and medical leadership. Because of the reduced participation, these results really can only produce a partial picture of the health of B-1 aviators. Further study would be required to see how their health compares to other operators in the B-1 community as a whole.

**Learning Objectives:**

1. Understand the specific occupational health risks encountered in the B-1 community and possible mitigation strategies.

### [216] ANALYSIS OF HEALTH CARE UTILIZATION AND MISSION IMPACT DISPOSITIONS AMONG U.S. AIRCREWS DEPLOYED DURING OPERATIONS ENDURING & IRAQI FREEDOM, 2008-2012

H. Li[2] and R.H. Gallavan[1]
*[1]USAFSAM/FHS, 711th Human Performance Wing, Wright-Patterson AFB, OH; [2]Aerospace Medicine, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH*

**INTRODUCTION:** Over the last decade, there have been numerous published studies focusing on military health issues related to Operations Enduring and Iraqi Freedom. These ranged from deployment-related diagnoses, mechanisms of injury, treatments, and return-to-duty rates to factors associated with medical evacuation. However, there is little information on U.S. aircrew, who played an essential role in the wars in Afghanistan and Iraq. By understanding how aircrew utilize military medical services and what illnesses render them mission non-capable, military commanders and medical corps leadership will be better able to devise and institute more effective countermeasures and preventive strategies to maintain the most effective fighting force. **METHODS:** De-identified data from the Armed Forces Health Surveillance Center of U.S. military aircrew deployed between 2008 and 2012 were used to determine health care utilization and mission impact dispositions. In addition to summary statistics, the relationships among disposition, injury type, number and location of deployments, age, rank, Air Force Specialty Code, gender, race, occupation, and marital status are explored with logistic regression. **RESULTS:** From 2008 to 2012, there were 1,439 battle injury, 34,363 non-battle injury, and 83,159 disease records. The disposition of cases was as follows: 107,800 returned to duty and 11,161 mission impact dispositions (7,819 assigned to limited duty, 1,960 assigned to quarters, 426 admitted for care, and 942 evacuated/transferred). The top three categories of diagnoses that resulted in mission impact dispositions were musculoskeletal injuries, respiratory illnesses, and gastrointestinal problems. Regression analysis did not find an effect of sex or ethnicity/race on mission impact dispositions. Significant effects ($p < 0.05$) include: year of deployment, service, component, marital status, occupation, number of deployments, and age. **DISCUSSION:** These findings suggest that military commanders and medical corps leadership should focus on decreasing and preventing musculoskeletal injuries, respiratory, and gastrointestinal problems to minimize mission impact and optimize mission readiness.

**Learning Objectives:**

1. Understand health care utilization among U.S. aircrews deployed in OEF and OIF, between 2008 and 2012.
2. Understand mission impact dispositions among U.S. aircrews deployed in OEF and OIF, between 2008 and 2012.
3. Understand top three diagnoses resulting in mission impact dispositions among U.S. aircrews deployed in OEF and OIF, between 2008 and 2012.

***Tuesday, April 26*** ***2:00 PM***
***Avalon 13-14***

## S-38: SLIDE: ASSESSMENT AND TREATMENT IN SPACE MEDICINE

**Chair: Mark Campbell**
*Paris, TX*

**Chair: Jeff Myers**
*Ft. Myers, FL*

### [217] 3D SCANNING AND PRINTING OF PERSONALIZED SPLINTS TO TREAT HAND/WRIST INJURIES ON EXPLORATION-CLASS SPACEFLIGHT MISSION

J. Wu[1], M. Waters[2], R. Satcher[3], T. Hunt III[2] and J.P. Sutton[1,2]
*[1]NSBRI, Houston, TX; [2]Baylor College of Medicine, Houston, TX; [3]MD Anderson Cancer Center, Houston, TX*

**INTRODUCTION:** This study investigates the feasibility of fabricating as-needed personalized splints for treatment of hand/wrist orthopedic injuries in no-resupply environments expected on exploration-class spaceflight missions. A proposed process model was developed with the following capabilities: pre-flight 3D scanning, computer-aided design (CAD) model processing, digital archiving, and in-flight as-needed 3D printing. **METHODS:** A 3D scanner was used to create a three dimensional digital rendering of the hand/wrist in 5 different positions for two independent subjects. Cropping and manipulation software tools were used to design the splint shape. A .STL CAD file was exported and electronically archived. CAD files were retrieved for as-needed 3D printing at 1, 2, and 4 weeks following initial scanning. All splints were printed with 2mm thickness, 100% fill, and 0.2mm print resolution using polylactic acid (PLA) feedstock material. **RESULTS:** 3D scanned personalized finger mallet and wrist splints took less than 30 minutes each to digitally create as CAD files. Total print duration of wrist and finger mallet splints was under 4 hours and 1 hour, respectively. The wrist and finger mallet splints weighed 25g and 4g, respectively. The shape and structure of all splints were assessed favorably by two orthopedic surgeons specializing in hand and wrist disorders. A comparison to conventional thermalplastic splints showed the 3D printed PLA splints to fit and conform to the subject's finger/wrist comfortably and did not break or warp following fabrication

and fitting. **DISCUSSION:** This study demonstrates the viability of using 3D scanning and printing to fabricate personalized splints for hand/wrist injuries during non-resupplied exploration-class spaceflight missions. The approach can be extended to include inflight scanning to conform splints to individualized anatomical alterations following injury, and the need to optimize the shape to promote healing and enable performance. Recyclable materials, reduced fabrication times, and other improvements can be expected in the future to enhance this clinical capability for exploration missions, where there are concerns of no resupply and limited stowage space for medical hardware.

**Learning Objectives:**

1. The emerging platform technologies of 3D scanning and printing can provided personalized, as-needed fabrication of medical hardware that can serve as an alternative means of medical operations on exploration-class spaceflight missions.

## [218] KIDNEY STONE DETECTION IN SPACE WITH THE COLOR-DOPPLER ULTRASOUND TWINKLING ARTIFACT

J.C. Simon[1], B.W. Cunitz[1], O.A. Sapozhnikov[1,2], Y. Wang[1], F. Starr[1], J. Thiel[1], J.R. Holm[3], M.D. Sorensen[4] and M.R. Bailey[1]

*[1]Center for Industrial and Medical Ultrasound/Applied Physics Lab, University of Washington, Seattle, WA; [2]Department of Acoustics, Physics Faculty, Moscow State University, Moscow, Russian Federation; [3]Center for Hyperbaric Medicine, Virginia Mason Medical Center, Seattle, WA; [4]Department of Urology, Department of Veteran Affairs Medical Center, Seattle, WA*

**INTRODUCTION:** Astronauts are at an increased risk of forming kidney stones due to the dehydration, stasis, and bone demineralization that occur in space. The twinkling artifact is a rapid color-shift that appears inconsistently when imaging kidney stones with color-Doppler ultrasound. Here, we present evidence to suggest that stable microbubbles on the kidney stone surface cause twinkling and test how the changes in ambient pressure and high carbon dioxide ($CO_2$) levels that occur in spaceflight affect kidney stone detection with twinkling. **METHODS:** Using a flexible ultrasound system and hydraulic pressure chamber, the influence of ambient pressure and color-Doppler ultrasound imaging parameters on twinkling was investigated in *ex vivo* kidney stones. With IACUC approval, 4 pigs were implanted with human kidney stones, imaged with ultrasound, and exposed to 6 mm Hg $CO_2$ in air (the upper level of $CO_2$ that has been reported aboard ISS). The twinkling amplitude was quantified as the pig was cyclically exposed to oxygen then $CO_2$. **RESULTS:** The overpressure threshold to reduce twinkling was found vary significantly depending on the exact location on the stone, gas content of the liquid and stone, and amplitude and number of cycles in the Doppler pulse. In some locations, twinkling was eliminated at pressures of 3 atm (absolute), while in other locations even on the same stone twinkling was only reduced at pressures exceeding 8 atm. When 0.2 atm (under-pressure) was applied, twinkling increased. Upon exposing pigs to $CO_2$, twinkling was significantly reduced or eliminated in 20-30 minutes. When pigs were returned to oxygen, twinkling returned, though at a level below what was initially observed. **DISCUSSION:** The significant reduction in twinkling in pigs exposed to $CO_2$ levels at the upper end of what is found on the ISS has important implications for ultrasound detection of kidney stones in flight. Nevertheless, these results support bubbles as the mechanism of twinkling and further suggest that under-pressure in addition to increasing the amplitude and number of cycles in a Doppler pulse could enhance twinkling for kidney stone detection in space. [Work supported by NSBRI through NASA NCC 9-58 and NIH DK043881, DK092197.]

**Learning Objectives:**

1. The participant will learn what is meant by the ultrasound "twinkling artifact".
2. The participant will learn how the appearance of the twinkling artifact may be affected by the unique environment of space.

## [219] RELIABILITY OF ORBITAL ULTRASOUND IMAGE ACQUISITION BY NOVICE VERSUS COMPETENT SONOGRAPHERS ON HEALTHY VOLUNTEERS

A. Sirek[1], W. Rusinow[1] and H. Boswell[2]

*[1]Family Medicine, St. John Hospital and Medical Center, Detroit, MI; [2]Biomedical Engineering, University of Texas, Austin, TX*

**INTRODUCTION:** A reliable, non-invasive measurement of intracranial pressure is crucial in understanding the Visual Impairment and Intracranial Pressure (VIIP) Syndrome. NASA currently uses minimally trained observers coupled with remote guidance to obtain clinically relevant images for medical surveillance. Several studies have shown that expert sonographers demonstrated high intra- and inter-operator reliability in orbital ultrasound image acquisition, however none evaluated the reliability of a novice operator. As exploration-class missions will require sonographer autonomy, we sought to demonstrate the image acquisition capability of a novice sonographer in comparison to a competent sonographer in performing orbital ultrasound. **METHODS:** 36 healthy subjects were placed supine with the head elevated to 30 degrees. The optic nerve sheath diameter (ONSD) and Doppler spectra were collected independently in triplicate for each eye (OD and OS) by each observer. Images were saved and later transmitted to a blinded reader who reported measurements of the ONSD and peak systolic velocity (PSV) of the central retinal artery. **RESULTS:** Our population demonstrated average measurements of 0.64 ± 0.02 cm (OD ONSD), 0.63 ± 0.02 cm (OS ONSD), 10.69 ± 1.26 cm/s$^2$ (OD PSV), and 10.42 ± 1.16 cm/s$^2$ (OS PSV). The average intraclass correlation coefficients were 0.89 for the OD ONSD (95% CI 0.79-0.95), 0.82 for the OS ONSD (95% CI 0.64-0.91), 0.77 for the OD PSV (95% CI 0.50-0.89) and 0.75 for the OS PSV (95% CI 0.46-0.88). **DISCUSSION:** Our data indicate a high reliability comparing novice to competent sonographer for repeat measurements of the ONSD with less reliability in our PSV capture. This is likely related to the difficulty of the Doppler technique. We conclude that even a novice sonographer will be independently capable of performing a moderately complicated orbital ultrasound scan of the ONSD and capture Doppler spectra for adequate post-hoc analysis. This study further demonstrates the power of ultrasound in real-time diagnosis and medical decision-making and may be applicable to further validate the protocols currently in use on orbit, as well as strengthening the evidence for future use on exploration class missions.

**Learning Objectives:**

1. The audience will be able to identify the various average measurements for normal optic nerve sheath diameter (ONSD) reported in literature and discriminate between the various values suggested for normal.
2. The audience will be able to summarize and discuss the various inherent differences in technique observed between the B-mode scan of the ONSD and Doppler technique which may affect data gathering methods utilized in the future.
3. The audience will gain an understanding of the general method of orbital ultrasound image acquisition and determine the importance of developing sonographer autonomy for exploration class or deep space missions.

## [220] RISK ASSESSMENT OF RECURRENT MELANOMA DURING SPACEFLIGHT USING A MONTE CARLO SIMULATION

E. Kerstman[1,2] and D.P. Reyes[1,2]

*[1]NASA, Houston, TX; [2]PMCH, University of Texas Medical Branch, Galveston, TX*

**INTRODUCTION:** Waiver for a history of specific medical conditions, such as malignant melanoma, requires determination of the risks of recurrence during spaceflight. Quantitative modeling methods can be used to bound medical risks for an individual and for the mission. **METHODS:** The NASA Integrated Medical Model (IMM), a Monte Carlo based simulation model consisting 100 medical conditions that have occurred or may occur in spaceflight, was used to estimate the risk related to a) new melanoma, b) recurrent melanoma, and c) recurrent melanoma that manifests as seizure – in a crew of six, spending six months in space. The incidence of each potential outcome was obtained by literature review. The incidence data was then entered into the model, which provides outputs estimating functional impairment, the probability of medical evacuation, and the probability of loss of crew life. Melanoma specific outcomes were compared with reference mission outcomes. **RESULTS:** Comparison of reference mission with melanoma specific outcomes showed only a slight increase in relative likelihood of medical evacuation for all medical events of 1.01, or 5.02% versus 4.97%. There were no significant changes in functional impairment or the likelihood of loss of crew life. Melanoma-specific medical evacuation probability increased from 0.05% to 0.18%, or from 1 in 2,000, to 1 in 556 missions. **DISCUSSION:** This work demonstrates the value of a Monte

Carlo simulation based model in the bounding of risk estimates of medical outcomes during spaceflight. Simulations of this nature can be used as decision support tools that enhance, rather than replace, sound clinical judgment.

**Learning Objectives:**

1. Understand the utility of Monte Carlo simulations for the quantification of medical risk in the aerospace environment.

### [221] MEDICAL OPTIMIZATION NETWORK FOR SPACE TELEMEDICINE RESOURCES

R.V. Shah and E. Kerstman
*Aerospace Medicine, UTMB/Wyle/NASA, Galveston, TX*

**INTRODUCTION:** Long-duration missions beyond low Earth orbit introduce new constraints to the space medical system. Beyond the traditional limitations in mass, power, and volume, consideration must be given to other factors such as the inability to evacuate to Earth, communication delays, and limitations in clinical skillsets. As the medical system for an exploration mission is developed, it is important to have an ability to evaluate the trade space of what resources will be most important. The Medical Optimization Network for Space Telemedicine Resources (MONSTR) was conceived and designed over the past year for this reason, and when it is complete, it can be used to perform quantitative risk analyses. **METHODS:** A list of medical conditions of potential concern for an exploration mission was referenced from the Integrated Medical Model (IMM), a probabilistic model designed to quantify in-flight medical risk. The diagnostic and treatment modalities required to address best- and worst-case scenarios of each medical condition, at the terrestrial standard of care, were cited and entered into a matrix. This list included both tangible assets (e.g. medical equipment, medications) and intangible assets (e.g. clinical skills required to perform a procedure). A team of physicians working within the Exploration Medical Capability Element of NASA's Human Research Program ranked each of the items listed according to its criticality. Data was then obtained from the IMM for the probability of occurrence of the medical conditions, including a breakdown of best case and worst case, during a Mars reference mission. The criticality and probability of occurrence information were both taken into account during analytics performed using Tableau Desktop v9.1. **RESULTS:** A weighting system to evaluate all the diagnostic and treatment modalities was created by combining the probability of condition occurrence data with the criticalities assigned by the physician team. **DISCUSSION:** MONSTR is a novel approach to performing a quantitative risk analysis that will assess the relative value of individual resources, both tangible and intangible, needed for the diagnosis and treatment of various medical conditions. It will provide members of both the operational and research communities at NASA with information to support informed decisions regarding areas of research investment, future crew training, and medical supplies manifested as part of the exploration medical system.

**Learning Objectives:**

1. The participant will be able to appreciate a novel approach to evaluating the trade space of what resources will be most important in the development of an exploration medical system.
2. The participant will be able to understand the assumptions, limitations, and areas for growth associated with development of the Medical Optimization Network for Space Telemedicine Resources.

### [222] CHALLENGES FOR DELIVERY OF ANESTHESIA IN THE SPACE ENVIRONMENT – AN UPDATE

M. Komorowski
*Intensive Care Unit, Imperial College London, London, United Kingdom*

**MOTIVATION:** During future space exploration missions, the risk of medical events requiring surgery is significant, and will rely on anesthetic techniques. The delivery of anesthesia will be complicated by a number of factors that schematically fall into two categories: missing technologies and missing knowledge. The latest advances in anesthetic techniques and training, as well as recent research in space physiology is reviewed, and provide new insights into available options. **OVERVIEW:** Thanks to an intense inflight countermeasure regimen, the cardiac systolic function appears preserved in astronauts, and the lower cardiac output measured seems to primarily result from hypovolemia. Available options during spaceflight include local, regional and general anesthesia. Minor surgery (e.g. stitches) is achievable with local anesthesia. Trauma and limb fractures are of main concern during the planetary phase of a mission. With only 3 regional anesthesia techniques (axillary brachial, femoral and sciatic nerve blocks) most interventions on the limbs are possible. Ultrasound guidance has accelerated the learning and improved the success rate of regional anesthesia. As little as 10 procedures per block can be sufficient to reach a 90% success rate [3]. Conscious sedation can be proposed for short procedures like joint relocation or to complement nerve blocks. Any deep or prolonged surgery involving the trunk will require a general anesthesia with endotracheal intubation. Here, a rapid sequence induction combined with video-assisted endo-tracheal intubation can be proposed [2]. The microgravity-exposed patient might exhibit a reduced sensitivity of alpha-adrenergic receptors and require increased doses of vasopressors [1]. **SIGNIFICANCE:** Despite a number of challenges, the safe delivery of an anesthetic procedure by non-anesthesiologists on previously healthy individuals and given our current knowledge and technologies could be possible, and does not represent a showstopper for future space exploration missions.

**References:** [1] Agnew J, Fibuch E, Hubbard J. Anesthesia during and after exposure to microgravity. Aviat Space Environ Med. 2004; 75:571-580. [2] Ambrosio A, Pfannenstiel T, Bach, K, Cornelissen C, Gaconnet C, Brigger MT. Difficult airway management for novice physicians: a randomized trial comparing direct and video-assisted laryngoscopy. Otolaryngol Head Neck Surg. 2014; 150(5):775-778. [3] Luyet C, Schüpfer G, Wipfli M, Greif R, Luginbühl M, Eichenberger U. Different Learning Curves for Axillary Brachial Plexus Block: Ultrasound Guidance versus Nerve Stimulation. Anesthesiol Res Pract. 2010. http://doi.org/10.1155/2010/309462.

**Learning Objectives:**

1. The audience will learn about what factors limit the safe delivery of anesthetic techniques in the space environment.
2. The audience will learn about what anesthetic techniques are available in the space environment, and what factors influence the choice of one technique over another.
3. The audience will learn about the safest way to perform a general anesthesia during a space exploration mission.

***Tuesday, April 26*** ***2:00 PM***
***Avalon 15-16***

## S-39: PANEL: DEVELOPMENT AND UTILIZATION OF SYNTHETIC ENVIRONMENTS TO ENHANCE UNMANNED AERIAL SYSTEM OPERATOR PERFORMANCE

**Chair: Chris Foster**
*NAS Patuxent River, MD*

**Chair: James Patrey**
*NAS Patuxent River, MD*

**PANEL OVERVIEW:** As the Department of Defense transitions to greater reliance on unmanned aerial systems (UAS), it is essential that synthetic environments be developed in such a way that they enable performance modeling and assessment, and enhance UAS operator performance. This panel presents the results of research into the development and application of such environments. To provide attendees a clear understanding of the problem space, presentations are organized into two areas: (1) Challenges and requirements for development of synthetic environment, (2) Utilization of synthetic environments for training and performance measurement, and (3) Utilization of synthetic environments to test and develop UAS requirements. The first presentation will describe a research and development effort that delivered a new synthetic environment that will support usability testing across platforms. The second presentation will describe research into the development of realistic semi-automated forces (SAF) for use in unmanned training scenarios. The third presentation will describe research into the use of

augmented reality to improve training capabilities and speed of trainee skill acquisition. The fourth presentation will describe research into the development of real-time automated performance measures and post mission reporting capabilities to enhance UAS operator performance and skill acquisition. The fifth presentation will describe the utilization of a synthetic environment for research into UAS airspace integration to inform UAS automation requirements.

### [223] PREPARATION OF A SYNTHETIC ENVIRONMENT FOR DEVELOPMENT AND EVALUATION OF UXS USER INTERFACES AND HUMAN-MACHINE PERFORMANCE AND TRAINING ASSESSMENT

D. Eksuzian
*Human Systems, NAVAIR 4.6, Patuxent River, MD*

**INTRODUCTION:** Evaluating vendor design solutions in the absence of direct experience or objective data regarding performance forces Human Systems Personnel to rely on human performance specifications and standards to evaluate effectiveness of unmanned systems operator interfaces. Needed are facility, methods, tools, and expertise to develop and evaluate new ideas and be able to evaluate vendor or third party human systems related designs and system behavior in a controlled environment (vs. vendor directed demonstrations). **METHODS:** The lab revised its simulation and network infrastructure to be flexible, responsive, and detailed enough to meet the technical and programmatic needs of a wide variety of projects. Objectives were to create tools and facility to represent system behaviors; incorporate the DoD RDTE network for intra-lab connectivity as well as inter-lab connections; maintain capability to construct full-scale physical mockups representing controls and displays and workspace equipment; and to incorporate simulated agents (entities controlled by humans-in-the-loop) that could behave as though they had various level of "intelligence," (levels of automation and autonomy). **RESULTS:** The AIR 4.6 Human Computer Interaction Lab (HCIL) was revamped to address all of the above objectives. The HCIL synthetic environment provides the facilities and expertise to research, engineering, and acquisition program customers to help them quickly develop and assess equipment usability and effectiveness, and human performance through the use of physical and software prototypes or mockups, system behavior representation, and mission scenario simulation. **DISCUSSION:** If undertaking a lab stand-up or overhaul program, there are several major frustrations one will encounter (among many lesser) including cost to maintain lab infrastructure and cyber security in labor time away from project work mostly; acquiring and retaining the software programming and system administration talent needed to run the sandbox and use its tools; and reliance on project customers alone (vs. "line-item" annual funds) to keep the facility operational during lean times as well as the fat times.

**Learning Objectives:**

1. Develop knowledge of how synthetic computer environments are developed and associated challenges.

### [224] DEVELOPMENT OF DYNAMIC, ADAPTIVE, AND MODULAR ENTITIES TO ENHANCE UNMANNED AERIAL SYSTEM OPERATOR TRAINING

H. Priest
*NAWCTSD, Orlando, FL*

**INTRODUCTION:** Navy UAS operators have identified training needs that require theater level realistic semi-automated force (SAF) behaviors in a format that can be integrated into the Navy's SAF generation technology. The Unmanned Aerial Systems Interface, Selection, and Training Technologies (U-ASISTT): Dynamic, Adaptive & Modular entities for UAS (DyAdeM) product will deliver a software based content generation capability that converts "raw" data (captured during live UAS exercises, recorded during actual missions, or generated from live range testing) into realistic Computer Generated Force (CGF) behaviors that will populate training scenarios within the Next Generation Threat System (NGTS), a U.S. Navy common product and SAF generation technology for a number of aviation platforms, including UAS. **METHODS:** The first year of development has focused on producing CGFs that create maritime Patterns of Life (PoLs) using sensor data that are: realistic, scalable, heterogeneous, and executable in NGTS using a variety of sensor data, to support training. The team is now working with stakeholders to identify additional data for required lightweight behaviors (e.g., NGTS enhanced distractors) and begin delivery of files to NGTS for testing and integration. FY16 work will also focus on research and experimentation identifying the impact on training and learning for UAS operators for these realistic CGFs within UAS training scenarios. **RESULTS:** As a result of this development, the DyAdeM team has provided white shipping waypoints for a realistic set of vessel types and activities for seven regions of interest to the Navy. The application of this capability with regards to UAS operator training needs will be discussed and the capability will be demonstrated. **DISCUSSION:** Based on the development of these waypoints and the improved realism and scalability of the distractor technology in NGTS, the training implications will be discussed with regards to needs of UAS operators. Use cases will be presented and discussed based on input from DyAdeM Stakeholders in the P8 and TRITON communities. This presentation will demonstrate the utilization of synthetic environments to enhance UAS training and skill acquisition.

**Learning Objectives:**

1. Identify the relationship between theatre level SAF and Virtual training needs for UAS.
2. Identify ways to leverage raw data for the development of theatre level SAF.
3. Identify training benefits of realistic theatre level SAF for UAS.

### [225] AUGMENTED REALITY TRAINING FOR UNMANNED AERIAL SYSTEM COMMON CTONROL SYSTEM OPERATORS TRAINING TRANSITION

M. Prince
*NAWCTSD, Orlando, FL*

**INTRODUCTION:** Human factors drive the majority of UAS mishaps (Mazzuchi, Sakani, & Rico, 2013). One potential cause is a lack of best practices in operator training. Ison, Terwilliger, and Vincenzi (2013) cited deficiencies in UAS operator training to include failure to effectively incorporate technology, communications, and lessons learned. This research seeks to investigate Augmented Reality (AR) training as an approach to appended training for Unmanned Aerial Systems (UAS) Common Control System (CCS) operators reducing the need to recertify the software for safety of flight concerns. **METHODS:** This study includes the documentation of the state of the art in AR, development of realistic UAS job scenarios to support training operator tasks using AR technology, analysis of existing AR technology usability for training, recommendations for AR tools for further exploration/implementation in operator training, design and development of AR software, and usability study. **RESULTS:** Usability study results and recommendations will be reviewed and lessons learned about AR and CCS development will be discussed. **DISCUSSION:** The implications of the study results will be discussed in terms of their impact on effective utilization of non-invasive training, which will influence training across a wide array of tactical systems. This study further illustrates the criticality of a synthetic environment for the development of necessary training technologies.

**Learning Objectives:**

1. Develop understanding of familiarization and procedural training.

### [226] PERFORMANCE MEASUREMENT & POST MISSION REPORTING FOR PERFORMANCE ASSESSMENT AND TREND TRACKING

B. Atkinson and R. Findlay
*NAWCTSD, Orlando, FL*

**INTRODUCTION:** As technologies continue to advance, there are opportunities to offset human-in-the-loop data entry and analysis with automated capabilities; however, observer performance metrics remain a relevant mechanism for assessing performance as well. Within operational and training environments, leveraging a combination of instructor ratings and capture of system-based data to support post-mission reporting and calculation of performance metrics are necessary to enhance readiness through improved after action feedback and reduction of workload for understanding performance trends. **METHODS:** Eighteen subjects from the MP&R Community were recruited to provide feedback on the current post-mission reporting

process. Subjects reported the length of time it took to complete their last post-mission report. Additionally, subjects were given the NASA Taskload Index (TLX) and asked to rate their perceived workload of the last post-mission report they completed. Ratings were obtained to provide a baseline of how the current post-mission reporting process impacts workload. **RESULTS:** Results from the baseline analysis indicate that the current process of post-mission reporting results in high levels of workload. TLX dimensions of Effort and Frustration were particularly high. Additionally, subjects reported that the post-mission report generally took more hours to complete than the amount of time allocated. **DISCUSSION:** Results from the baseline study show that the current post-mission reporting process requires high amounts of workload and more time than the amount of time allocated. These findings indicate that the MP&R Community, and all those who complete post-mission reports, would benefit from automated post-mission reporting, which would result in reductions in workload and time to complete. This study shows another application of synthetic environments and how they can enhance the effectiveness of Unmanned Aerial System operators.

**Learning Objectives:**

1. Understand the purpose and capabilities of the Post Mission Assessment for Tactical Training & Trend Analysis (PMATT-TA) system's current capabilities.
2. Understand the benefits of observer-based and system-based measures.
3. Understand the benefits of leveraging performance metrics for post mission reporting.

### [227] AIRSPACE INTEGRATION OF UNMANNED AERIAL SYSTEMS - DISCUSSION OF HUMAN PERFORMANCE METRICS AND MODELING

J.W. Geeseman
*Human Systems, Naval Air Systems Command, Patuxent River, MD*

**INTRODUCTION:** One of the key components of human behavior that requires evaluation during the assessment of human capability in the sense-and-avoid system is the decision-making process. The U.S. Federal Aviation Administration (FAA) has identified several aeronautical decision-making (ADM) models: 5-P, 3-P, CARE, TEAM, OODA, and DECIDE (Pilot's Handbook of Aeronautical Knowledge, 2008). Although each model provides strengths and weaknesses in their recommendations for ADM, some components of these models are easier to evaluate than others. Five common components of these models for the ADM process considered for this project are detect, evaluate, prioritize, decide, and execute. **METHODS:** Participants include current/past AVOs flying simulated UAS while attempting to maintain self-separation from intruder aircraft. For the purposes of this presentation, two types of measurements will be discussed in regards to ADM – timing and accuracy. Timing measures indicate the amount of time elapsed from the beginning of an intruder aircraft event until the point in time that is being discussed (i.e., the event timeline) or the time from the end of one phase in the ADM process to the end of a subsequent phase. Accuracy measures borrow terminology from signal detection theory (see Green & Swets, 1969), in that, each component of ADM should be evaluated in regard to the successful or unsuccessful mitigation of an intruder aircraft event (i.e., high hit rate and low false-alarm rate). **RESULTS:** Results suggest that as encounter geometries become more difficult, AVO response timing increases and response accuracy decreases. Additionally, as the airspace increases in complexity, participants demonstrated higher levels of "workload" which also revealed similar behavioral changes as difficult encounter geometries. **DISCUSSION:** The results of these experiments will be used to more fully understand the human performance component of airspace integration of UAS in different flight environments. Although the current project focuses on sparse airspace and relatively simple response requirements, the future of this line of research will investigate on more complex airspace and international airspace integration.

**Learning Objectives:**

1. Five common components of the aeronautical decision making process that should be considered when developing a method for human component evaluation and, more specifically, human performance modeling are detect, evaluate, prioritize, decide, and execute.

***Tuesday, April 26*** ***2:00 PM***
***Avalon 17***

## S-40: PANEL: PREDICTORS AND RISK FACTORS RELATED TO SUCCESSFUL MANAGEMENT OF OPERATIONAL DEMANDS WITHIN UNITED STATES AIR FORCE COMBAT SEARCH AND RESCUE

**Chair: Steve Rush**

**Chair: Emily Skinner**
*Wright-Patterson AFB, OH*

**PANEL OVERVIEW:** This panel presents results from empirical studies that elucidate the inherent cognitive and non-cognitive aptitudes associated with success and resilience in the Combat Search and Rescue (CSAR) career field as well as data from an occupational health screening of the community. A snapshot of the primary stresses faced within the career field and the subsequent collective impact on the overall psychological health and wellness of United States Air Force (USAF) CSAR personnel will be provided. The first presentations identify key psychological variables critical to performance and adaption to the rigors and unique demands of the Pararescue and Combat Rescue Officer career fields. The following presentations detail the results from an occupational health assessment conducted by the USAF School of Aerospace Medicine across multiple CSAR units in 2015. Sources of stress and risk factors for exhaustion and medically significant distress among CSAR personnel will first be presented. Additional results from the occupational health screening related to role overload and role conflict in relation to operator burnout within the CSAR community will follow. Role overload and conflict will then be explored as predictors of social role distress among CSAR personnel. The final presentation will describe the health related behaviors (such as sleep, exercise, alcohol consumption, caffeine/energy supplement usage) of the community revealed by the occupational health assessment. Health related behaviors are often unique to each operational community and a reflection of operators overall ability to adapt to the demands of the operational tempo and environment as a whole.

### [228] ASSESSING COGNITIVE AND NON-COGNITIVE PSYCHOLOGICAL PREDICTORS OF UNITED STATES AIR FORCE PARARESCUE TRAINING OUTCOMES

W. Thompson[2], W. Chappelle[1], T. Goodman[2], E. Skinner[1] and K.A. Traut[1]
*[1]USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; [2]Neurostat Analytical Solutions, LLC, San Antonio, TX*

**INTRODUCTION:** U.S. Air Force (USAF) Pararescue specialists (PJs) represent an elite group of battlefield airmen within the Combat Search and Rescue (CSAR) special tactics arm of the USAF. These special duty operators are responsible for protecting the lives of U.S. military personnel and non-military civilians who may find themselves injured, in harm's way, and in need of life-saving assistance. The high risk demands of these missions are high stress, high tempo, and require a special physical, cognitive, and personality type capable of adapting to the critical nature of these missions. The present study examined the utility of cognitive and non-cognitive psychological testing to predict training outcomes within the Pararescue pipeline. **METHODS:** Participants included 899 PJ training candidates who completed measures of cognitive (Armed Services Vocational Aptitude Battery) and personality (NEO-PI-3) assessment upon entry to Basic Military Training and prior to entering the PJ training pipeline. Performance outcomes (e.g., pass/fail) were matched to each candidate and a series of statistical regression analyses, to include survival analyses, were performed to identify psychological attributes predictive of performance and adaption to training and operational task requirements. **RESULTS:** The results of the study identified key areas of cognitive, emotional, and social functioning predictive of performance and that significantly improved aeromedical capabilities for assessing suitability of candidates. Furthermore,

pre-training psychological testing enhanced flight medicine interventions related to lifecycle sustainment and performance optimization. **DISCUSSION:** This study provides an efficient and objective method for improving aeromedical selection and evaluation procedures of Pararescue special duty operators and training candidates supporting U.S. and allied nation personnel recovery operations. Further, these results enable cooperative opportunities between flight medicine and line personnel in maximizing airman performance through identifying those strengths and weaknesses necessary for optimal performance and providing mentorship and training for success.

**Learning Objectives:**

1. The participant will be able to identify cognitive and non-cognitive predictors of training success within the Pararescue pipeline.

## [229] SOURCES OF STRESS AND RISK FACTORS FOR HIGH LEVELS OF EXHAUSTION AND DISTRESS AMONG COMBAT SEARCH AND RESCUE AIRCREW AND SPECIAL DUTY OPERATORS

W. Chappelle[3], J. Swearingen[1], T. Goodman[1], L. Prince[2] and W. Thompson[1]

*[1]Neurostat Analytical Solutions, San Antonio, TX; [2]FHOH, USAF School of Aerospace Medicine, Birmingham, AL; [3]Neuropsychiatry, USAF School of Aerospace Medicine, Wright-Patterson Air Force Base, OH*

**INTRODUCTION:** United States Air Force combat search and rescue (CSAR) conducts search, rescue, and recovery operations for combat and humanitarian missions in support of both the Department of Defense and allied nations. Long work hours have been associated with high levels of exhaustion and distress in career fields similar to CSAR. This study investigates self-reported sources of stress and demographic and occupational risk factors for high exhaustion and psychological distress. **METHODS:** Participants were 421 CSAR members (123 aircrew and 298 special duty operators) from Air Combat Command, Air Force Special Operations Command, and Air National Guard. Participants completed a web-based occupational health screening that included demographic items, self-reported sources of stress, and measures of exhaustion (Maslach Burnout Inventory General Survey - Exhaustion subscale) and psychological distress (Outcome Questionnaire-45). Parametric and logistic regression analyses were performed to identify levels and risk factors for exhaustion and psychological distress. **RESULTS:** Top sources of stress included low manning and long work hours, organizational and leadership issues, and additional administrative duties. Approximately 1 in 7 aircrew and 1 in 10 special duty operators self-report high levels of exhaustion. One in 10 aircrew and 1 in 15 special duty operators report high psychological distress. Working more than 50 hours per week was a risk factor for high exhaustion (3x for aircrew/2x for special duty operators) and high psychological distress (2x for aircrew/4x for special duty operators). Risks for high levels of exhaustion and psychological distress increased when participants endorsed both long work hours and supervisor status (4x for aircrew/3x for special duty operators and 2x for aircrew/5x for special duty operators, respectively). **DISCUSSION:** The results show that exhaustion and psychological distress levels for both CSAR aircrew and special duty operators are affected by long work hours. When combined with additional supervisory duties, the rates of elevated distress and exhaustion rose even more. Primary and secondary intervention measures are discussed to prepare, support, and protect CSAR personnel.

**Learning Objectives:**

1. Understand the relationship among occupational factors (such as work hours and supervisory status), exhaustion and psychological distress in Combat Search and Rescue personnel.

## [230] ROLE OVERLOAD AND CONFLICT AS PREDICTORS OF AIR FORCE COMBAT SEARCH AND RESCUE AIRCREW AND SPECIAL DUTY OPERATOR BURNOUT

W. Chappelle[2], E. Skinner[2], T. Goodman[1], L. Prince[3] and W. Thompson[1]

*[1]Neurostat Analytical Solutions, LLC, San Antonio, TX; [2]USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; [3]Prince Research and Analytic Solutions, LLC, Birmingham, AL*

**INTRODUCTION:** United States Air Force combat search and rescue (CSAR) operators are tasked with the challenge of rescue and recovery operations throughout a wide range of combat and humanitarian missions in support of Department of Defense and allied nation operations. As a result, research has shown that such operators self-report high levels of role overload and role conflict, which may elevate their risk for occupational burnout. This study investigates the prevalence and predictors of such conditions. **METHODS:** Participants included 123 CSAR aircrew and 298 special duty operators from Air Combat Command, Air Force Special Operations Command, and Air National Guard. Participants completed a web-based occupational health screening in 2015 that included demographic and occupational items, the Sharon Glazer role survey (including Role Overload, Role Conflict, and Role Ambiguity), and the Maslach Burnout Inventory General Survey (including Exhaustion, Cynicism, and Professional Efficacy). Parametric and logistic regression analyses were performed to identify levels and predictors of occupational burnout. **RESULTS:** Self-reported high levels: 20% role overload and conflict, 10% role ambiguity, 15-20% exhaustion, 5-10% cynicism, and 2% low professional efficacy. Risk factors for high exhaustion include high role overload (3x-aircrew, 8.5x-special duty), role conflict (3x-special duty), and role ambiguity (3x-special duty). Risk factors for high cynicism include high role conflict (4x-special duty) and role ambiguity (3x-special duty). **DISCUSSION:** Results show that exhaustion levels for both CSAR aircrew and special duty operators are affected by role overload and exhaustion and cynicism levels for special duty operators are affected by perceived role conflict and ambiguity. The implications of study findings include the following: the expansion of proactive measures to psychologically prepare and support CSAR aircrew and special duty operators, reprioritizing flight medicine and mental health support requirements to focus on the highest risk areas, increasing post-mission socialization following weapon strikes, and improving line leadership engagement and support.

**Learning Objectives:**

1. The participant will learn to identify aspects of role conflict, role overload, and occupational burnout and recognize the risks role overload and conflict present to occupational burnout.

## [231] ROLE CONCERNS AS PREDICTORS OF SOCIAL ROLE DISTRESS (SRD) AMONG USAF COMBAT SEARCH AND RESCUE AIRCREW AND SPECIAL DUTY OPERATORS (SDO)

L. Prince[3], W. Chappelle[4], E. Skinner[5], T. Goodman[1] and W. Thompson[2]

*[1]Neurostat Analytical Solutions, LLC, San Antonio, TX; [2]Experimental Psychology/Physiology/Biostatistics, Neurostat Analytical Solutions, LLC, San Antonio, TX; [3]FHOH, USAF School of Aerospace Medicine, Birmingham, AL; [4]Neuropsychiatry, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; [5]USAF School of Aerospace Medicine, Wright-Patterson AFB, OH*

**INTRODUCTION:** USAF combat search and rescue (CSAR) personnel support DoD and allied nation operations by conducting rescue and recovery operations across a range of combat and humanitarian missions. Research has revealed that CSAR aircrew and special duty operators (SDOs) report high levels of role overload, ambiguity, and role conflict, which may contribute to elevated rates of emotional distress, specifically social role distress (SRD). This study investigates the rates of social role distress among CSAR personnel and the link between role concerns and SRD for this community. **METHODS:** Participants included 123 CSAR aircrew (48 flight engineer and gunners, 18 combat systems officers, and 57 helo pilots), 240 pararescuemen, and 58 combat rescue officers from the Air Combat Command, Air Force Special Operations Command, and Air National Guard. Participants completed a web-based occupational health screening in 2015 that included demographic and occupational items, the Sharon Glazer Role Survey (assessing Role Overload, Conflict, and Ambiguity), and the Outcome Questionnaire OQ45.2 (focusing on the SRD sub-scale). Parametric and logistic regression analyses were performed to identify levels and predictors of social role distress. **RESULTS:** Approximately 20% of CSAR personnel report high role overload, 19% high role conflict, and 10% high role ambiguity. Between group comparison revealed no difference between aircrew and SDOs on the percentage meeting role thresholds. SRD was

reported by 21% of all CSAR participants, with no difference in rate between groups. Elevated role concerns emerge as significant risk factors for SRD, increasing SRD likelihood as follows: Role Overload (3x-SDOs), Role Conflict (2x-SDOs), and Role Ambiguity (2.5x-aircrew, 3x-SDOs). **DISCUSSION:** The results show that social role distress is prevalent among CSAR personnel and to varying degrees is affected by perceived role conflict, overload, and ambiguity. The implications of study findings include: the need for expanded measures to psychologically prepare CSAR personnel for operations, prioritization of medical and mental health assets toward those at highest risk, and improvement of line leadership engagement and support to CSAR crews.

**Learning Objectives:**

1. Nearly one out of every five participant CSAR operators endorse experiencing key role concerns as characterized by the Sharon Glazer Role Survey (SGRS). Specifically these concerns include Role Overload and Role Conflict. Role Ambiguity, the third measured area in the SGRS, was reported to a lesser degree (1 out of every 10 CSAR Participants endorsing in this manner).
2. 21% of all participant CSAR personnel endorse experiencing clinically high Social Role Distress, as defined and measured by the Outcome Questionnaire (OQ45.2). The Social Role Distress question sequence assesses complaints such as work stress and dissatisfaction, as well as the ability to effectively interact with others at work.
3. High Role Overload, Conflict and Ambiguity are all significantly associated with endorsement of Social Role Distress among CSAR pararescuemen and combat rescue officers. All emerge as significant risk factors for the experience of clinically high levels of Social Role Distress for this CSAR sub-population.

### [232] HEALTH BEHAVIORS OF U.S. AIR FORCE COMBAT SEARCH AND RESCUE (CSAR) PERSONNEL

W. Chappelle[3], J. Swearingen[1], T. Goodman[1], L. Prince[2], W. Thompson[4] and L.E. Reardon[1]
*[1]Neurostat Analytical Solutions, LLC, Albuquerque, NM; [2]FHOH, USAF School of Aerospace Medicine, Birmingham, AL; [3]Neuropsychiatry, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; [4]Psychology/Physiology, University of West Florida, San Antonio, TX*

**INTRODUCTION:** United States Air Force (USAF) combat search and rescue (CSAR) aircrew and special duty rescue personnel are highly trained airmen operating under high-demand, high-risk conditions across the globe in a wide range of combat and humanitarian operations. The health and wellness of CSAR personnel are critical to sustaining performance readiness. The USAF School of Aerospace Medicine conducted a field survey to assess for general areas of health-related behaviors. **METHODS:** A total of 476 CSAR aircrew and rescue personnel from three USAF major commands completed a web-based survey. Statistical analyses were performed to assess quantitative and qualitative items assessing alcohol, caffeine and tobacco use; changes in use of health services since joining unit; medical problems exacerbated by work environment; and OTC and prescription medication use. Differences between aircrew and rescue personnel are assessed. **RESULTS:** CSAR personnel reported the following: 1) 17-24% of respondents reported elevated levels of alcohol use; 9% reported monthly binge drinking, which is higher than other airborne ops; 2) 26-32% reported increase in caffeine use, with 14% reporting daily consumption of 5 or more caffeinated beverages; 3) 19% of respondents reported tobacco use with 11% reporting increase in use since joining unit; 4) 26% reported increase in use of medical services since joining unit; 32% reported increased use of alternative health services since joining unit; top medical problems reported to be exacerbated by work environment included pain, headaches/eyestrain, and sleep; 5) 8% of respondents reported increase in OTC medication use and 6% reported increase in prescription medication use. Comparison of aircrew and rescue personnel revealed a significant difference only with respect to increase in use of alternative health services, with rescue crews reporting greater increase in use of these services than aircrew (38% compared to 22%, respectively). **DISCUSSION:** Recommendations are provided for line and medical leadership for optimizing health for CSAR personnel such as improving manning, embedding medical providers in units, and improving training of coping skills at calculated stages of training.

**Learning Objectives:**

1. Participants will increase awareness of frequency of problematic health behaviors among CSAR personnel.
2. Participants will take away recommendations for optimizing health behaviors among CSAR personnel.

***Tuesday, April 26*** ***2:00 PM***
***Avalon 6***

## S-41: PANEL: CELEBRATING THE LEGACY OF BROOKS AIR FORCE BASE (FIELD/CITY-BASE)

*Sponsored by The Life Sciences and Engineering Branch (LSBEB)*

**Chair: William Ercoline**
*San Antonio, TX*

**Chair: Brian Self**
*San Luis Obispo, CA*

**PANEL OVERVIEW:** The airfield known originally as Kelly Field #5 (1917) , then subsequently Brooks Field (1918), Brooks Air Force Base (1948), and lastly Brooks City-Base (2002), spent nearly a century conducting critical research in aerospace physiology, training aerospace physicians, and training U.S. fast jet pilots and aircrew. As the role of Brooks has been realigned and transferred to other units, it is only fitting that we pay tribute on the eve of the 100 year anniversary of the opening of the airbase in San Antonio. Readers of the Blue Journal are probably most familiar with the ground-breaking research done in the area of aerospace physiology. The Brooks centrifuge opened in 1961, and personnel investigated the limits of human sustained acceleration tolerance and countermeasures to protect pilots. Research and modeling of the effects of altitude began in 1960, and the laboratory ran thousands of human studies in the altitude chamber to examine the risks of decompression. The newest area of research to blossom at Brooks was in the area of Spatial Disorientation. Although first developed at Brooks Field in 1928, ground-based SD trainers have existed at Brooks for over 70 years. Most recently the four-degree of freedom Advanced Spatial Disorientation Demonstrator (opened in 1993) was the primary research platform, which was supplemented by in-flight and non-motion based simulator research efforts. Finally, Brooks served to tie these different areas of research together by serving as both a developer and a test site for life support equipment. Reviews of each of these critical areas will be provided, highlighting the enormous contributions that Brooks has made to aviation physiology.

### [233] MODELING OF DECOMPRESSION SICKNESS (DCS) RISK AT BROOKS AFB/CITY-BASE, TX

J.T. Webb
*SARC, LLC, Bandera, TX*

**MOTIVATION:** A large number of experimental high altitude research studies have been accomplished at Brooks AFB/City-Base since 1963. Models to predict altitude decompression sickness risk have been based on the data collected. These models have attempted to define DCS risk during high altitude exposure and provide guidance for operational activities. Better understanding of the risk factors is relevant to design of any such model. **OVERVIEW:** In the early 1980s, a database of information relating to each subject-exposure at Brooks was conceived and developed, incorporating detailed information from what has become over 3000 human subject exposures. These exposures were conducted to evaluate risk, preventive equipment, and procedures. Later, a concerted effort was initiated to create a model based on data in the Air Force Research Laboratory High Altitude Research Database. Early attempts were based on tables of exposure duration, exercise, prebreathe time, and altitude. The Altitude DCS Risk Assessment Computer (ADRAC) model incorporated database statistical and venous gas emboli models. This model was implemented for operational employment. It uses inputs of altitude, time at altitude, prebreathe time, and exercise (Rest, Moderate, and Heavy). As validated with novel exposure trials, this model serves operational planners. While the first three parameters have been well documented and

their effects quantified, the exercise parameter was not well defined or quantified. **SIGNIFICANCE:** Recently completed experimental exposures at Brooks have provided additional data on the effect of activity during exposures. This oxygen consumption data indicates its use may improve ADRAC's risk assessment accuracy. Flights in fighter and unpressurized aircraft where activity consists of seated rest during cruise flight at high altitude may currently be ascribed higher ADRAC-predicted DCS risk than indicated by a study recently completed. The experimental and modeling efforts conducted at Brooks AFB have greatly increased our understanding of DCS risks. Incorporation of new data may lead to an even better understanding of relatively mild activity on DCS risk while decompressed.
**Learning Objectives:**
1. Understand the history of Brooks AFB/City-Base decompression sickness (DCS) research to include attempts to model DCS risk and with what information and the type of new information to augment this effort.

## [234] ACCELERATION PHYSIOLOGY RESEARCH AT BROOKS AIR FORCE AND CITY-BASES, TEXAS

U.I. Balldin
*Wyle Laboratories, San Antonio, TX*

**MOTIVATION.** The centrifuge at Brooks AFB was built in 1961 for research to reduce acceleration-induced accidents in fighter pilots. **OVERVIEW.** Human subjects and swine were used in studies of physiologic reactions to high G-loads. Introduction of +9-G fighter aircraft emphasized the need for G-protection and information on G-LOC. An animal centrifuge was used to study G-LOC in rats and baboons evaluating brain tissue and gene products, cerebral and spinal blood flow and EEG during G-LOC recovery. Hemodynamics during +Gz exposures in swine and baboons were studied during pressure breathing during G (PBG), using anti-G straining maneuver and anti-G suit inflation, and related to coronary artery disease. Human centrifuge studies were conducted in developing anti-G suits and detecting G-induced pulmonary atelectases, cardiac dysrhythmias, muscle activity with extended coverage anti-G suits and PBG, and the influence of hypo/hyperoxia on +Gz endurance. Simulated aerial combat maneuvers were used to define G-endurance with anti-G suits and the physiologic limits at very high +Gz (+12 Gz) with G-protection were determined. G-induced arm pain studies with protective devices and studies of thermal effects on acceleration tolerance with different types of G-protection equipment with and without counter-pressure vest were conducted. Transcranial Doppler Ultrasound measurements to determine the cerebral artery blood flow velocity were used at high G-loads and during LBNP. Female G-tolerance was studied, mathematical models for predicting G-duration and tolerance were developed, peripheral arterial resistance at +Gz was examined and errors in measurements of +Gz acceleration tolerance were calculated. Color vision with rapid onset acceleration, spinal disc abnormalities in acceleration subjects, and limited space medicine were also studied. The last decade included evaluating life support systems for F-22 and Joint Strike Fighter, anti-G suit and PBG system study, and testing an electric muscle stimulation suit. **SIGNIFICANCE.** The research performed at Brooks AFB/CB was instrumental in our understanding of acceleration physiology, helping to reduce G-induced aircraft accidents and to increase pilot high-G performance.
**Learning Objectives:**
1. Knowledge of how the acceleration physiology studies using a centrifuge for animal and human subjects created information that could increase the understanding of the effects of high G, the G-induced Loss of Consciousness and the effects on pilot performance as well as the effects of G-protecting equipment and procedures.

## [235] SPATIAL DISORIENTATION RESEARCH AND TRAINING AT BROOKS FIELD/AIR FORCE BASE/CITY BASE.

W.R. Ercoline
*IS&E, Wyle , Brooks City-Base, TX*

**MOTIVATION:** The topic of spatial disorientation (SD) has been of interest to aerospace physiologists and aeromedical professionals since the problem was first recognized in 1927. Brooks Air Force Base aerospace medicine personnel have arguably played the most significant role of developing ways to understand the causes, costs and countermeasures of this inflight issue. This presentation reviews the research and development of SD countermeasures over the past eighty plus years, primarily focused on the accomplishments of those who were involved with work at Brooks AFB and the USAF School of Aerospace Medicine. **OVERVIEW:** SD research required a multi-faceted approach and the overarching plan needed input from all three military services. A research plan to support this level of effort was first developed at Brooks in 1990. This plan was the culmination of years of earlier research that took the work of vestibular researchers and coupled it with a broader sense of the definition of spatial disorientation in aviation. This broader definition helped to bring into light some of the real issues causing SD. This roadmap focused on using operationally relevant terms to better quantify the overall problem. Researchers, flight surgeons and pilots from all services now had commonality to the problem. **SIGNIFICANCE:** The significance of this work paved the way for many research and development studies to better understand how the human perceives spatial orientation and how best to counter SD. It resulted in standardization of flight symbology, numerous visual and vestibular perception studies, and this work resulted in the first textbook devoted solely to the subject of SD in aviation. In addition, numerous related projects helped improve existing technology to better train the pilot without having to do so in flight. Results of his work eventually changed the way SD training would be accomplished within the USAF. From the first SD trainer (the Vertigo Stopper Box) to the most recent SUPT SD trainer, an examination of the pros and cons of current technology will be discussed, and lessons learned from the associated SD studies.
**Learning Objectives:**
1. To appreciate the role of Brooks AFB and USAFSAM on our understanding of spatial disorientation and the contribution to SD countermeasures.
2. Understand the pros and cons of ground-based SD trainers.

## [236] LIFE SUPPORT EQUIPMENT DEVELOPMENT AND TESTING AT BROOKS AIR FORCE BASE

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**MOTIVATION:** Research efforts at Brooks Air Force Base were closely linked to the development and testing of life support equipment and countermeasures to protect aircrew from the effects of sustained acceleration, altitude exposure, spatial disorientation, and even chemical/biological exposure. **OVERVIEW:** Due to the wealth of expertise and availability of sophisticated equipment, in the mid 1980's Brooks entered the acquisition arena with an Advanced Development program for a "Tactical Life Support System" (TLSS). This was a dem-val system for a variety of new technologies and was so successful that it served as the prototype for the emerging F-22 program, and its component technologies were picked up separately in their own retrofit programs: On Board Oxygen Generation (OBOGS), better high altitude pressure breathing protection (PBA) and the protection afforded by pressure breathing for G (COMBAT EDGE) were retrofitted to the F-15 and F-16 fleets. The Advanced Technology Anti-G Suit (ATAGS) soon followed. Researchers at the centrifuge have continued to test and develop equipment under sustained acceleration, including arm sleeves, night vision goggle systems, and aircrew chemical defense systems. The last decade included evaluations of life support systems for the F-22 and the F-35, continued work with full coverage anti-G suits and PBG systems, and testing an electric muscle stimulation suit. The altitude chambers were also used to test a number of life support ensembles, as well as the development and man-rating of NASA's Launch Escape System (LES). Both altitude and sustained acceleration capabilities were tested at Brooks as part of the development of aircrew chemical defense gear. Working closely with the Systems Program Office, researchers served as technical consultants and helped to develop and test various chemical defense ensembles, including COMBAT ACE and the Joint Services Aircrew Mask. Additional capabilities at Brooks included ingress/egress testing, field of vision evaluation, and display symbology development and testing. **SIGNIFANCE:** Brooks Air Force Base not only conducted critical basic and applied research, but also played a major role in testing and developing life support equipment.
**Learning Objectives:**
1. List three main life support equipment ensembles that were tested at Books Air Force Base.
2. Discuss the contributions that Brooks Air Force base researchers made to G-protection.

***Tuesday, April 26*** ***2:30 PM***
***Avalon 18-19***

## S-42: POSTER: ISSUES IN HUMAN PERFORMANCE

**Chair: Brent Haskell**
*Gerogetown, KY*

**Chair: Roy Marsh**
*San Antonio, TX*

### [237] AN OVERVIEW OF THE CELLULAR SENTINELS OF TOXICITY PLATFORM

H. Pangburn[1], J.M. Gearhart[4], L.H. Smith[2], S. Malany[2], A. Bang[3] and D.K. Ott[5]
*[1]STS on contract to USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; [2]Conrad Prebys Center for Chemical Genomics, Sanford Burnham Prebys Medical Discovery Institute, Orlando, FL; [3]Conrad Prebys Center for Chemical Genomics, Sanford Burnham Prebys Medical Discovery Institute, La Jolla, CA; [4]Henry M. Jackson Foundation on contract to 711th Human Performance Wing/RHDJ, Wright-Patterson AFB, OH; [5]USAF School of Aerospace Medicine, Wright-Patterson AFB, OH*

The current approach to quantitatively assessing the health risks of chemical exposure relies extensively on high dose, expensive, low-throughput animal studies that depend on conservative extrapolations to relate animal studies to much lower dose human exposures. While animal studies represent the foundation of toxicology and as such are unlikely to be entirely replaced, the low throughput and high cost make them entirely unsuitable for assessing the potential toxicities of the thousands of chemicals present in commercial processes, chemicals to which the population is exposed. A new generation of technologies is now poised for development into a high-throughput platform toxicological screening that can be used to assess, in a first line evaluation, the potential toxicity of large collections of chemicals. Leveraging recent breakthroughs in cell engineering and high-throughput cell imaging, scientists at Sanford Burnham, in collaboration with the United States Air Force, have produced a highly relevant platform — The Cellular Sentinels of Toxicity Platform — that relies on high-throughput, physiologically relevant, human-induced pluripotent stem cell-based assays to elucidate the mechanistic basis of toxicity. Results from this effort will allow for the early assessment of potential toxicities in a rapid, cost-effective manner that will simultaneously improve the relevance of the data produced while reducing the downstream use of animal studies.

**Learning Objectives:**
1. To become aquainted with the benefits/power and applicability of this high-throughput screening platform.

### [238] CELLULAR SENTINELS OF TOXICITY PLATFORM FOR ASSESSMENT OF LIVER TOXICITY USING MULTI-PARAMETRIC ANALYSIS OF HUMAN-DERIVED HEPATOCYTES

K. Whig, N. Bryan, J. Kirby, L.H. Smith and S. Malany
*Sanford Burnham Prebys Medical Discovery Institute, Orlando, FL*

**INTRODUCTION:** Current approaches to environmental toxicity screening rely on low-throughput, expensive animal models. There is a need for high-throughput technologies using human cell-based assays as a front line to assess toxicity of large numbers of unknown environmental toxins for risk assessment. This poster highlights the hepatotoxic module of the toxicity platform. **METHODS:** We have developed a tier-based, multi-parametric testing platform utilizing phenotypic-based imaging assays, liquid chromatography and mass spectrometry technology, and cellular bioenergetics assays to evaluate mechanisms of compound toxicity in human-derived hepatocytes. This approach was applied to screening of the Enzo SCREEN-WELL hepatotoxicity library, which contains structurally diverse and mechanistically distinct compounds as well as nontoxic controls. **RESULTS:** Compounds were tested at 20 µM in the live cell imaging platform at 1 h and 24 h to assess both acute and chronic effects on cell viability, mitochondria potential and oxidative stress in a 384-well, multiplex plate format using fluorescent dyes specific to each readout. Dose-dependent and time-dependent changes in cell health were further characterized using our liquid chromatography and mass spectrometry screening platform to monitor specific biotransformations of cytochrome P450 enzymes responsible for metabolism of most toxins in the liver that can lead to hepatotoxicity. We further characterized compounds by measuring fatty acid oxidation, oxidative phosphorylation, and glycolysis. **DISCUSSION:** The combination of using human-derived hepatocytes and multi-parametric analysis measuring phenotypic and functional responses has resulted in a robust high-throughput method to assess human hepatotoxicity while reducing the overall number of compounds requiring extensive toxicity testing *in vivo*.

**Learning Objectives:**
1. The participant will have a good understanding of high-throughput toxicity screening in human derived hepatocytes as a platform for human risk assessment upon exposure to environmental toxins.

### [239] CELLULAR SENTINELS OF TOXICITY PLATFORM: UTILIZING HUMAN- INDUCED PLURIPOTENT STEM CELL-DERIVED NEURONS TO SCREEN FOR NEUROTOXINS

S. Hinckley[1], S. Sherman[1], J.M. Gearhart[2] and A. Bang[3]
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**INTRODUCTION:** Low throughput and high cost of animal studies preclude their use in assessing health risks of chemical collections. We describe development of a suite of assays based on human induced pluripotent stem cell (hiPSC) derived neurons as a high-throughput, first-line evaluation of potential neurotoxicity. These hiPSC-derived neurons are advantageous in that they are normal, non-transformed and commercially available. Our approach utilizes human neurons to monitor neurite growth, mitochondrial function and neuronal network activity endpoints for toxicity. **METHODS:** A library of 81 compounds was assembled to include suspected and known neurotoxins as well as non-toxic controls. Assays were developed using hiPSC-derived iCell neurons and iDopa neurons (Cellular Dynamics International). Neurite growth and mitochondrial screens were performed on the Opera High Content Screening System (Perkin Elmer) and analyzed with Acapella software. Neurophysiology assays were performed on multi-electrode arrays (Axion Biosystems) and analyzed using Axis 2.0 and Neuroexplorer (NEX Technologies) software. **RESULTS:** We used hiPSC-derived iCell neurons to develop high-content, image-based assays with sufficient robustness (Z-factor >0) to screen in high-throughput as replicates. Our neurotoxin collection was screened on 384-well plates in dose response for neurite growth in a fixed-cell, image-based assay and mitochondrial dysfunction in a live-cell, image-based assay, multiplexed to assess mitochondrial membrane potential and generation of reactive oxygen species. In addition, we developed a physiological assay with hiPSC-derived iDopa neurons on 48-well multi-electrode array plates to screen for the effects of potential neurotoxins on neuronal network activity. **DISCUSSION:** We demonstrated feasibility of using hiPSC-derived neurons to screen for neurotoxins in a high-throughput, first-line evaluation based on highly relevant assays allowing identification of potential neurotoxins for further analysis. Future development of this scalable source of human neurons, in terms of neuronal sub-type and complexity of phenotypic read-outs, will provide a powerful approach to determine neurotoxicity of large chemical collections.

**Learning Objectives:**
1. High-throughput evaluation of compound neurotoxicity using human neurons.

### [240] CELLULAR SENTINELS OF TOXICITY PLATFORM FOR ASSESSMENT OF CARDIAC TOXICITY USING MULTI-PARAMETRIC ANALYSIS OF HUMAN-DERIVED CARDIOMYOCYTES

J. Kirby, N. Bryan, F. Qi, S. Phatak, K. Whig, L.H. Smith and S. Malany
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**INTRODUCTION:** Human-induced pluripotent stem cells (hiPSC) provide a cost-effective, higher throughput alternative to *in vivo* animal toxicology studies with increased relevance to human subjects that can be used to screen for cellular toxicity and flag compounds for further analysis. **METHODS:** Label-free impedance-based detection of hiPSC-derived cardiomyocyte contractility using the ACEA xCELLigence platform provides real-time monitoring of compound-induced cardiac risk in a 96-well format. We have developed bioinformatic approaches to assess changes in cell viability, beat rate, amplitude, and arrhythmia using automated algorithms to rapidly process large kinetic datasets and integrate results into data sharing and visualization platforms. This method was applied to screening of the Enzo SCREEN-WELL cardiotoxicity library, which contains structurally diverse and mechanistically distinct compounds as well as nontoxic controls. **RESULTS:** Sixty-nine of 130 compounds tested at 10 µM were determined to have acute or chronic effects on cardiomyocyte viability or contractility. Dose-dependent and time-dependent changes in cell viability and beat patterns induced by these compounds were further characterized using both the impedance platform and high content live cell imaging to assess the effect of the compounds on mitochondrial integrity and cellular oxidative stress. **DISCUSSION:** Results demonstrate the feasibility of this platform to provide higher throughput methods for assessing cardiac liabilities of potential toxins utilizing physiologically relevant human stem cells while reducing the overall number of compounds requiring extensive toxicity testing *in vivo*.

**Learning Objectives:**

1. The participant will have a good understanding of high-throughput toxicity screening in human-derived cardiomyocytes as a platform for human risk assessment upon exposure to environmental toxins.

## [241] TEACHING OLD ESSENCE NEW OCCUPATIONAL ILLNESS SURVEILLANCE TRICKS

P. Kim
*U.S. Air Force, AP*

**PROBLEM STATEMENT:** To comprehensive capture patient encounters that are occupational illnesses in nature, a new method has been developed using Electronic Surveillance System for the Early Notification of Community-Based Epidemics (ESSENCE), which has been traditionally used for routine medical surveillance. **TOPIC:** DODI 6055.07 "Mishap Notification, Investigation, Reporting, and Record Keeping" states it is DoD policy to protect DoD personnel from occupational illness. AFI 48-145 "Occupational and Environmental Health Program" charges Public Health to monitor and track occupational illness investigations until completion in Air Force Safety Automated System (AFSAS). During an occupational illness investigation, Bioenvironmental Engineering (BE) accomplishes workplace exposure study, and a Flight Surgeon (FS) confirms occupational relatedness. Public Health usually initiates such investigations based on provider referrals, Emergency Room encounters, and during shop visits, but many cases go unnoticed especially when patients are seen by Family Practice providers for hobby related exposures or when patients are not enrolled in occupational health programs. We have created a new User-Defined Syndrome Category in ESSENCE to survey for ICD 9 and ICD 10 codes that are most likely associated with occupational exposures. Since ESSENCE tracks all patient encounters, all occupational related encounters can be captured using this new User-Defined Syndrome Category, which produces a comprehensive situational awareness of all potential cases. A further investigation on these possible cases is warranted to rule out false positive occupational illnesses, but this method provides users with an expedited surveillance tool. **APPLICATIONS:** This new use for ESSENCE provides preventive medicine experts another useful tool to comprehensive capture potential occupational illnesses, especially for bases with big occupational health programs, where 100% record review is not practical. Once suspected cases have been identified, more in-depth investigations can follow. Coordination with BE and FS, one can identify and report all true occupational illnesses in AFSAS.

**Learning Objectives:**

1. Learn how ESSENCE can be used to conduct occupational illnesses surveillance.

## [242] A SER326CYS SUBSTITUTION IN HOGG1 ASSOCIATED WITH HIGH- FREQUENCY HEARING LOSS SUSCEPTIBILITY IN CHINESE PILOT CADETS

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*[1]Air Force Aviation Medicine Research Institute Affiliated Hospital, Beijing, China; [2]ENT Department of General Hospital of Air Force, Beijing, China*

**INTRODUCTION:** Oxidative DNA damage plays an important role in the process of hearing loss. Human 8-hydroxyguanine glycosidase I (hOGG1) encodes an 8-hydroxyguanine repair enzyme capable of 8-hydroxyguanine-specific excision repair. The purpose of this study was to assess the relationship between the hOGG1 Ser326Cys mutation and high-frequency hearing loss susceptibility in Chinese pilot cadets. **METHODS:** We detected the genetic polymorphism by sequencing the DNA of 169 pilot cadets with high-frequency hearing loss (4,000, 6,000, 8,000 Hz) and 886 pilots with normal hearing from an aviation university in China. **RESULTS:** We found that the risk of high-frequency hearing loss in pilot cadets carrying the hOGG1 Cys / Cys genotype was 1.73 times higher than in those carrying the hOGG1 Ser / Ser genotype (OR = 1.73, 95% CI = 1.07 - 2.78). Combining the hOGG1 Ser / Ser genotype and the Ser / Cys genotype in a recessive model showed that pilot cadets carrying the hOGG1 Cys / Cys genotype exhibited a 1.53-fold greater risk of high-frequency hearing loss (OR = 1.53, 95% CI = 1.03 - 2.27). **DISCUSSION:** In conclusion, our data indicate that the Ser326Cys substitution in the hOGG1 gene may be correlated with susceptibility to high-frequency hearing loss in Chinese pilot cadets.

**Learning Objectives:**

1. The purpose of this study was to assess the relationship between the hOGG1 Ser326Cys mutation and high-frequency hearing loss susceptibility in Chinese pilot cadets.

## [243] STUDY ON HEARING IMPAIRMENT AT HIGH FREQUENCY AMONG THE FLIGHT CADETS

H. Zhang[1] and R. Guo[2]
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**INTRODUCTION:** To study the incidence of hearing loss at high frequency and the related influence factors among the flight cadets. **METHODS:** Using multi-stage sampling method, 426 flight cadets were randomly selected from grade 2012 2013 2014. The level of binaural hearing threshold at 4kHz, 6kHz, 8kHz were measured by hearing-assistant evaluative apparatus. Whether or not have hearing loss was chosen as dependent variable. Territory, smoking, dietary habit, previous history of tinnitus, the noise exposure time, the vestibular function and the psychological quality were chosen as independent variables. T test, ANOVA and accumulative logistic regression were performed to analyze the influence factors on hearing impairment by software SPSS18.0. **RESULTS:** The morbidity of hearing impairment among flight cadets was 17.1%. Results from single factor analysis showed that the levels of hearing thresholds at 4kHz, 6kHz frequency were statistically significant among smoking group and non-smoking group ($P<0.01$). The levels of hearing thresholds at 4kHz frequency were statistically significant among spicy diet group and not spicy diet group ($P<0.01$). The levels of hearing thresholds at 4kHz, 6kHz, 8kHz frequency were statistically significant among different strong noise exposure group ($P<0.01$), and that under the same frequency hearing loss is increasing trend with the increase of noise exposed. The levels of hearing thresholds at 4kHz, 6kHz frequency were statistically significant among different vestibular function group ($P<0.01$). Results of accumulative logistics regression showed that smoking and strong noise exposure were risk factors causing hearing impairment at 4 kHz frequency, and excellent vestibular function seemed to be a preventive factor. Smoking and strong noise exposure were also risk factors causing hearing impairment at 6 kHz frequency. **DISCUSSION:** Hearing impairment appears higher morbidity among flight cadets, and it has statistical correlation with smoking, strong noise exposure and vestibular function.

**Learning Objectives:**

1. To study the incidence of hearing loss at high frequency and the related influence factors among the flight cadets.

## [244] OCCUPATIONAL FACTORS AND THEIR INFLUENCE ON MENTAL HEALTH CONDITIONS IN ACTIVE DUTY AIR FORCE MEMBERS 2006 - 2010

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**INTRODUCTION:** Since entering combat operations in 2001, military mental health diagnoses trended upward. The Occupational and Environmental Air Force Health Study database created opportunities to identify occupational factors in mental health burden. This database connects over 33.7 million records with 221 variables from six health and personnel databases with 519,000 subjects from 2006-2010. We investigated environmental and occupational factors affecting health and risk-taking behaviors of active duty Air Force (ADAF) personnel. **METHODS:** Inpatient and outpatient data were queried for mental health conditions using International Classification of Diseases, 9th Revision, Clinical Modification codes. Annual burden was counted in an ever/never method as to whether a service member had a mental health condition. Demographic data were used to evaluate risk factors for mental health burden. **RESULTS:** Enlisted members experienced higher rates of mental health issues. This trend was also evident among females, married individuals, and those with lower education. Organizationally, members in mission support, security forces, logistics readiness, medical/dental, and maintenance units had the highest rates of mental health conditions. Occupationally, enlisted personnel with a Duty Air Force Specialty Code (DAFSC) of special duty, medical, and acquisition had the highest rates, while officers with special duty and medical DAFSC were the highest. As compared to civilians, ADAF members had lower age adjusted rates of mental health treatment/counseling from 2006-2010. ADAF males had treatment/counseling rates ranging from 1,271-1,870 cases per 100,000, while civilians ranged from 8,900-9,500 cases per 100,000. ADAF females had treatment/counseling rates ranging from 2,206-3,128 cases per 100,000, civilians ranged from 16,600-17,800 cases per 100,000. **DISCUSSION:** We identify associations between mental health burden and demographic, organizational, and occupational risk factors. Future studies can utilize these data to model value of proposed interventions. We envision the intended outcome to be specific counseling and prevention program implementation geared toward reducing stress-related outcomes.

**Learning Objectives:**

1. To better understand associations between mental health burden and demographic, organizational, and occupational risk factors.
2. To understand statistical and epidemiological methods used to determine these associations.

## [245] ASSOCIATION BETWEEN MEDICAL CONDITIONS AND AVIATION ACCIDENTS IN THE GENERAL AVIATION POPULATION

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**INTRODUCTION:** The Federal Air Surgeon has called for more research on the overall health of our pilot population. He expressed interest in determining if current policies for airmen that have diabetes are sufficient. In this study, we estimated risk of an aviation accident by evaluating the relationship between diabetes and its comorbidities, presence of special issuances, and baseline certificate variables. **METHODS:** We conducted a case-control study of pilots that held third-class medical certificates and were involved in aviation accidents, each matched with 7 controls that did not have accidents from 2009 to 2013. Our primary exposure variables were diabetes and its comorbidities. The diabetes variable combined non-insulin (N=1,037) and insulin treated (N=58) conditions due to the small numbers in the latter. Covariates included baseline characteristics such as BMI, gender, and flight time recorded at the most recent medical certificate examination. Conditional logistic regression models were used to calculate odds ratios and 95% confidence intervals. **RESULTS:** There were 2,485 cases that had aviation accidents matched with 17,395 controls that did not have accidents during the study period. Cases and controls did not significantly differ between diabetes and its comorbidities at an alpha of 0.05. However, when we used a count of distinct diabetes condition and its comorbidities for each airman as the exposure of interest, compared to those that had no diabetes pathologies or comorbidities, pilots with 3 or more diabetes-related pathologies had a 31% decrease in odds of having an accident (95% CI 0.52-0.89), adjusting for flight time and BMI. When we restricted the cases to fatal accidents and their subsequent matched controls, adjusting for BMI, the odds of a fatal accident were 39% lower in pilots that possessed a special issuance compared to pilots that did not possess a special issuance (OR=0.61, 95% CI 0.38-0.97). **DISCUSSION:** The significant decrease in risk of fatal aviation accidents of pilots that are more actively monitored compared to those less heavily monitored in our certification system suggests preliminary support against eliminating the extra scrutiny in third-class medical certificates.

**Learning Objectives:**

1. The participant will be able to understand how diabetes and related conditions are affecting the pilot population.

## [246] STUDY ON THE DISTINGUISHING HEROIN ABUSE FROM THE TRADITIONAL CHINESE MEDICINE PRESCRIPTIONS ADMINISTRATION

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**INTRODUCTION:** To help prevent accidents and injuries resulting from the use of prohibited drugs by employees who perform safety-sensitive functions in civil aviation, we conducted drugs screen testing. However, 104 kinds of Traditional Chinese Medicine prescriptions (TCMPs) contain pericarpium papaveris, which administration would cause positive results of opiates. It's a problem to distinguish opiates abuse from the TCMPs administration. **METHODS:** Among above 104 kinds of TCMPs, 47 kinds contained licorice. A strategy was proposed to compare the PK profiles of heroin and FuFangGanCaoKouFuRongYe in rats. An UPLC-MS/MS method was developed to simultaneous quantification of opium alkaloids and characteristic compounds of licorice in TMCPs and in rat specimens. **RESULTS:** The concentrations of opium alkaloids and characteristic compounds of licorice in 13 kinds TCMPs were detected by the UPLC-MS/MS method. Five opium alkaloids (morphine, codeine, papaverine, narcotine, and thebaine) and two characteristic compounds of licorice (glycyrrhizic acid and liquirritin) were detected in all samples. We obtained the PK profiles of heroin, opium alkaloids and characteristic compounds of licorice. The results indicated that the constituent species detected and concentration ratio of each others could provide reference for distinguishing heroin abuse from the TCMPs administration. **DISCUSSION:** This method provides more substantial foundation for establishment of an opiates abuse testing false positive identification system.

**Learning Objectives:**

1. The study provides guidance for distinguishing heroin abuse from the TCMPs administration.

## [247] HEAD INJURY CRITERIA (HIC) IMPACT VALUES BY A 5KG DRONE

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**INTRODUCTION:** Drones, UAV/UAS or aeromodels present injury threats to operators or by-standers. Their lightest category, i.e. up-to- 5 kg aeromodels for air sports are hazardous as their kinetic energy is large enough to make it lethal. In Japan, there had been more than 7 death cases in the past. In this paper we measured Head Injury Criterion (HIC) index values to assist in understanding injury mechanism by drones. **METHODS:** A human dummy with acceleration sensors was submitted for impact measurement. A plastic representative of aeromodel fuselage with a mass of 5 kg was launched toward head of the dummy. The velocity of the projectile was up to 30 m/s. Analysis followed the standard automobile industry HIC algorithm. **RESULTS:** Impact was the largest at the moment of projectile contacted with the forehead when the fuselage starts to either deformed or disintegrated at around 10 ms from the contact. For 30 m/s case, it was 11 to 12 ms. Accessory impact by torso fall, etc. was much smaller than this event. The largest HIC value recorded in 30 m/s case was 2,160, which corresponds to 30 % fatality rate due to head injury.

**DISCUSSION:** The right model for drone collision with human body has not been developed yet. With fixed wing drone, substantial yaw results after initial contact with human body, making standardization complex. This study better corresponds with multicopter impact where relatively concentrated mass hits the human body. With a single rotor helicopter case, kinetic energy of blade rotation plays the principal role. A 3m-diameter composite blade transfers ~6 kJ energy to human body [Shimada2014], several times larger than that by a NATO rifle bullet. Traditional would ballistics are well studied, but pattern of injury does not match with that of drone collision. For example, the kinetic energy of this study projectile (2,250 J) is somewhat larger than that of NATO rifle bullet (~1,800 J), but the nature of would be different. Still what is readily available for estimating the extent of injury are HIC and absorbed energy. One big issue for injury prevention is that details of accident cases are rarely recorded. We would like to see building of injury database of drones.

**Learning Objectives:**

1. To understand that hobby drones are one new source of injury.

## [248] ATTACK HELICOPTER 'GUN TAPE' EXPLOITATION AS A MEANS TO IMPROVE PILOT PERFORMANCE

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**INTRODUCTION:** Attack helicopter (AH) 'gun tape' exploitation is a critical post-mission event for intelligence, battle damage assessment, and near future operational events. Following combat engagements, this process is conducted within a framework of After Action Review (AAR) of pilot performance with aircrew, leadership, instructor pilots (IP), and master gunners (MG). While there exists doctrinal guidance for AARs in general, the conduct of post-engagement AARs is not standardized across the force. This event may have important implications with respect to psychological processing following a Potentially Traumatic Event (PTE) as well as future performance. **METHODS:** Current psychological and sport science literature was reviewed with respect to PTE and post-event (PE) performance coaching. Samples of unit standard operating procedures (SOPs) were solicited from operational AH formations to assess the spectrum of practices. A consortium of subject matter experts (IPs/MGs) was organized to review SOPs, discuss AAR formats, and adjudge various procedures and techniques. Sanitized gun tapes were reviewed to augment discussion. SOPs were cross-walked with current literature to highlight formats, techniques, and best practices with respect to post-engagement pilot resiliency and future task performance. **RESULTS:** Unit SOPs were remarkably consistent. PTE management highlights a holistic approach before, during, and after as important for psychological health and resiliency. Sport science literature also advocates for a comprehensive multifactorial methodology such as the "post mortem" for PE coaching and performance improvement but is less uniform in the literature. Many important elements from both were present within AAR formats reviewed. **DISCUSSION:** Aviation leadership, IPs, and MGs consistently communicate through formal and informal channels to share information, techniques, and best practices that have been refined through years of armed conflict. Many elements of PTE management and PE coaching techniques were present within the SOP frameworks for AARs. Recommendations were made to codify these important procedures in academic instruction of new MGs, as well as standardization of best practices across the force.

**Learning Objectives:**

1. Understand the elements of attack helicopter After Action Review within the context of current psychological and sport science literature with respect to critical event management and post-event performance coaching.

## [249] THE IMPACT OF NUTRITIONAL INTAKE DURING SUSTAINED AVIATION OPERATIONS: CONSIDERATIONS FOR CURRENT AND FUTURE POLICY

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**MOTIVATION:** Military aviation operations often occur during overnight hours, include long-duration missions, and frequently result in minimal access to meals. Sustained operations in aviation require the pilot to maintain alertness and be at his or her optimal performance level; however, there are no policies in place which address the importance of proper nutrition in this regard. This presentation will outline the case for short term policy recommendations and future research regarding nutrition during overnight, sustained operations, in order to optimize performance outcomes. **OVERVIEW:** The successful operation of an aviation mission is often dependent on the pilot who is faced with a variety of factors that may impact performance including fatigue, managing a high cognitive workload, and operating in a stressful environment. However, the pilot's performance may also be influenced by nutritional intake, but little attention has been brought to this factor in pilot performance. Previous studies have shown that the type and quantity of food consumed positively or negatively impact cognitive performance, and is further influenced by task demands. Additionally, the time of day of consumption has also been shown to play a role in cognitive performance and alertness, which may affect to pilot performance during nighttime operations. The latest research regarding nutrition, its impact on cognitive processes, and its impact on alertness has been reviewed to identify how it can be applied to aviator performance during sustained operations. **SIGNIFICANCE:** While there is ample literature regarding the effects of nutrition and cognitive processes, there are currently no policies in place for military aviators regarding nutritional intake during sustained operations. To maintain optimal aviator performance, consideration of nutrition's impact on alertness and cognitive performance is required and polices are needed to optimize safety. This work will support military aviator policy makers to determine policies regarding nutrition, as well as lay the groundwork for future research endeavors.

**Learning Objectives:**

1. The participant will be able to understand the importance of nutrition on cognitive performance during sustained operations.

## [250] EMESIS HISTORY AND CURRENT MOTION SICKNESS EXPERIENCE PREDICT MOTION SICKNESS TOLERANCE

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**INTRODUCTION:** Motion sickness (MS) has been studied for decades. More recently virtual environments and head mounted displays (HMDs) have been shown to generate significant sickness. Research has shown that almost anyone can be made motion sick. There are a few theories explaining *how* MS occurs, but no definitive findings on predicting an individual's experience of MS. Some studies have related an individual's history of MS to their susceptibility of sickness. The purpose of this experiment was to assess how far MS history and acute MS predict the subjects' ability to endure nauseogenic stimulation. **METHODS:** 120 subjects participated in up to five trials of a nauseogenic task while wearing an HMD with manipulated latency. MS and emesis history were measured using the Motion Sickness Susceptibility Questionnaire. Acute MS was measured at the end of the experimental task using the Motion Sickness Assessment Questionnaire (MSAQ). Subject withdrawal was measured based on the subjects' ability to complete all experimental trails or not. **RESULTS:** 95 subjects completed all experimental trails, and 25 subjects withdrew early. A logistic regression was used to assess the predictability of subject withdrawal based on MS history, emesis history, MSAQ scores, and interactions between those variables. Only MSAQ scores significantly predicted subject withdrawal ($b$=.127, Wald $\chi^2(1)$=12.90, $p$<.01). A t-test was used to examine differences in emesis history between subjects who completed the experiment and those who withdrew early. No significant differences were found, but the trend in the data suggests subjects who withdrew early had less history with emesis than subjects who completed the experiment. **DISCUSSION:** Results show acute MS, not MS history predict subject withdrawal. However, the trend in the data indicates that there may be a relationship between emesis history and subject withdrawal. Past experience with emesis may inform subjects on their MS tolerance, allow them to better recognize when they are about to vomit, and give them more experience with compensatory strategies. Therefore those subjects are able to endure the stimulus longer. Lack of significance may be due to the low number of subjects who withdrew early.

**Learning Objectives:**
1. This experiment aids in understanding the roles motion sickness history and motion sickness experience in a current task play in predicting an individual's ability to carry out the current task.

## [251] MILD TRAUMATIC BRAIN INJURY ALTERS PULSE OXIMETRY IN NORMOBARIC HYPOXIA

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**INTRODUCTION:** Physiological and/or emotional stress can increase symptoms of mild traumatic brain injury (mTBI), and either form of stress may reveal symptoms in individuals with mTBI who are asymptomatic at rest. Hypoxia is an environmental stress that can be easily, repeatedly, and reliably generated and controlled in a laboratory setting. Here we report pulse oximetry and oculometrics measured under conditions of normobaric hypoxia (NH) in normal controls and in those with a history of mTBI who are asymptomatic at mean sea level (MSL). **METHODS:** A group of 36 subjects with mTBI was compared to a group of 36 subjects with no mTBI history. The two groups were matched on age, gender, body mass index, and smoking behavior. Each subject was exposed to NH equivalents of MSL (fraction of inspired oxygen 21%), 8,000, (15.5%), 12,000 (13%), and 14,000 (12%) feet above MSL. The Reduced Oxygen Breathing Device (ROBD) generated the NH stress. Conventional pulse oximetry provided peripheral arterial oxygen saturation ($SpO_2$) and pulse rate. Oculometrics, measured with the Functional Impairment Tester, consisted of saccadic velocity, pupil diameter in the dark, and the latency and amplitude of the pupillary light reflex. The study was reviewed and approved by the USAARL Regulatory Compliance Office and the U.S. Army Medical Research and Materiel Command Office of Research Protections and the Human Research Protection Office. **RESULTS:** The mTBI group had significantly lower $SpO_2$ than the controls during the final minute of exposure for the three NH stress conditions [$F(2.17,151.8)=5.29$, $p<.001$] and the rate of $SpO_2$ change was significantly lower for the mTBI than the controls across all hypoxic conditions ([$F(2.3,161.3)=2.863$, $p<.001$], Greenhouse-Geisser corrected). Overall, mTBI had lower heart rate but the difference was only significant for the NH 14,000 ft. stress. The oculometric measures, while sensitive to hypoxia, were insensitive to group differences. **DISCUSSION:** These findings demonstrate that a relatively minor NH stress challenge can reveal measurable differences in $SpO_2$ and heart rate between subjects without and subjects with a history of mTBI who are asymptomatic at MSL.
**Learning Objectives:**
1. To describe the influence that environmental stressors can have on symptoms of mild traumatic brain injury.

## [252] 14 MINUTES OF INCAPACITATION IN A FIGHTER PILOT DURING FLIGHT

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**INTRODUCTION:** We report the case of a fighter pilot who became unresponsive during a mission for 14 minutes during which time his WSO had to control the aircraft. **CASE REPORT:** A fighter aircraft, flown by young age pilot was on a routine Basic Fighter Maneouvre mission. Upon reaching the training area, the pilot put his aircraft into a tight turn to engage the other aircraft and reached +11 Gz in the process. He instantly experienced a clicking sensation in the neck with pain and tingling going down his upper limbs. Realising that he had exceeded the performance limit of the aircraft and fearing that he may have damaged his neck and or spinal cord, he pushed the stick forward and sent the aircraft into -3.5 Gz, all within a space of 4-5 seconds. Following this he became unresponsive for 14 minutes. His WSO took control of the aircraft until the pilot recovered and flew safely back to base. Extensive investigations including cardiac and psychiatric evaluation were unremarkable. Centrifuge assessment was surprising in that he suffered GLOC at +5.5 Gz and remained unconscious for 42 seconds. **DISCUSSION:** GLOC has been well documented in aircrew flying high performance aircraft. ALOC is a similar entity but without total loss of consciousness. The pilot in this case claims to have been conscious the whole time and attributed his lack of response to feeling frightened. He had a reputation of being impulsive and his personality trait may have contributed to his performance in flight. This pilot was eventually transferred to helicopters.

## [253] PERSONALITY PROFILES OF PILOTS BY TYPE AIRCRAFT FLOWN AND ASSOCIATION WITH LICENSE SUSPENSION

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**INTRODUCTION:** U.S. military fighter pilots scored lower on agreeableness and higher on conscientiousness on the NEO-PI-R inventory than pilots of other aircraft, and conscientiousness was the most important determinant of performance. Also, a large study of Canadian pilots analyzed questionnaires about characteristics that may predict susceptibility to "pilot error" accidents, and found that over half the items were significant accident markers in at least one of four pilot-license categories examined. **METHODS:** We studied the Temperament and Character Inventory (TCI 240) profiles in civil and military pilots, flying school pupils, SWAT force members, Argentinean Navy SEALS (Buzos Tácticos), extreme sportsmen, traffic air controllers and a group of pilots who have lost their licenses. As negative controls we collected data on 108 people of middle class urban general population and as positive control, 100 psychiatric outpatients with mood or anxiety disorder diagnosis. TCI raw scores for the four temperament (harm avoidance -HA-, persistence -PS-, reward dependence -RD-, novelty seeking -NS-) and character (self-transcendence -ST-, self-directedness -SD-, cooperativeness) mean levels were compared by one way ANOVAs followed by Bonferroni. **RESULTS:** Pilots with suspended licenses had significantly higher HA and higher NS than population controls and other pilots. Fighter pilots had significantly lower HA than other pilots and controls. A discriminant analysis correctly separated psychiatric patients from all others, but was not able to separate pilots with suspended licenses. Latent Class analysis (unsupervised) provided an optimal three cluster solution with one cluster including population controls, patients and suspended pilots, another with population controls, non-fighter pilots (commercial, private and helicopter licenses), and a third with fighter pilots, navy SEALs and SWAT members primarily. **CONCLUSIONS:** Our data suggest that TCI scores may be an useful adjunct to identify pilots at risk for accidents and to design specific interventions.
**Learning Objectives:**
1. To establish the role of personality profiles on risk of aviation accidents.
2. To compare the personality profile of pilots involved in accidents with those of other high responsibility groups, risk-takers or control groups.

## [254] RELATIONSHIP BETWEEN COMPUTER-BASED SPATIAL COGNITIVE TASK, SMALL-SCALE SPATIAL ABILITY TESTS AND FLIGHT PERFORMANCE.

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**INTRODUCTION:** The ability to maintain a sense of direction and location while flying in the sky is a fundamental cognitive ability of pilots. In earlier studies we developed a computer-based spatial cognitive task and reported that the task could detect differences between the pilots and enlisted personnel. In this study, we investigated the relationship between the spatial cognitive task, existing basic small-scale spatial ability tests and spatial working memory task. We also carried out correlation analysis to identify the relationship between spatial cognitive ability and flight performance. **METHODS:** Forty three pilot candidates conducted the spatial cognitive task, the four kinds of small-scale spatial ability tests (Block rotation, Form rotation, Perspective and Form completion task) classified by Elliot (2000) and spatial working memory task. In our spatial cognitive task, participants flew in the predetermined flight path, they completed three types of spatial tasks: a cardinal judgment task, a judgment about the location of the object task and a path integration task. Accuracy and response time were measured. We investigated that the relationship

between the spatial cognitive task, small-scale spatial ability tests, spatial working memory task and flight performance. **RESULTS:** The result showed that a cardinal judgment task and a path integration task correlated with block rotation task, form rotation task and spatial working memory task. The score of a judgment about the location of the object task correlated with the score of block rotation task and spatial working memory task. The observed correlation between the flight performance grade and judgment about the location of the object task was 0.402 (P<.05). **DISCUSSION:** Our spatial cognitive task aims to measure pilot's spatial cognitive ability in a 3-D flight environment from a first-person perspective. In addition, our spatial cognitive task may also measure two small-scale spatial abilities and spatial working memory. The predictive validity of spatial cognitive task was statistically significant. The analysis of covariance structure will be needed to examine the model of our task, small-scale spatial abilities and flight performance in future study.

**Learning Objectives:**

1. Attendees will discuss the relationship between spatial cognitive ability, small-scale spatial ability and flight performance and will understand the importance of the spatial cognitive ability in identifying the KSAOs that are needed for success as a pilot.

## [255] INCREASED VARIABILITY OF VEHICLE CONTROL IN ABSENCE OF DYNAMIC GRAVITATIONAL CUE

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**INTRODUCTION:** We previously developed a protocol to measure participants' ability to balance a vehicle near an unstable equilibrium point (direction of balance, DOB) in roll. When the roll plane was vertical and the DOB was offset from the gravitational vertical, participants' alignments were biased towards the gravitational vertical. When the roll plane was horizontal and the participants supine, which eliminated gravitational cues about the DOB, alignment variability, perceived task difficulty, and motion sickness increased. The present study investigates balance performance as a function of the pitch angle of the participant and the roll plane. **METHODS:** Twelve blindfolded participants were seated in a multi-axis rotation system that simulated inverted pendulum dynamics about a roll axis pitched back between 35° and 90° (supine). Participants used lateral joystick deflections to orient themselves to the DOB, which coincided with the gravitational vertical when the chair was not supine. These orientations were termed achieved angles. Joystick trigger presses were used to indicate where the DOB was perceived (indicated angles). **PRELIMINARY RESULTS:** Four participants aborted the experiment during first exposure to a pitch condition ≥75°, due to either inability to control the chair or to nausea. Planned comparison t-tests showed that within-trial standard deviation of achieved angle differed from the baseline 45° pitch beginning at 70° pitch ($p<0.027$ at least), A similar tilt dependency was not found in within-trial standard deviations of indicated angles. There was no effect of pitch condition on mean achieved or indicated angles ($p>0.136$). Data collection is ongoing. **DISCUSSION:** The increased variability of performance when the participant is pitched back ≥70° suggests that the dynamic gravity cue, as detected by the otoliths, plays an important role in vehicle control. Backwards pitch to ≥70° could potentially be used as an analog environment for studying vehicle control tasks in weightlessness.

**Learning Objectives:**

1. Recognize the pitch angle at which an individual's control of a vehicle around an unstable equilibrium point becomes more variable.

## [256] BONE CONDUCTION AUDIO TRANSDUCERS OUTPERFORM HEADPHONE SPEAKERS IN FIGHTER COCKPITS

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**INTRODUCTION:** Studies show that long-term noise exposure may cause serious psychological effects, and over 40% of pilots suffer from long-term hearing damage. Currently, fighter pilots are required to wear foam earplugs under their flight helmets. Although this solution attenuates some unwanted noise, the ear is still threatened by artificially high levels of audio noise from the helmet's integrated speaker. The present study was conducted to determine if bone conduction audio transducers could provide a better communication pathway than traditional headphone speakers in a flight helmet system. **METHODS:** A standard military flight helmet with integrated headphone speakers was modified to include an array of bone conduction audio transducers (BCTs). Using a clinical audiometer, hearing threshold levels were measured using headphones only in three distinct test regimens: 1) no earplugs in a quiet room; 2) foam earplugs worn under the helmet in a quiet room; and 3) foam earplugs worn under the helmet and 100dB of broadband ambient noise. After a brief rest, the three test regimens were repeated using the BCTs in place of the headphones. Data were measured and plotted for each test subject (n=3). **RESULTS:** Conventional headphone speakers wore more effective than BCTs when earplugs were not worn and the environment was quiet. When foam earplugs were worn, however, the BCTs outperformed traditional headphones, showing an average HTL 10% lower than the headphones. This trend was further exaggerated in the presence of simulated-cockpit noise. The BCTs advantage over headphones in this environment was as much as 30%, with the most benefit being in the mid-to-high frequency hearing range (>1500Hz). **DISCUSSION:** Despite many technological advances in tactical aviation, the most basic human-integrating systems have gone largely unchanged these past few decades. Furthermore, solutions for enhancing hearing protection while providing high-fidelity, dependable audio communications have exclusively focused on the traditional hearing pathway. The results of this study demonstrate that BCTs are superior to prior art implements, especially when wearing earplugs in the presence of ambient noise as would be found in practice.

**Learning Objectives:**

1. A new method of transmitting audio using bone conduction audio transducers was evaluated.

## [257] VISUAL, VESTIBULAR, AND GRAVITATIONAL CONTRIBUTIONS TO THE PERCEPTION OF BALANCE EQUILIBRIUM

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**INTRODUCTION:** We previously tested blindfolded participants using a joystick to balance themselves in a chair programmed to roll in a vertical plane with inverted pendulum dynamics. When the chair's direction of balance (DOB) was offset from the gravitational vertical (GV), participants' alignments were biased towards the GV. This bias was also seen in their indications (via joystick trigger presses) of when the chair was at the DOB. When supine, achieved and indicated orientations were closer to the DOB on average, but more variable. We tested whether these effects would be present when the balance task is carried out using visual, vestibular, or combined cues. **METHODS:** Six participants (2 naïve, 4 experienced) were seated in a motorized chair that simulated inverted pendulum dynamics in roll. Participants used lateral joystick deflections to orient themselves to the DOB, and pressed the joystick trigger to indicate when they perceived themselves to be at the DOB. Testing included physical roll in darkness (vestibular), visually simulated roll (visual), and combined cues (visual-vestibular), in upright and supine planes. A head-mounted display presented 3D urban scenery in the visual conditions. **PRELIMINARY RESULTS:** During upright roll balancing, the within-trial standard deviations of the DOB indications in the combined and vestibular conditions were the same and both were smaller than in the visual condition ($p<0.015$). During supine roll, variances in the combined and visual conditions were equivalent, but variance in the combined condition was smaller than in the vestibular condition ($p=0.001$). In the visual and vestibular conditions, the within-trial standard deviations were larger during supine than upright roll balancing, while in the combined condition variance was smaller during supine than upright roll. Data collection is ongoing. **DISCUSSION:** Our results suggest that the availability of gravitational cues affects the relative weighting of visual and vestibular cues during perception of balance equilibrium.

**Learning Objectives:**
1. Compare the weighting of visual and vestibular cues during a balancing task with and without a dynamic gravity cue.

### [258] BEFORE 9/11- FLIGHT DECK MEASURES OF PILOT AROUSAL. THE PARADOXICAL RESPONSE ON APPROACH AND LANDING. INDICATOR OR ENIGMA?

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**INTRODUCTION:** The Paradoxical Arousal Response (PAR) has been noted as a reduction of the measured level of arousal whilst under high arousal conditions. This has been described previously with pulse rates (PR) with the opinion that "pilots who show this response may be less able to deal with sudden emergencies". An unexpected PAR was initially found during a routine pilot investigation of fatigue using the EMG. There was no indication on that occasion of any deficiency in the pilot's ability, and note was taken therefore of all subsequent PARs in an attempt to clarify their significance. **METHODS:** EMG levels (frontalis muscle) were recorded on each pilot during 8 phases of flight - (taxi, take-off, climb, cruise, descent, approach, landing, taxi.) A total of 64 pilots were measured. There were no selection methods. Permission to conduct the study was previously obtained by the airlines involved and the pilots were all asked to agree beforehand. Only 2 pilots, who were being flight-tested, were left out of the study. **RESULTS:** The results indicate that a PAR is common in pilots. Of the 64 pilots who were measured 26 showed a PAR on approach and landing. Of these 17 were Captains and 9 were 1st Officers. **DISCUSSION:** That the PAR may indicate "a lessened ability to deal with sudden emergencies" is not borne out by these results. Indeed, considering the preponderance of Captains, it would seem likely that the reverse is the case. .If the PAR is not of use as an indicator, can its "Enigma" be solved? A chance encounter with a group of experienced sports parachutists subsequently gave the impression that a confident, determined and resolute attitude had to be maintained prior to jumping. This attitude may not be often necessary for a pilot on approach and landing unless the conditions of flight are particularly adverse. Unfortunately this work had to interrupted before this matter could be elucidated, but it does seem that our "objective measures of arousal" are faulty and there must be other elements in the so-called "Arousal Pattern" that need to be measured and which may apply outside aviation.
**Learning Objectives:**
1. Objective measures (EMG & PR) of arousal in pilots during approach and landing can show a paradoxical response (PAR).
2. The PAR remains an enigma, further work is indicated to elucidate more elements in the patterns of Arousal.

***Tuesday, April 26*** ***4:00 PM***
***Avalon 1-3***

## S-43: SLIDE: AIRCREW PROTECTION

**Chair: Leon Hrebien**
*Philadelphia, PA*

**Chair: Deborah White**
*Poulsbo, WA*

### [259] ESTIMATING AIRCREW NECK LOAD PROFILES USING AN INTEGRATED MODEL OF HUMAN PHYSICAL WORK

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**INTRODUCTION:** In 2014, 75% of CH-146 Griffon Helicopter aircrew reported neck pain (Chafe & Farrell, draft). We postulate that smaller neck loads reduce injury risk and ultimately neck pain. An integrated model of human physical work was developed to identify differences between neck load results across various mission types and helmet configurations. Resultant neck load profiles provide insight into aircrew neck loading exposure for a given helmet system, as well as a development and assessment tool for proposed solutions that reduce neck pain. **METHODS:** This study uses an Integrated Mission, function, task analysis and Physical demands analysis Model (IMPM) to generate neck load profiles. The IMPM was developed by interviewing and capturing motions from 13 aircrew performing 92 postural sequences in and around a CH-146 airframe. Neck load profiles were generated with the IMPM for two missions, with two different helmet configurations (day and night). The profiles were then used to generate cumulative neck load values per hour that allowed us to determine any differences between missions and helmet configurations. The two missions were: 1) Logistics Support and Surveillance (LSS), and 2) Slung Load Training (SLT). The calculated neck load values were compression and shear forces, and resultant torque. **RESULTS:** Cumulative C7 neck torques, normalized by mission duration, were 13.3 (LSS Day), 14.7 (LSS Night), 13.5 (SLT Day), and 15.2 (SLT Night) kNms/h. Compression forces, in the same order, are 213, 270, 212, and 270 kNs/hh. Similarly, shear forces are 8.9, 14.6, 8.0, and 13.5 kNs/h. **DISCUSSION:** The results show smaller neck loads for Day helmet configurations compared to Night (e.g., torque is 13.3 < 14.7 kNms/h for LSS and 13.5 < 15.2 kNms/h for SLT). At the same time, the normalized neck loads are similar between LSS and SLT missions (e.g., torque is 13.3 » 13.5 kNms/h for Day and 14.7 » 15.2 kNms/h for Night). Thus, Day compared to Night helmet configurations produced smaller cumulative neck loads, potentially reducing risk of neck injury and pain. IMPM can be used as an assessment to ensure that proposed solutions reproduce neck load profiles that are less than or equal to Day helmet configurations.
**Learning Objectives:**
1. Understand the problem of neck pain stems from not only neck-borne helmet systems but also mission types.
2. Appreciate the need for biomechanical tools and techniques to investigate neck pain problems, and assess potential solutions.

### [260] UNIFORMITY ASSESSMENT OF TRI-SERVICE EQUIPMENT AND METHODOLOGY FOR MASS PROPERTIES MEASUREMENTS OF PROTECTIVE HEADGEAR

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**MOTIVATION:** The U.S. Army, U.S. Air Force, and U.S. Navy all conduct mass properties measurements of aviation helmets and head-borne systems. However, each Service conducts these measurements with different methodologies and references different coordinate systems, which introduces confusion and inconsistency when comparing results of aircrew headgear. **OVERVIEW:** Aviation headgear mass properties are of crucial importance to the safety and protection of all Aircrew Service Members. Mass property assessments are used by all Services in the development of aviation protective headgear, as the head-borne mass properties have been associated with risk of neck injury. A uniformity assessment of the U.S. Army, U.S. Navy, and U.S. Air Force laboratory methodologies for measuring mass properties was conducted. The assessment included a review of coordinate systems, method for measuring center of gravity (CG), and method for measuring moment of inertia (MOI). It was found that the U.S. Army and the U.S. Navy use similar procedures for measuring CG and MOI; however, they differ in headform and axis system. The U.S. Air Force uses three different coordinate systems with one being the same as the U.S. Navy, one being the same as the U.S. Army, and one being different from both other Services. Translating results between coordinate systems requires coordinate transformations, as well as implementation of the parallel axis theorem for the CG and MOI results. After this translation, the axis system for the helmet is still different for the U.S. Air Force than from that of the other two Services. In addition, the U.S. Air Force procedure for both CG and MOI measurements differ from that of the U.S. Army and the U.S. Navy. **SIGNIFICANCE:** Inconsistency in methods and data reporting between Services leaves room for confusion in aviation headgear mass properties comparisons and assessments of injury risk. This can lead to aviation headgear being approved by one branch of the armed forces while it is not approved by another. A uniform mass properties assessment methodology is ultimately recommended for all Services. This will allow for assessment of new aviation technologies to be completed by all branches and the data easily used for another branch's assessment.

**Learning Objectives:**
1. Quantify the different aviation helmet and head-borne system mass properties assessment techniques between the U.S. Army, U.S. Navy, and the U.S. Air Force.
2. Understand the need for and advantage of a uniform aviation helmet and head-borne system mass properties assessment technique in aerospace medicine and neck injury research.

## [261] PILOT CHALLENGES ADAPTING TO HELMET-MOUNTED DISPLAY SYSTEM (HMDS) IN NEXT GENERATION MILITARY AIRCRAFT

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**PROBLEM STATEMENT:** The new fourth generation helmet-mounted display system (HMDS) will visually challenge many aircrew and push them beyond their visual limit. Many engineering and aircrew selection issues need to be addressed prior to implementing the HMDS as a primary aircraft system. **TOPIC:** HMDSs have been used in varying degrees in manned aircraft since the 1970s when the South African Air Force first deployed primitive HMDSs in Angola in armed combat. The new fourth generation HMDS utilizing thermal, infrared, or visual image superimposed onto a see-through binocular visor displayed simultaneously with the real world will challenge the visual demands of many pilots. This presentation will discuss HMDS helmet fit, ocular alignment, green glow, potential induced illusion of virtual reality in different wavelengths, diplopia, jitter, and dynamic prismatic effects of canopy. Engineering and human performance visual requirements will be discussed. **APPLICATIONS:** Problems of the fourth generation HMDS are significant for international military flight surgeons in over 20 countries. Fourth generation HMDSs are currently being produced by BAE Systems in the Striker II HMDS, Thales in the Top Owl HMDS, and Rockwell Collins in the F-35 HMDS. These three HMDSs are being developed for multiple rotary wing and fixed wing applications worldwide.
**Learning Objectives:**
1. Describe two unique visual demands of the new fourth generation helmet-mounted display system.
2. Discuss the advantages of helmet-mounted display system over conventional legacy aircraft heads down or HUD systems.
3. Describe the engineering challenges of producing a helmet-mounted display system.

## [262] EFFECTIVENESS OF PROTECTIVE GLOVES AGAINST BURNS OF CABIN CREW

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**INTRODUCTION:** Hand and arm burns are the most frequent occupational injuries among KLM cabin crew members. On average there are 600 reports per year for 10,000 cabin crew. Preventive measures have been taken by equipment improvement and changing service procedures. Also new gloves were specified to better protect against hot liquids and to improve wearer comfort. Several sizes are available and cabin attendants can choose between a short and a long model. **METHODS:** Reports of burn incidents of the year before introduction were compared to the year after. The number of reports shows a strong decrease in the year after introduction of the new gloves. A sample of 200 cabin attendants filled out a questionnaire. **RESULTS:** More than 70 % of the respondents indeed use the new gloves and about half of them opted for the short model. Positive aspects mentioned were protection against hot liquids (65%), long model (27%) and good grip (5%). Negative aspects were smell of material (25%), bulky size (21%) and bad grip (8%). **DISCUSSION:** It was concluded that the majority of KLM cabin crew members indeed use the new gloves. They offer good protection which leads to less burn incidents. The gloves also have disadvantages and for future designs special attention should be devoted to material use (no smell), wearer comfort (finger sizes) and bulkiness (for stowage in handbag).
**Learning Objectives:**
1. How to evaluate measures to reduce occupational injury.
2. Antropometry and ergonomics of the human hand.

## [263] AIRCREW IMMERSION PROTECTION - ENSURING WE ARE UP TO DATE

N.D. Green[1], J. Boyd[2] and A. Weller[2]
*[1]RAF Centre of Aviation Medicine, Henlow, United Kingdom; [2]Air Division, QinetiQ, Farnborough, United Kingdom*

**MOTIVATION:** One important function of aircrew flight equipment is to provide thermal protection in a survival scenario. Following a recent fast jet mishap, published guidance on cold water immersion was reviewed to determine whether it remains consistent with the latest knowledge in thermal physiological protection. **OVERVIEW**: The thermal model used by UK MOD to predict survival times is based on that developed by Wissler and was later modified by the Royal Air Force Institute of Aviation Medicine in 1987. For this review, the output of this model was compared to the current Cold Exposure Survival Model and the 6-cylinder thermal model used by other nations to provide survival information. The usability of the existing UK guidance material was assessed, and the sea temperature below which immersion suits should be worn was reviewed. When validated against measurements made on human subjects, the existing model demonstrated root mean square differences in predicted core temperature that were similar to the other models, noting the many variables that alter survival in cold water. The model was therefore considered to be contemporary and no modification was required. Guidance material was reformatted into a simple zonal graphical style to show estimated time to rescue against sea temperature; it was refined by an aircrew panel for ease of use before publishing. Factors driving the sea temperature threshold at which immersion suits are worn were found to be complex and include likelihood of rescue, potential pre/in-cockpit thermal burden and protection against cold shock, but a robust evidence base is lacking. A sea temperature threshold of 15°C for Royal Air Force and 10°C for Royal Navy operations was retained. **SIGNIFICANCE**: The existing UK model supporting cold water immersion protection guidance remains valid. However, other factors including cockpit thermal burden and risks imposed by cold shock are not currently included in guidance and require further study.
**Learning Objectives:**
1. The participants will be able to understand the principles used to protect aircrew against cold water immersion.
2. The participants will be able to understand the principles used to predict aircrew survival time in cold water.
3. The participants will be able to understand how the level of protective clothing required for cold water survival can best be conveyed to aircrew.

## [264] IMPACTS OF MOVEMENT AND SATURATION ON LIFE PRESERVER EFFECTIVENESS

M.L. Hancock[1,2] and M. Trudgill[2]
*[1]USAF, APO, AE; [2]Aircrew Equipment Integration, RAF Centre of Aviation Medicine, RAF Henlow, United Kingdom*

**INTRODUCTION:** The Aircrew Equipment Integration Group at the RAF Centre of Aviation Medicine regularly tests aircrew flight equipment for fitness of purpose. Life preservers are commonly tested to ensure they meet the European Aviation Safety Agency standards for buoyancy and flotation angle before used for flotation after an aircraft accident. Recent tests of future life preserver design have shown freeboard over 20 minutes to have significantly decreased, potentially increasing risk to life of aircrew despite technically meeting the standard. Previous similar work has shown decreased pillow volume to be a consistent factor in LPUs that fail to meet the freeboard standard. This series of trials was completed to better understand how movement, such swimming to a life raft or dynamic water entry, and clothing saturation from extended duration in the water, affect a life preserver's buoyancy and flotation angle. **METHODS:** Nine subjects (3 small, 3 medium, 3 large) completed a 20 min soak, 25 m swim and a 2 meter platform entry into the water while wearing each of 7 life preservers currently or previously in use in RAF aircraft. Freeboard and flotation measurements were taken at designated points within each test serial. **RESULTS:** Changes in flotation angle significantly affected freeboard. Clothing saturation and movement can negatively affect the flotation angle and flight equipment shift, resulting in reduced freeboard. **DISCUSSION:** In some cases, the LPU fails to meet

the EASA standard from early in the test phase because of previously identified issues with pillow volume and stole lobe proximity to the torso. These tests show that clothing saturation and movement results in a later failure to meet the standard in a small segment of trials. Because the freeboard standard ensures minimal risk from splash drowning, both early fail and later fail scenarios present a significant risk to life in downed aircrew. These factors should be considered by research and acquisition professionals prior to purchase and fielding new life preservers.
**Learning Objectives:**
1. Identify factors that affect life preserver efficacy.

***Tuesday, April 26*** ***4:00 PM***
***Avalon 7-9***

## S-44: PANEL: NEUROPSYCHIATRY GRAND ROUNDS – CASE PRESENTATIONS, WORKING UP NEW-ONSET PSYCHOSIS IN A USAF PILOT

**Chair: Terry Correll**
*Wright-Patterson AFB, OH*

**Chair: Mark Hubner**
*Wright-Patterson AFB, OH*

**PANEL OVERVIEW: PROBLEM STATEMENT:** This case will describe new-onset psychosis in a U.S. Air Force (USAF) pilot and how it was handled at the Aeromedical Consultation Service at the USAF School of Aerospace Medicine. **BACKGROUND / LITERATURE REVIEW:** New-onset psychosis (as well as other psychiatric conditions) is common in younger individuals and is potentially detrimental to safe flight/mission completion on multiple levels. All such conditions can be disqualifying to the aviator and require optimal evaluation and treatment to ensure the potential for waiver and return to fully operational flight status. **CASE PRESENTATION:** The young USAF pilot experienced extreme paranoia and frank psychosis during a mission several continents away requiring a 7-d inpatient hospitalization for evaluation and stabilization. Their mission was clearly delayed and disrupted, necessitating another member of the crew remaining in the foreign country/hospital providing one-to-one support for the affected pilot. **OPERATIONAL / CLINICAL RELEVANCE:** This presentation will focus on working through the comprehensive aeromedical evaluation of this pilot seen at the Aeromedical Consultation Service. Audience members will be encouraged to participate in the diagnosis, risk assessment, disposition, and discussion during this case presentation.

### [265] NEUROLOGIC ASPECTS OF COMPLEX AEROMEDICAL CONSULTATION SERVICE NEUROPSYCHIATRY CASE

R.R. Hesselbrock
*Aerospace Medicine Consultation Division, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH*

**PROBLEM STATEMENT:** Psychosis can be either a primary symptom complex or secondary to other causes. **BACKGROUND/ LITERATURE REVIEW:** Organic provocative factors should be assessed in all patients presenting with acute psychosis. Neurologic conditions make up many of these possible organic precipitants. **CASE PRESENTATION:** A newly-trained C-17 pilot developed subacute delusional psychosis while on his first overseas mission. He had taken doxycycline during the mission, but had not previously been ground-tested. He consumed ethanol during his recreation time, but the reported amount was not excessive compared to previous reported use. He required physical restraint due to combative behavior. He was hospitalized and given antipsychotic medication. Imaging studies were initially suspicious for possible temporal lobe abnormalities, but spinal fluid examination and further imaging were unremarkable. No seizure activity or diffuse slowing was noted on electroencephalogram. The patient's condition gradually returned to baseline over several days. He was ultimately assessed as having an unprovoked brief psychotic episode and was recommended for disqualification from flight duties. He has remained clinically stable with no further reported behavioral episodes. **OPERATIONAL / CLINICAL RELEVANCE:** Psychosis is uncommonly seen in aviators. It has obvious adverse impact on individual health, flight safety, and mission effectiveness. If modifiable or preventable precipitating factors can be identified, return to fly recommendation may be possible. The evaluation of acute psychosis with attention to the major possible neurologic condition precipitants will be presented and will be applied specifically to this complex case that was evaluated at the Aeromedical Consultation Service. The diagnostic evaluation of this patient will be presented and discussed. Factors favoring a return to fly recommendation will be presented. Time will be allotted for audience questions and discussion.
**Learning Objectives:**
1. List the major neurologic disease considerations in evaluation of patients with psychosis.
2. State the expected electroencephalogram findings in delirium and psychosis.
3. List factors that favor a return to fly recommendation for aviators with organically provoked psychosis.

### [266] WORKING UP NEW-ONSET PSYCHOSIS: THE COMPLEX DIFFERENTIAL

R. Peirson[1,2]
*[1]Aeromedical Consultation Service - Neuropsychiatry, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; [2]Psychiatry, Wright State University, Boonshoft School of Medicine, Dayton, OH*

**PROBLEM STATEMENT:** Despite a tendency to limit considerations to one or two primary psychiatric diagnoses, the differential considerations for new-onset psychosis can be quite broad. It is important for clinicians to maintain a working knowledge of not only the most common causes but also the commonly overlooked causes of new-onset psychosis. **TOPIC:** The presentation will focus on working through the differential diagnosis and evaluation as it relates to a complex case seen at the Aeromedical Consultation Service. Special attention to changes in the Diagnostic and Statistical Manual will augment a clinical discussion informed by the particular elements of the history. Audience attendees will be oriented to a psychiatric diagnostic framework that may be useful in their practice if facing similar situations. **APPLICATIONS:** Flight surgeons and aeromedical examiners alike encounter individuals with new-onset psychosis. Potentially rendering the aircrew member unable to participate in aviation, it is important to ensure a good diagnosis. Further, a good diagnosis may serve to rule out a life-threatening condition or one that may be mitigated sufficiently so that the aircrew member may return to aviation duties. The topic is generalizable to military, commercial, and general aviation environments.
**Learning Objectives:**
1. Understand a basic algorithm for psychosis evaluation.
2. Identify major psychiatric disorders that can potentially cause psychosis.
3. Understand the need to rule out multiple medical causes of psychosis.

### [267] MAKING THE DIFFICULT CALL: BALANCING PATIENT ADVOCACY WITH ORGANIZATIONAL DEMANDS

T. McBride
*U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH*

**PROBLEM STATEMENT:** It can often be very difficult for aeromedical professionals to navigate the multitude of competing demands when making challenging case determinations. Recognizing these competing demands, carefully evaluating various options, and proceeding with a thoughtful course of action are essential to making safe, legal, ethical, and effective clinical decisions. **TOPIC:** This presentation will utilize the complex neuropsychiatric case presented by the panel to illustrate a model of effective decision-making. This framework incorporates the challenges of patient care, the demands of organizational requirements and dynamics, and the aeromedical professional's emotions and intuition in the decision-making process. **APPLICATIONS:** Aeromedical professionals will be oriented to a decision-making framework that can improve their practice skills and comfort level when faced with managing challenging patient situations.

**Learning Objectives:**
1. Aeromedical professionals will be oriented to a decision-making framework that can improve their practice skills and comfort level when faced with managing challenging patient situations.

***Tuesday, April 26*** ***4:00 PM***
***Avalon 10-12***

## S-45: PANEL: RESIDENT RESEARCH PANEL--PART 3

**Chair: Richard Allnutt**
*Beavercreek, OH*

**Chair: Patrick Storms**
*Dayton, OH*

**PANEL OVERVIEW:** This panel will consist of aerospace medicine residents presenting the findings from their scholarly activity. During their residency practicum years, residents develop and execute a research project on a topic of aeromedical importance and prepare a presentation to report the results of their research. Residents will present the findings from their research projects. Engaging in scholarly activity advances resident learning and produces information that contributes positively to the body of knowledge relevant to aerospace and operational medicine.

### [268] MUSCULOSKELETAL ISSUES IN PILOTS FLYING HIGH-G AIRCRAFT IN TRAINING PROGRAMS: A SURVEY OF STUDENT PILOTS AND INSTRUCTOR PILOTS

K.R. VanValkenburg[1] and A.J. Thompson[2]
*[1]Residency in Aerospace Medicine (RAM), USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; [2]47 OG, Laughlin AFB, Del Rio, TX*

**INTRODUCTION:** Musculoskeletal (MS) symptoms of neck and upper back pain are noted in pilots flying high-G aircraft impacting mission readiness and concerns for chronic MS problems. Focused MS strength training and alternative medical treatments of chiropractic, osteopathic manipulation and massage therapies should benefit our pilots. Instructor pilots benefitted from osteopathic manipulation at Laughlin AFB. Student pilots were not seen due either to underreporting or insignificant prevalence. We hypothesized similar prevalence of MS issues in our student pilots. **METHODS:** Aeromedical literature review on MS issues in pilots was conducted. We distributed 356 surveys to and collected 270 surveys from student and instructor pilots in the T-6, T-38 and T-1 squadrons at Laughlin AFB. **RESULTS:** MS issues interfere with flying and non-flying activities. Pilots support chiropractic, osteopathic and massage therapies. Mission requirements interfere with strength training. Low back pain is also reported as a concern. Pilots are reluctant to report MS issues due to potential grounding and push through pain to complete training and avoid stigmas of expressing discomfort. More pilots would report MS issues if they could receive timely and effective therapies without being grounded. **DISCUSSION:** Results indicate significant concern for MS issues interfering with flying abilities and need for on-base chiropractic and osteopathic services at training bases for timely treatment without grounding. Pilots also want focused instruction on MS strength training by certified trainers and physical therapists and time in their training schedules for this training. Finally, they were concerned that MS issues not addressed early, due to stigmas of reporting and lack of availability of effective therapies, are resulting in chronic long-term disabilities that will affect their quality of life both during and after their military flying careers. We should provide appropriate training as well as sufficient and timely access to alternative therapies early in pilot training to potentially avoid future problems.
**Learning Objectives:**
1. Be aware of the musculoskeletal effects of flying high-G aircraft on our military pilots and potential interventions.

### [269] SEROTONIN AS A BIOMARKER TO PREDICT INDIVIDUAL STRESS RESILIENCE IN BATTLEFIELD AIRMEN TRAINEES

S. Wolf and R. Shia
*USAF School of Aerospace Medicine, Wright-Patterson AFB, OH*

**INTRODUCTION:** Repeated exposure to stress can cause detrimental effects on cognitive processes, which could impair skill acquisition and performance during intensive military training. Recent evidence suggests that increased serotonin levels are associated with fatigue, sleep disturbance, and depressive symptoms. This study investigates the expression of serotonin during the an early phase of Battlefield Airmen training. It is hypothesized that participants with higher serotonin levels will demonstrate decreased performance in mood, memory, and reaction time. **METHODS:** Thirty active duty male subjects 18 to 35 yr old, were recruited from one training course. Nine blood samples per participant were collected beginning the day before experimental testing. Subjective evaluations of mood were made using the Profile of Mood States. The Continuous Memory Test to assess working memory, Math Processing, and Rapid Decision Making were administered following each day of testing. Descriptive statistics, Pearson correlation coefficients, and t-test were performed. **RESULTS:** Only 22 of the recruited 30 participants met inclusion criteria. All participants were male. Mean age was 25. Mean serotonin levels were 308 ng/mL overall, 305 ng/mL (graduates), 352 ng/mL (non-graduates). Graduates started with a lower mean serotonin level than non-graduates. There was an inverse but weak correlation between serotonin and fatigue (r=-0.17), total distress (r=-0.04), and friendliness (r=-0.07); there was an inverse but moderate correlation with vigor (r=-0.41). There was a weak correlation between serotonin and anger/hostility (r=0.15), confusion (r=0.16), and depression/dejection (r=0.05). There was a mild correlation between serotonin and anxiety (r=0,26). **DISCUSSION:** The results of this study demonstrate that participants with lower serotonin levels were more likely to graduate, suggesting that serotonin may be a good biomarker for resilience. There was a low correlation between serotonin and depression, but this may be a power issue related to the study.
**Learning Objectives:**
1. The participant will be able to understand the relationship between serotonin levels and stress resilience.

### [270] COLOR VISION CHANGES AND EFFECTS OF HIGH CONTRAST VISOR USE AT SIMULATED CABIN ALTITUDES

T.W. Woodard[2], S.T. Wright[1], J.T. Haynes[1] and S.D. Humphrey[1]
*[1]Aeromedical Consultation Service, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH; [2]Aerospace Medicine Residency, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH*

**INTRODUCTION:** Color vision is sensitive to hypoxia and may degrade with altitude exposure. These effects may be clinically and operationally significant, especially for aircrew utilizing color multi-function displays. High-contrast visor (HCV) use may exaggerate these changes, as its use is known to distort color perception. There is limited research on the effects of altitude on color vision utilizing modern automated color vision testing techniques. The purpose of this aerospace medicine resident research was to evaluate the effects of normobaric altitude simulation on color vision and whether using the HCV would result in degradation of color vision under these conditions. **METHODS:** Following Institutional Review Board approval, a reduced oxygen breathing device was used to expose subjects with normal color vision to simulated cabin altitudes of surface level, 8,000 ft, and 12,000 ft. Color contrast sensitivity for each cone (S, M, or L) was measured with, and without, the HCV at each altitude. Paired t-tests with Bonferroni correction were then used to compare the mean changes in color sensitivity at each simulated altitude and visor condition. **RESULTS:** Utilizing nine subjects, the results demonstrated a decrease in color sensitivity between surface level and simulated altitudes without the HCV. This association was limited to only the S cone though. There was no decrease in color contrast sensitivity appreciated at the simulated altitudes when using the HCV. **DISCUSSION:** This is the first study to exam the feasibility of combining normobaric hypoxia exposure with enhanced color vision screening techniques and HCV use in aviators. Our results are consistent with prior studies that describe decreased cone sensitivity under hypoxic conditions. This study therefore suggests that normobaric hypoxia and computerized color vision testing may be useful for future color vision and altitude studies. Compared with hypobaric exposure, this may enhance subject safety while continuing to advance human performance in aviation and space operations.

**Learning Objectives:**
1. Be aware of the physiologic relationship between increasing altitude and color vision degradation.
2. Be aware of current automated color vision testing techniques.
3. Understand the benefits of utilizing normobaric hypoxia systems when conducting human performance and aerospace medicine research.

### [271] VISUAL EFFECTS OF IN-FLIGHT HIGH CONTRAST VISOR (HCV) USAGE WITH MULTI-FUNCTION COLOR DISPLAYS (MFCD)

J.S. Woolford
*Aerospace Medicine, U.S. Air Force, Sykesville, MD*

**INTRODUCTION:** Changes in protective flight equipment and modern aircraft cockpit configurations have led to increased aircrew visual demands, highlighting the need to determine the impact yellow-tinted "blue-blocker" lenses have on aircrew operations. The aim of this pilot study is to assess aircrew blue-blocker lens usage habits, and investigate color-distortion effects on aircrew ability to discern color-coded symbology presented on modern cockpit color displays. The working hypothesis is that currently qualified aircrew are aware of this risk to flight safety, and have self-limited the use of blue-blocker lenses. **METHODS:** Aircrews were asked to voluntarily complete an 11-question survey about their in-flight visual perceptions while wearing a High Contrast Visor (HCV) in an aircraft equipped with Multi-Function Color Displays (MFCD). Informed consent and survey administration was delivered using SurveyMonkey®. **RESULTS:** The ideal number of participants necessary to ensure a statistically significant result is n=139. Assumptions include a 95% confidence interval with a concordant alpha of 5%, an exaggerated adverse color perception prevalence rate of 10%, and a precision of 5%. Analysis of the survey results (n=76) reveal that 4.84% (3 of 62) of aircrew answered "yes" when asked if there had ever been a time that they were unable to see certain color symbols on the MFCD when performing flying duties while using a HCV. Furthermore, 5.00% (3 of 60) indicated that they had voluntarily stopped using the HCV due to associated color contrast difficulties. **DISCUSSION:** The results of this study demonstrate a legitimately hazardous and previously unrecognized risk to flight safety due to individual incompatibility for some aircrew when using a HCV in aircraft equipped with a MFCD. However, recognizing that only 76 responses were recorded, the study is underpowered. The author recommends a more robust investigation into this color-vision discrepancy as necessary to ensure flight safety, and encourage aviation medical authorities to review their current blue-blocker lens usage policies in an effort to mitigate such risk to safe and effective flying operations.

**Learning Objectives:**
1. The participant will appreciate the risk current blue-blocker lens usage policies present to aircraft operations.

***Tuesday, April 26*** ***4:00 PM***
***Avalon 13-14***

## S-46: SLIDE: AEROMEDICAL EFFECTS OF MICROGRAVITY

**Chair: Alan Hargens**
*San Diego, CA*

**Chair: Derek Nusbaum**
*Houston, TX*

### [272] EFFECTS OF HEAD DOWN TILT WITH AND WITHOUT 0.5% CARBON DIOXIDE ON INTRACRANIAL AND INTRAOCULAR PRESSURE

K. Marshall-Bowman[1,3], J. Rittweger[1,3], J.I. Suarez[2], C. Venkatasubba Rao[2], D. Donoviel[2], E. Mulder[1] and E.M. Bershad[2]
*[1]Institute of Aerospace Medicine, German Aerospace Center (DLR), Cologne, Germany; [2]Baylor College of Medicine, Houston, TX; [3]Faculty of Medicine, University of Cologne, Cologne, Germany*

**INTRODUCTION:** The Visual Impairment and Intracranial Pressure (VIIP) syndrome currently affects more than half of astronauts on the International Space Station (ISS), inducing structural and functional ophthalmic changes. Although the exact causative mechanisms of the VIIP syndrome are unknown, it is hypothesized that increased intracranial pressure (ICP) is a contributing factor. Several factors including microgravity-induced headward fluid shifting and elevated atmospheric carbon dioxide ($CO_2$) levels may lead to elevated intracranial volume, which in turn would increase ICP once compensatory volume accommodation is exhausted. We hypothesized that the addition of 0.5% $CO_2$ to 12 degree head down tilt (HDT) would increase ICP, and to a lesser extent, intraocular pressure (IOP). **METHODS:** A double-blinded, cross-over design study (the SpaceCOT Study) was performed in which six healthy subjects underwent two spaceflight analog conditions in random order: 12 degree HDT for 28h with ambient air (0.04% $CO_2$), and 0.5% $CO_2$ atmosphere. Non-invasive measurements of ICP and IOP were performed at baseline (seated position) and at multiple time points during HDT. **RESULTS:** Statistical analyses revealed no change in ICP with HDT. Furthermore, the two atmospheric conditions did not influence ICP. IOP, however, was found to increase during HDT and remain elevated during the 28h of HDT, regardless of atmosphere. **DISCUSSION:** The results indicate that short-term exposure to 12 degree HDT does not result in an increase in ICP, presumably due to volume compensatory mechanisms. In contrast, IOP increased with HDT in both atmospheric conditions. Short duration exposure to 0.5% $CO_2$ does not appear to have large effects on intracranial and intraocular pressure in combination with 12 degree HDT, however further research is necessary to determine consequences of long-duration exposure.

**Learning Objectives:**
1. A 0.5% carbon dioxide atmosphere was not found to have significant additive effects on intracranial or intraocular pressure during 12 degree head down tilt.

### [273] CEREBRAL PULSATILITY IN PREFRONTAL CORTEX CORRELATES WITH ACUTE EXPOSURE TO MICROGRAVITY

V. Ivkovic[1,2], G. Spielmann[3], D. DiPasquale[1,2], G. Hu[1,2], Q. Zhang[1,2] and G.E. Strangman[1,2]
*[1]Psychiatry, Massachusetts General Hospital, Charlestown, MA; [2]Psychiatry, Harvard Medical School, Charlestown, MA; [3]Department of Health and Human Performance, University of Houston, Houston, TX*

**INTRODUCTION:** Cerebral autoregulation (CAR) enables maintenance of cerebral blood flow (CBF) despite fluctuations in intracranial pressure (ICP) and arterial blood pressure (ABP). Pulsatility analysis of CBF has previously been used to assess CAR function, and may offer insight into onset/progression of the visual impairment and intracranial hypertension (VIIP) - a condition affecting over 60% of long duration mission crewmembers that is thought to involve elevated ICP. Assessment of cerebral pulsatility (CP) however, has been confined to invasive and/or operator-based procedures that are less practical during spaceflight. We sought to investigate CP in the prefrontal cortex (PFC) during acute exposures to microgravity in parabolic flights, using a custom-developed near infrared spectroscopy (NIRS) instrument. **METHODS:** Data was collected from N=12 seated subjects (4 females), aged 34.3±8.8 years during 4 parabolic flights. Cerebral hemoglobin concentrations were monitored by a NINscan4a optical sensor positioned over PFC location F4 (International 10-20 system). The sensor consisted of a dual-wavelength laser light source (780/830nm) and two optical detectors located co-linearly at 1.5 and 4 cm from the source. A tri-axial accelerometer measured head acceleration vectors. The Gosling Pulsatility Index (GPI) was calculated for cerebral NIRS signals. The relationship between GPI and acute microgravity exposure was assessed via correlating GPI and accelerometer data during parabolas. **RESULTS:** Cerebral perfusion changes were consistently observed during gravitational modulations across flights/subjects. CP was positively correlated with gravity changes in six (50%; r=0.51±0.15; p<0.0001), negatively correlated in two (17%; r=-0.35±0.13; p<0.0001), and exhibited positive correlation trends in four (33%; r=0.1±0.06; p>0.05) data sets. **DISCUSSION:** Results suggest that CP in PFC is reduced in response to acute microgravity exposure. Since decreased CP has previously been associated with decreased ICP, hypercapnia, vasodilation, and increased ABP, these results corroborate findings of improved CAR (and decreased ICP) in short duration spaceflight. The variability in the strength and sign

of the relationship across subjects, highlights individual variability. To our knowledge this is the first finding of CP changes associated with acute microgravity exposure in the PFC, and represents an important application of NIRS for assessment of CAR and/or ICP during spaceflight.
**Learning Objectives:**
1. The participant will be able to understand current concepts about cerebral hemodynamic changes in short- and long-duration spaceflight, and the role of NIRS technology for inflight hemodynamic monitoring.

### [274] JUGULAR VEIN VOLUME, MIDDLE CEREBRAL VEIN HEMODYNAMIC AND PORTAL VEIN VOLUME DURING DRY IMMERSION

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*UMPS CERCOM Faculte de Medecine, Tours, France*

**PURPOSE:** The objective was to measure the effect of dry immersion on the cephalic blood pooling, the intracerebral vein velocity, and the splanchnic blood pooling, considering that the dry immersion may induce a fluid shift comparable to the one produced by microgravity. **METHOD:** Jugular vein (JV) volume was measured by 3D ultrasound starting at the collar bone, the Middle cerebral vein (MCV) velocity was measured by transcranial Doppler (Temporal window)? The portal vein (PV) volume was measures by echography. **RESULTS:** After 2h of Dry immersion the following parameters increased significantly from pre DI in the same relax seated position: Jugular vein volume (440%+/-187 p<0.05), Portal vein cross section and volume (20%+/-10 p<0.05), MCV velocity (55%+/-66 p<0.05). The venous parameters had returned to pre DI baseline after 3d in DI while the plasma volume had drop by 17%+/-8. **CONCLUSION:** DI induced a significant fluid shift towards the upper part of the body which is responsible for the huge blood pooling at the cephalic level. Such high amount of fluid stagnation may be responsible for the increase in intracranial vein velocity which suggests an increased intracranial pressure. During DI the Jugular blood pooling was associated with a Splanchnic blood pooling as indicated by the increase in Portal vein volume like already observed inflight. Nevertheless the changes in vein volume and intracranial vein velocity were very different from one subject to another.
**Learning Objectives:**
1. Effect of the fluidshift at the cephalic level.
2. Relationship between neck blood pooling and brain pressure.

### [275] UNDERSTANDING VISUAL IMPAIRMENT AND INTRACRANIAL PRESSURE SYNDROME: TECHNIQUE FOR PERFORMING LUMBAR PUNCTURE IN MICROGRAVITY

D.J. Lerner[1], S. Don[1] and A. Parmet[2]
*[1]Mallinckrodt Institute of Radiology, St. Louis, MO; [2]Environmental and Occupational Medicine, St. Lukes Hospital, Kansas City, MO*

**INTRODUCTION:** Some male astronauts have suffered visual impairment during and after long-duration space flight. This has only been evaluated using indirect methods in microgravity. Further elucidation of Visual Impairment and Intracranial Pressure Syndrome (VIIP) is an important aspect in order to reduce the incidence of VIIP during long space flights. Knowledge gained by direct measurement of intracranial pressure and fluid analysis via in flight lumbar puncture could prove beneficial in understanding the cause(s) and developing treatment regiments. Lumbar puncture however carries risks especially when performed by inexperienced personnel. Image guidance facilitates an easier lumbar puncture by visually guiding the needle through the interspinous space. Portable direct digital radiography is a possible imaging tool in microgravity. The purpose of this study is to report a proof-of-concept, safe, and effective way to perform a lumbar puncture using portable, direct-digital radiography. **METHODS:** An anthropomorphic radiologic phantom of an adult lumbar spine using anatomically correct radio-opaque vertebral bodies was made. A fluid-filled space in the spinal canal with a latex membrane simulated the dural sac and cerebrospinal fluid. The phantom was placed in the prone position for radiographically guided lumbar puncture with a portable direct-digital radiography system with wireless transmitting image receptor and screen. The images were acquired on a high-resolution Cesium Iodine detector. Multiple images were taken to visualize a 22-gauge spinal needle tip using a "down the barrel" approach as the needle was advanced into the deep tissues and through the interspinous space and into the spinal canal. **RESULTS:** Technical success was demonstrated by return of fluid through the needle after removal of the inner stylet. **DISCUSSION:** Diagnosing and developing treatment for VIIP is important for future long-duration space flight. Currently only indirect measures of intracranial pressure have been performed while in space with pre- and post-flight direct measurements. Further information can be gained with in flight lumbar puncture. This can be easily achieved using portable digital radiography imaging. Although further research is needed, digital radiography could be very helpful on future flights to perform direct measurements of intracranial pressure.
**Learning Objectives:**
1. Using portable radiography is a feasible way to perform an image guided lumbar puncture in microgravity.

### [276] IDIOPATHIC INTRACRANIAL HYPERTENSION: A GROUND BASED ANALOG FOR VISUAL IMPAIRMENT INTRACRANIAL PRESSURE SYNDROME?

G. Knox
*Surgery, University of Florida, Jacksonville, FL*

**INTRODUCTION:** Visual Impairment Intracranial Pressure Syndrome (VIIP) is characterized by visual decrement after spaceflight. A defined subset of crew members develop refraction changes, papilledema, optic nerve sheath distention and elevated intracranial cerebrospinal fluid pressure (ICP) with varying degrees of severity and chronicity. Idiopathic Intracranial Hypertension (IIH) is also characterized by increased intracranial pressure as well as ophthalmic changes such as papilledema. Thus, IIH may serve as a useful analog for the study, treatment and/or prevention of VIIP. **METHODS:** A retrospective analysis of patients with IIH seen by the author from 2013 through 2015 was undertaken to determine common characteristics of IIH. A literature review of VIIP syndrome was utilized to determine index characteristics of this syndrome. **RESULTS:** Eighteen patients were identified in the retrospective chart review of patients with IIH. All had pulsatile tinnitus. A literature review of VIIP syndrome revealed 15 cases. One series of seven astronauts with VIIP syndrome was of interest because presence or absence of tinnitus was noted. Six of the seven astronauts did not have pulsatile tinnitus. The seventh astronaut was not noted to have either the presence or absence of pulsatile tinnitus. Three of the astronauts in this series had postflight magnetic resonance venograms (MRVs) all of which were negative. One astronaut in this series was treated with acetazolamide postflight with a resultant decrease in intracranial pressure. **DISCUSSION:** VIIP and IIH are similar in that both syndromes involve elevated intracranial pressure and visual disturbances. However, all of the IIH patients had pulsatile tinnitus. None of the VIIP patients complained of pulsatile tinnitus. MRVs of three VIIP patients were negative. In IIH, transverse sinus stenosis is a common finding on MRV and may be the source of the pulsatile tinnitus. Acetazolamide is the treatment of choice for IIH. It may be useful for VIIP. Indeed, it has been utilized in at least one case with reduction of ICP. Further research on the use of acetazolamide for treatment and/or prophylaxis of VIIP is warranted.
**Learning Objectives:**
1. After this presentation, participants will be able to define idiopathic intracranial hypertension.
2. After this presentation, participants will be able to define visual impairment intracranial pressure syndrome.
3. After this presentation, participants will be able to compare and contrast VIIP and IIH in terms of pathophysiology, symptoms, diagnostic studies, and treatment.

### [277] $CO_2$ ON THE INTERNATIONAL SPACE STATION: AN OPERATIONS UPDATE

J. Law and D. Alexander
*NASA Johnson Space Center, Houston, TX*

**PROBLEM STATEMENT:** We describe $CO_2$ symptoms that have been reported recently by crewmembers on the International Space Station and discuss our continuing efforts to control $CO_2$ to lower levels than historically accepted. **BACKGROUND:** Throughout the International Space

Station (ISS) program, anecdotal reports have suggested that crewmembers develop $CO_2$-related symptoms at lower $CO_2$ levels than would be expected terrestrially. Since 2010, operational limits have controlled the 24-hour average $CO_2$ to 4.0 mmHg, or below as driven by crew symptomatology. In recent years, largely due to increasing awareness by crew and ground team, there have been increased reports of crew symptoms. The aim of this presentation is to discuss recent observations and operational impacts to lower $CO_2$ levels on the ISS. **CASE PRESENTATION:** Crewmembers are routinely asked about $CO_2$ symptoms in their weekly private medical conferences with their crew surgeons. In recent ISS expeditions, crewmembers have noted symptoms attributable to $CO_2$ starting at 2.3 mmHg. Between 2.3-2.7 mmHg, fatigue and full-headedness have been reported. Between 2.7-3.0 mmHg, there have been self-reports of procedure missed steps or procedures going long. Above 3.0-3.4 mmHg, headaches have been reported. A wide range of inter- and intra-individual variability in sensitivity to $CO_2$ have been noted. **OPERATIONAL / CLINICAL RELEVANCE:** These preliminary data provide semi-quantitative ranges that have been used to inform a new operational limit of 3.0 mmHg as a compromise between systems capabilities and the recognition that there are human health and performance impacts at recent ISS $CO_2$ levels. Current evidence would suggest that an operational limit between 0.5 and 2.0 mmHg may maintain health and performance. Future work is needed to establish long-term ISS and future vehicle operational limits.

**Learning Objectives:**

1. The participant will gain an understanding of typical CO2 levels on the International Space Station and the type of symptoms that have been reported by crewmembers.
2. The participant will get an overview of the current strategy for managing CO2 on the ISS.

***Tuesday, April 26*** ***4:00 PM***
***Avalon 15-16***

## S-47: PANEL: TOTAL EXPOSURE HEALTH INITIATIVE

**Chair: Kathy Fullerton**
*Wright-Patterson AFB, OH*

**Chair: Richard Hersack**
*Xenia, OOH*

**PANEL OVERVIEW:** The Total Exposure Health (TEH) Initiative incorporates workplace, environment, and lifestyle exposures; provides a path to "Precision Medicine"; advances epidemiology, bioinformatics, and "Big Data"; and fosters research and technology in accordance with the 2015 National Security Strategy, the 2015 National Health Security Strategy, and the President's Precision Medicine Initiative. This approach for disease prevention and treatment takes into account an individual's unique genes, environment, and lifestyles to provide personalized healthcare and ultimately improve human performance for mission success. This panel provides an overview of the TEH Initiative and presents four key research projects undertaken by the 711th Human Performance Wing in support of TEH. The overview will define the TEH initiative, a novel concept that associates exposures to the lowest common denominator—an individual's DNA and cellular function. Socio-cultural status, lifestyle choices, occupational and environmental factors will be linked to workplace, environment, and lifestyle exposures. In addition, three key aspects of TEH will be highlighted: 1) TEH advances epidemiology, bioinformatics, and "Big Data" by aggregating and analyzing large amounts specific group and individual exposure data using advanced informatics to provide individual and population health risk analysis; 2) TEH incorporates environment, workplace, and lifestyle exposures by accounting for all exposures and their ties to genetics/genomics and a person's predispositions to disease; and 3) TEH fosters research and technology by supporting sensor development and applied toxicology models for rapid identification of unknown threats and low-level exposure biomarkers in human genomics. Following the overview, four 711th HPW research studies covering each of the topics will be presented: use of epidemiological data to assess noise induced hearing loss risk; individual miRNA expression based on exposure to jet fuels; passive sensor development to measure longitudinal exposures; and characterization of aircraft cabin air to measure exposures to volatiles, semi-volatiles, and aerosols. The panel will conclude with a Q&A session with a diverse group of exposure scientists.

### [278] *IN VIVO* INHALATION EXPOSURES TO JET A AND JP-8 ALTER BRAIN MIRNA EXPRESSION PROFILES

C.A. Mauzy[1], J. Frey[2], K. Henderson[2], K. Mumy[3], C. Gut[3], J. Reboulet[3] and M. Grimm[3]
*[1]711 HPW/RHDJ, Air Force Research Laboratory, Wright-Patterson AFB, OH; [2]AFRL 711 HPW/RHDJ, Henry Jackson Foundation, Wright-Patterson AFB, OH; [3]NAMRU-D, Navy, Wright-Patterson AFB, OH*

**INTRODUCTION:** Jet fuel exposure is a known occupational exposure hazard among military personnel, with exposures initiating neurological symptoms. We hypothesize that microRNA expression changes occur in specific brain regions from repeated exposure to jet fuels, altering gene expression to signaling pathways. **METHODS:** Animal protocol F-WA-2014-0152 was reviewed and approved by the AFRL IACUC prior to initiation of research. To obtain miRNA levels in the brain, Fisher 344 rats were exposed to 4 doses (0, 500, 1000, 2000 mg/m3) of jet fuel administered as an aerosol/vapor combination of either Jet Fuel 8 (JP-8) or Jet A in whole body inhalation chambers. Molecular changes were anchored to phenotype alterations using post-exposure neurobehavioral testing (Morris water maze and acoustic startle reflex). Total RNA was isolated post-exposure from the prefrontal cortex, hippocampus, and cerebellum regions dissected from harvested brain tissue. The isolated RNA samples were analyzed using Affymetrix GeneChip 3.0 miRNA arrays, with the resultant data examined using GeneChip-compatible Expression Console Software v1.2 software (Affymetrix). **RESULTS:** Differential miRNA expression in the brain was seen between control/JP-8 in prefrontal cortex (miR-429, miR-200a, miR-200b), hippocampus (miR-301a, miR-29c, miR-21), and cerebellum (miR-301a, miR-153, miR-29c). Interestingly, while some overlap in expression alterations was seen, the miRNA signature to Jet A exposure contained unique specific miRNA species: prefrontal cortex (miR-582, miR-291a-3p, miR-466d), hippocampus (miR-352, miR-9, miR-301a, miR-199a-5p, miR-30e), and cerebellum (miR-582, miR-291a-3p, miR-466d). To further explore the biological significance of these molecular changes, pathway analysis was conducted using the Ingenuity IPA software (Qiagen). **DISCUSSION:** The result of this study will likely provide novel insight into the molecular mechanism of jet fuel neurotoxicity, as well as the knowledge needed for warfighter protection from the adverse effects of jet fuel exposure.

**Learning Objectives:**

1. The participant will be able to describe miRNAs and how can they be used as biomarkers.
2. The participant will understand how miRNA signatures in blood are anchored to alterations in the brain.
3. The participant will understand what miRNA and pathway alterations are seen in jet fuel inhalation exposures.

### [279] CHARACTERIZATION OF AEROSOLS AND VOLATILES IN CARGO AIRCRAFT CABINS

C. Grabinski[1], J. Jackson[2], L. Thrasher[1], A. Moore[1], L.E. Flory[1], A. Irvin[1], S. Harshman[1], B. Geier[1], J. Martin[1], C.C. Grigsby[1] and D.K. Ott[2]
*[1]Human Signatures Branch, U.S. Air Force Research Laboratory, Wright-Patterson AFB, OH; [2]Aeromedical Research Department, U.S. Air Force School of Aerospace Medicine, Wright-Patterson AFB, OH*

**INTRODUCTION:** In the event of faulty seals and spills, components from engine fuels, lubricants, hydraulic fluids, and aircraft deicer have been found to enter the Environmental Control System (ECS), which provides air supply for aircraft cabins. Air contamination can affect both the health and performance of crew members and passengers. In order to understand this risk in currently operational aircraft, we characterized aerosols and volatiles in the cabin of cargo airframes using a suite of instruments that were mounted onto a litter. **METHODS:** Real-time measurements of aerosols and volatiles were completed using direct reading instruments. Particles were collected onto polycarbonate filters for offline analysis by electron microscopy, and semi-volatile aerosols and volatiles were collected onto glass fiber filters and thermal desorption tubes, respectively, for offline analysis by gas chromatography mass

spectrometry. **RESULTS:** Real-time measurements indicated the emission of aerosols at high concentrations with peaks ranging from 350,000 to 450,000 particles per cubic centimeter during idle before take-off and after landing. Aerosol concentrations were reduced by two orders of magnitude to about 500 particles per cubic centimeter during flight. The concentration of volatiles spiked at various times during flight. **DISCUSSION:** The results indicate that during flight, there was no emission of aerosols, but there was emission of volatiles in the aircraft cabin. The source for volatiles could be either from an operation within the cabin or from a leak upstream of the ECS vents. Background air quality testing in aircraft cabins supports our ability to understand total exposure health.

**Learning Objectives:**

1. Background air quality testing in aircraft cabins supports our ability to understand total exposure health.
2. Particles are efficiently filtered in the aircraft cabin during flight, but reach potentially unsafe concentrations when the engines are running and doors are open on the ground.
3. Volatile concentrations spike during flight, which could be due an operation within the cabin or a leak upstream of the environmental control system vents.

### [280] ADVANCES IN INDIVIDUAL LONGITUDINAL EXPOSURE RECORDS – THE ULTIMATE PASSIVE DOSIMETER

H. Rubenstein[1], G. Wilson[2], K. Fullerton[1] and K. Anderson[2]
*[1]School of Aerospace Medicine, U.S. Air Force, Wright-Patterson AFB, OH; [2]EMT, Oregon State University, Corvallis, OR*

**INTRODUCTION:** Military members are exposed to unique operational environments that include toxic industrial chemicals and materials. Capturing these exposures using current methods is often problematic due to logistics of obtaining supplies, power requirements, ruggedness of equipment, and shipping back to analytical labs located far outside of theater. The goal of this research is to provide a low cost dosimeter that is rugged, sensitive, specific, small, and lightweight and that can integrate doses over time. This dosimeter would provide Individual Longitudinal Exposure Records for service members. **METHODS:** A specially prepared silicon wristband (SWB) was evaluated for 45 volatile organic compounds (VOCs) including those found in aircraft exhaust. Compounds that may be encountered in aircraft exhaust include JP-8 and BTEX, which is traditionally collected on charcoal tubes. Aircraft lubricant leakage chemicals include tri-organophosphates and poly alpha olefins. SWBs were infused with VOCs. VOCs were determined by thermal desorption gas chromatography mass spectrometry. Transport studies were performed and SWBs were infused and stored at 4°C for 7 d. Stability studies were performed and SWBs were stored for 27 d and then analyzed. **RESULTS:** All compounds were successfully infused into the SWB. Recovery studies were performed over three different days in three different analytical runs. The average VOC recovery was 95% with a relative standard deviation of 4%. SWB transport and stability after 7 d at 4°C averaged 107% for VOCs and the relative standard deviation was 7.9%. Stability of the infused SWB after 27 d averaged 108% with a relative standard deviation of 6.0%. **DISCUSSION:** The SWB shows excellent promise as an approach to recover multiple classes of Air Force relevant VOCs. The transport and stability of VOCs in the SWB will add to their use and utility under challenging conditions. Future testing will expand the collection effort to polychlorinated biphenyls, dioxins, nitro-aromatics (explosives), and other compounds of concern for our warfighter. Field testing is also anticipated.

**Learning Objectives:**

1. Understand the importance Individual Longitudinal Exposure Records.
2. Understand the issues and shortfalls of current methodologies and standard monitoring equipment in the deployed environment.
3. Know the limitations of any single approach to collecting ILER information.

### [281] ANALYSIS OF NOISE-INDUCED HEARING LOSS IN UNITED STATES AIR FORCE AVIATION-RELATED SPECIAL DUTY PERSONNEL

B. Greenwell[1], G. Maupin[2], A.P. Tvaryanas[1] and Q. Hecht[1]
*[1]School of Aerospace Medicine, Wright Patterson AFB, OH; [2]Aeromedical Research, USAF School of Aerospace Medicine, Wright-Patterson AFB, OH*

**INTRODUCTION:** Exposure to aircraft noise is considered to be the primary cause of hearing loss among military aircrew. Our study aims to determine the relationship between age, years of exposure, flying time, aircraft type, and, if available, hearing protection type (among other available covariates) as potential risk factors for hearing loss among Air Force aviation-related special duty personnel. **METHODS:** A retrospective cohort study was conducted of active duty Air Force aviation-related special duty personnel with an audiogram available in 2013 and who were without evidence of hearing loss from causes other than noise exposure. A combination of longitudinal and advanced regression methods was used to identify risk factors, interactions and, more importantly, how they each impact hearing threshold shift. **RESULTS:** In total, 14,132 subjects were included in the final learning sample. Of these, only 8,368 (3.07%) experienced a significant threshold shift. The subjects' age, exposure time, and rank were all flagged as being predictive of hearing change. Age was, by far, the most influential predictor. Both age and exposure time had a monotonically increasing relationship with significant threshold shift. There is also evidence of a slight interaction between these two variables (as well as others); young individuals with a high amount of exposure had the highest risk of significant threshold shift. **DISCUSSION:** This study provides needed evidence to begin identifying specific subpopulations that are at greater risk for hearing loss.

**Learning Objectives:**

1. To learn about the potential risk factors for hearing loss among Air Force aviation-related special duty personnel.

***Tuesday, April 26*** ***4:00 PM***
***Avalon 17***

## S-48: PANEL: COMPLEX PROBLEMS, NOVEL SOLUTIONS: JUNIOR AND FUTURE FLIGHT SURGEONS LEADING INNOVATION ACROSS THE UNITED STATES AIR FORCE

*Sponsored by Society of United States Air Force Flight Surgeons (SoUSAFFS)*

**Chair: Diane Ritter**
*Keesler AFB, MS*

**Chair: Colby Uptegraft**
*Keesler AFB, MS*

**PANEL OVERVIEW: BODY:** The diverse mission of special duty operators, aviators, and trainees across the United States Air Force presents complex operational medicine problems. This panel features junior and potential Flight Surgeons from various Air Force bases (AFB) presenting how their flight medicine office delivers and could deliver innovative operational medicine solutions to meet these problems. All solutions have one central theme: bringing medical services directly to supported populations increases the value of clinical services and minimizes lost performance and/or training. Our first presentation discusses how combining multiple, high-demand medical services into an in-garrison "forward-operating clinic" increases clinical utilization and efficiency while increasing the overall performance of special duty operator students and trainees at Keesler AFB, MS. Our second and third presentations offer unique solutions to minimizing mission impact of required, low-acuity clinical encounters. Columbus AFB, MS uses a twice-daily RAC clinic (Return to Flying/Controlling Status, Airsickness, & Commander's Awareness Program) within the flying squadron to allow student and instructor pilots rapid access to certain flight medicine services while increasing clinic appointment access for higher acuity encounters. Dover AFB, DE will present a similar solution. Rather than in-person encounters, however, Dover is currently implementing a telemedicine program. Our fourth presentation addresses the hand, foot, and mouth disease outbreak at Lackland AFB, TX during Summer 2015 and how the local flight medicine office resolved the outbreak while minimizing mission impact. The final and fifth presentation features instructor pilots from Columbus AFB discussing how the Air Force can foster more pilot-physicians, dual-rated professionals uniquely trained to bridge operational demands and aerospace medicine.

### [282] THE KEESLER AFB 'FORWARD-OPERATING CLINIC': COMBINING MULTIPLE CLINICAL SERVICES INTO A SINGLE LOCATION WITHIN THE OPERATIONAL COMMUNITY

M. Coghlan, C. Uptegraft, C. Rogers, B. Nishikawa and D. Ritter
*81st Medical Group, U.S. Air Force, Keesler AFB, MS*

**MOTIVATION:** The Air Force Medical Home aims to create the healthiest and highest performing segment of the United States by 2025. To accomplish this vision, the Air Force Medical Service must increase proactive, preventive medicine and tailor reactive medical services to a whole person concept. Delivering this type of medicine is even more important in operational and trainee populations where missed training results in wash backs, money lost, and fewer trained assets. Keesler AFB hosts many student subpopulations, including special duty and non-special duty trainees. These students have minimal free time and limited transportation. Keesler, therefore, integrated five clinical services into a single clinic located on the bottom floor of Erwin Manor, one of the student dormitories, offering convenient, integrated access to multiple specialties. **OVERVIEW:** Erwin Manor includes Flight and Operational Medicine (FOM), Trainee Health (TH), Physical Therapy, Mental Health, and a Preventive Medicine specialist. Outside their primary care provider, Mental Health and Physical Therapy are the most highly utilized clinics among the trainees. Combining these services into a single location allows for integrated clinical workflows, which increases access to care and provides better continuity. Prior to Erwin Manor, many students walked across base to receive these services. With an embedded Preventive Medicine specialist, Erwin Manor analyzes trends and adjusts care delivery to proactively meet new trainee medical demands. This presentation with discuss how integrating these clinical services decreases lost training days, saves money for the training group, and better supports the training mission. **SIGNIFICANCE:** The training mission of Keesler AFB supports many career fields across the Air Force. As a support function, the medical group should deliver medical care that allows Keesler to fulfill this mission. Erwin Manor expands the definition of operational medicine to include multiple, high-demand specialties and offers a perfect example of how embedding medical support within supported populations synergistically increases the value of clinical services and maximizes human performance.

**Learning Objectives:**

1. To illustrate how placing multiple high-demand clinical services together benefits the operational community.
2. To describe how the Keesler AFB Flight and Operational Medicine Clinic integrates with these other clinical services within a single location.
3. To show how the integration of these clinical services affected clinical demand and utilization and lost training due to medical or mental health illness.

### [283] RAPID ADMINISTRATIVE MEDICINE TO INCREASE FLIGHT MEDICINE EFFICIENCY AND POSITIVELY IMPACT THE MISSION

Q. Keigley[2], C. Rogers[1] and A. Delos Santos[2]
*[1]81st Medical Group, U.S. Air Force, Keesler AFB, MS; [2]14th Medical Group, U.S. Air Force, Columbus AFB, MS*

**MOTIVATION:** Many aerospace medicine clinics in the Air Force serve flying or operational populations with limited access to care and frequent interruptions from urgent or emergent administrative tasks. These tasks have a tendency to fill appointment availabilities, thereby shrinking acute patient care or disrupting higher acuity encounters. Columbus Air Force Base (AFB), an undergraduate pilot training base, developed a specialized clinic to address these issues. The acronym RAC is used because of the clinic's top three encounters: Return to Flying/Controlling Status (RTFS/CS), Airsickness Program, and Commander's Awareness Program (CAP). The RAC was strategically placed on the flightline to reduce wait times. This specialized clinic is a fine example of how junior Flight Surgeons are leading innovation across the Air Force because it demonstrates how creative delivery of military healthcare increases the value of clinical services while positively impacting the mission. **OVERVIEW:** Columbus AFB provides a vibrant and diligent medical operation in caring for its instructors, students, and controlling members. RTFS/CS, airsickness, and CAP encounters encompass a large portion of the Flight Surgeon's administrative duties. The RAC has proven that administrative encounters can be accomplished at a much faster rate if placed in a specialized clinic. The RAC is held twice-a-day for one hour and can accommodate 10-20 patients because of its unique setup. This presentation will describe the history of and need for specialized administrative clinics and their role in supporting mission capability. **SIGNIFICANCE:** The RAC specialized clinic efficiently addresses the top aerospace medicine administrative needs at Columbus AFB. By bringing clinical services to the flightline, the RAC also fosters a culture of teamwork and strengthens rapport with the military members it serves. As this presentation will explain, similar systems should be adopted across the military, where such a demand exists. For example, Dover AFB has adopted a telemedicine clinic using similar concepts to the RAC; decrease in wait times, increase in access to care, and a positive impact on the flying mission.

**Learning Objectives:**

1. To understand the clinical methods used to create and run a RAC program to target visits with a high administrative workload.
2. To understand the success achieved from the creation of the RAC system at Columbus AFB, an undergraduate pilot training facility.

### [284] UTILIZATION OF TELEMEDICINE TO IMPROVE AEROSPACE MEDICINE DELIVERY AND OPERATIONAL EFFICIENCY

B. Levy and N. Govil
*436th Medical Group, U.S. Air Force, Dover AFB, DE*

**MOTIVATION:** The United States Air Force recently shifted the grounding management of special duty operators and aviators to an entirely paperless system. Although digital, Flight Surgeons perform most, if not all, return-to-flying/controlling-status (RTFS/CS) examinations in-person even though physical examinations may not be warranted. Transitioning in-person appointments to telemedicine encounters offers an operational advantage for patients and uses clinical personnel and availability more efficiently. Using telemedicine to batch administrative medical appointments mimics the twice-daily process at Columbus AFB, but with telemedicine both medical personnel and special duty operators or aviators never leave the vicinity of their work environment. Patients may be returned to operational status quickly while clinics can reserve appointment availability for higher acuity encounters requiring face-to-face (F2F) physical examinations. **OVERVIEW:** Dover AFB, DE is starting this telemedicine system for administrative encounters. Members may RTFS/CS after a medication ground trial, acute simple illness (e.g. acute non-complicated gastroenteritis), and/or after off-base specialist visits. Two portals are available, one in the Flight Surgeon office and one in the flying squadron. Each morning the clinic hosts a "virtual sick call" where special operators and aviators present for their RTFS/CS examination or other administrative concern. With safeguards and established guidelines to ensure safe clinical care, the Flight Surgeon makes a final disposition or requests the patient to present for a F2F encounter. **SIGNIFICANCE:** As with the Columbus AFB system, batching administrative encounters together and embedding medical group assets within operational squadrons saves work hours and prevents unnecessary mission loss. Telemedicine allows this same teamwork with the operational community while saving additional provider and medical technician time. This presentation will present the effects of telehealth administrative appointments on F2F visits, appointment availability, RTFS/CS timeliness and compliance, and the perception of usefulness and operational impact from the local flying community.

**Learning Objectives:**

1. To show the operational advantage of batching administrative appointments into a high-flow process within a flying squadron.
2. To demonstrate how telemedicine may be used in the aeromedical community.

### [285] OUTBREAK RESPONSE: HAND, FOOT, AND MOUTH DISEASE CAUSED BY COXSACKIEVIRUS A6 IN BASIC MILITARY TRAINEES

K. Laskoski and K. Ma
*559th Medical Group, U.S. Air Force, Lackland AFB, TX*

**MOTIVATION:** Hand, foot, and mouth disease (HFMD) is a common viral illness that typically occurs in infants and young children. In the past

3-4 years coxsackievirus A6 has emerged as a new causative pathogen in large-scale HFMD outbreaks and appears to have an unusual predilection for adults. This presentation will describe the response to an outbreak of coxsackievirus A6 in a military training setting at Lackland AFB. Similar to Keesler AFB's Flight and Operational Medicine Clinic, it will highlight how an interdepartmental response across multiple subspecialties led to bringing aerospace medicine directly to affected patients to maximize operational effectiveness. **OVERVIEW:** From July 6 to September 18, 2015, 53 confirmed and suspected HFMD cases were identified in basic military trainees (BMT's). Five of eight nasopharyngeal specimens tested locally by polymerase chain reaction (PCR) were positive for enterovirus. Four of five nasopharyngeal specimens sent to the CDC tested positive for coxsackievirus A6 by PCR. As the clinical presentation and skin findings were particularly severe in these patients, the initial differential diagnosis was broad. This called for involvement from Preventative Medicine and Dermatology to weigh in on the diagnosis and management. As increasingly more patients began presenting with similar findings, it then became prudent to involve Public Health in helping to contain the outbreak. Infectious Disease at Brook Army Medical center was also consulted to assist with the proper handling of specimens sent to the CDC. **SIGNIFICANCE:** In military training and operational environments, where service members sleep in close proximity for lengthy periods, communicable diseases may spread rapidly. As part of the *Junior and Future Flight Surgeons Leading Innovation* panel, this presentation will discuss how to recognize a more severe and atypical form of HFMD, the approach to and lessons learn from an outbreak containment across an array of subspecialties, and the importance of aggressive management to mitigate viral spread and lost training days.

**Learning Objectives:**

1. To present an outbreak of hand, foot, and mouth disease in the Basic Military Training population.
2. To discuss recognition and control of such an outbreak and ways to improve in the future.
3. To demonstrate the importance of bringing medicine directly to the affected population in a training or operational setting in the context of an outbreak response.

### [286] HOW THE UNITED STATES AIR FORCE CAN FOSTER MORE PILOT-PHYSICIANS: PERSPECTIVES FROM ACTIVE PILOT-PHYSICANS AND LINE PILOTS

J. Grove[1], J. Haas[1] and W. Mueller[2]
*[1]14th Operations Group, U.S. Air Force, Columbus AFB, MS; [2]Air Force Life Cycle Management Center, U.S. Air Force, Wright-Patterson AFB, OH*

**MOTIVATION:** Pilot-Physicians (PPs) are simultaneously qualified as pilots and flight surgeons. Subject matter experts in both of these areas, PPs provide an invaluable role in advancements in aerospace and operational medicine. With required pilot training, medical school, and post-graduate education, the pipeline to produce these assets is long and the application window is narrow and highly selective. Awareness of the Pilot-Physician Program (PPP) must begin early within the medical core and line to sustain a steady pool of qualified applicants. PPs bridge operational demands and aerospace medicine and often lead innovation in both the Air Force Medical Service and flying arenas. As part of the *Junior and Future Flight Surgeon Leading Innovation* panel, this presentation will present perspectives from active PPs and line pilots on how the USAF can strengthen the PPP applicant pool and enhance innovation across the Air Force. **OVERVIEW**: This presentation will start with a description of the PPP and examples of how its members lead innovative projects in the aerospace and operational medicine community. All USAF PPs will be interviewed and their consolidated ideas on how to strengthen the PPP and its applicant pool will be presented. With these ideas and the additional perspective from line pilots, presenters will discuss a new application roadmap, suggested timeline for pilot applicants, ways for the medical community to help pilots meet this timeline, and potential hurdles to its success. **SIGNIFICANCE:** The future of the PPP depends on the awareness of its importance in both the medical and non-medical communities and creating qualified applicants. New next-generation and remotely piloted airframes present unique human performance and human systems integration challenges. The significance of this program has never been greater; the Air Force will need PPs to meet these complex operational and aerospace medicine demands.

**Learning Objectives:**

1. To discuss how the United States Air Force can foster more Pilot-Physicians within and outside the medical community.
2. To increase awareness and stress the importance of the Pilot-Physician Program across aerospace and operational medicine.
3. To propose a new timeline and education strategy to promote more qualified applicants within the pilot community.

***Tuesday, April 26*** ***4:00 PM***
***Avalon 6***

## S-49: PANEL: ADVANCES IN AEROSPACE MEDICINE IN IBEROAMERICA

*Sponsored by the Iberoamerican Association of Aerospace Medicine*

**Chair: Ramon Dominguez-Mompell**
*Madrid, Spain*

**Chair: Lina Sanchez**
*Bogota, Colombia*

**PANEL OVERVIEW:** In 2016, the panel sponsored by the Iberoamerican Association of Aerospace Medicine (IAAM) celebrates its 19th year of sharing scientific advances in the Spanish language. Chaired by IAAM President, Dr. Ramon Dominguez-Mompell of Spain, and co-chaired by Dr. Lina Sanchez, President-elect, of Colombia, the panel will commence with a description of the psychology of flight, including classification and characteristics of fear of flying, flying phobia, and anxiety flight, presented by Dr. Jose Mirabal, of Venezuela. Next, Dr. Rossana Goette, of Argentina, will discuss the preventive control of psychoactive substances in civil aviation. Dr. Miguel Cima, of Argentina, will then discuss issues encountered in travel medicine, such as the diagnosis and treatment of malaria. The panel will continue with a presentation by Dr. Angela Gomez, of Colombia, on a tool to measure fatigue. Dr. David Puerta, of Colombia, will complement the session by discussing a study conducted on a group of aspiring pilots that included the use of the CogScreen neuro-cognitive test battery. As always, the panel offers an opportunity to learn from our colleagues and encourages an internationally united environment towards enhancing world aviation safety.

### [287] PSYCHOLOGY OF FLIGHT: CLASSIFICATION AND CHARACTERISTICS OF FEAR OF FLYING, FLYING PHOBIA, AND ANXIETY OF FLIGHT

J. Mirabal
*Central University of Venezuela, Caracas, Venezuela*

**INTRODUCTION:** Among the areas of study of psychology, is the psychology of aeronautics (P-AER), which model concerns how flight activities affect the psychological area of people who pilot an aircraft and also those who are passengers. The session will offer a theoretical and practical review about the fear of flying that is experienced by many people before and during flight. This fear has been classified into three different entities differentiating between fear of flying, flying phobia, and anxiety of flight. This classification is based on symptoms, signs, and attitudes allowing better differentiation between each of the situations and facilitating their treatment. According to world statistics, one in four people presents one of these difficulties which generates thousands of economic losses and a health problem little studied. This classification was formulated to provide better identification of the problem in those who experience it and open up greater possibilities for its solution. **METHODS:** A theoretical review of different definitions of fear of flying was performed and compared to a sample of 15 cases. **RESULTS:** We found that there are marked differences between the three proposed categories. In relation to gender, there was a slightly higher incidence of anxiety flight in women. In terms of age, it did not indicate significant differences between persons 20 to 30 years of age and those 40 years or

older. **CONCLUSION:** The so-called fear of flying is not a single clinical entity to assign to patients who suffer this problem, but a syndrome with different nuances that can be classified into three different entities.
**Learning Objectives:**
1. The so-called fear of flying is not a single clinical entity to assign to patients who suffer this problem, but a syndrome with different nuances that can be classified into three different entities.

### [288] MEDICAL PSYCHOANALYTICAL CROSSLINKING: WHY SHOULD WE ALLOW THE PREVENTIVE CONTROL OF PSYCHOACTIVE SUBSTANCES IN CIVIL AVIATION?

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*[1]National Administration of Civil Aviation, Buenos Aires, Argentina; [2]Subsecretary of Air Transport, Buenos Aires, Argentina*

The consumption of legal and illegal psychoactive substances during the last 25 years has increased around the world, due to vertiginous processes of globalization, which involve subjective crushing. Some aviators solve and/or compensate for this situation through the use of psychoactive substances, because this action guarantees their efficient psychic activity and performance, which also adapts itself to the market demands. Due to the effect and the consequences that the mentioned substances produce over the human body, it is very important to promote measures leading to the mitigation of the negative impact that their use could have on operational safety. Aviation community authorities face this issue with programs that aim to realize fast recovery, that is, non-consumption. But these measures are not optimal, because the use of psychoactive substances takes the subject to a pleasure situation which is not possible to refuse. For that reason, at present, prevention is the way to address this issue, providing training to the aviation community to avoid the mentioned problem. How? Not omitting the place that the substances occupy in the subjective structure, since something is lacking and /or is being sustained from their consumption to that psychic economy. Taking into account the cases treated aiming at providing a medical waiver from the field of mental health during the last 3 years, they have represented approximately 39% of shown cases, and of those, 55% are cases related to problematic use of psychoactive substances. This data prompts the authorities to emphasize prevention measures. Reviewing the legislation concerning aeronautic workers, aero commercial companies, trade unions, and civil aviation authorities, we consider that the elaboration and application of a preventive program is possible, taking into account International Civil Aviation Organization (ICAO) documents, in order to implement such guidance as part of the civil aviation normative body in Argentina.
**Learning Objectives:**
1. Incidence of use of psychoactive substances in Argentina's aviation community and methods of prevention.

### [289] STRONG SUSPICION FOR MALARIA—TO TREAT OR NOT TO TREAT?

M. Cima[1], N. Moulin[1], P. Rodriguez[1], V. Feuillie[1], B. Davidson[2] and E. Lacono[3]
*[1]Air France-KLM, New York, NY; [2]EL AL Airlines, New York, NY; [3]Aerolineas Argentinas, Buenos Aires, Argentina*

Despite advances in the prophylaxis and treatment of malaria, new cases keep appearing and recently there have been fatalities. Occasionally, a crew member with a clinical picture strongly suggestive of malaria, may test negative in the laboratory and the treating physician faces the dilemma of to treat or not to treat. Two air crew members presented to the designated company physician almost at the same time with severe chills, fever, quick deterioration of their general status, and a history of having served in Africa two to three weeks earlier. Apparently, they did not take malaria prophylaxis. The first patient tested positive for intra-erythrocytic plasmodium, and was treated with antimalarial drugs and showed significant improvement in a few hours. The second, with a similar clinical presentation strongly suggestive of malaria, tested negative twice. As his condition deteriorated quickly he was treated empirically and he felt much better in the ensuing few hours. A recent article in the Annals of Internal Medicine suggests that patients coming from malaria endemic areas in Africa have a 40 percent chance of having malaria. These two crew members had visited one of those countries about three weeks before and had not taken malaria prophylaxis. It appears that giving treatment on empirical bases is probably justified to prevent bad outcomes or fatalities. This view is shared by several infectious diseases specialists that were consulted. Summarizing, crews with high possibility of having malaria should be treated empirically even if laboratory testing does not confirm the diagnosis.
**Learning Objectives:**
1. Crews with high possibility of having malaria should be treated empirically even if laboratory testing does not confirm the diagnosis.

### [290] AN EASY TOOL TO MEASURE FATIGUE

A.M. Gomez[1] and O.G. Granados[2]
*[1]Private Practice, Bogota, Colombia; [2]Servicios Grancolombiana IPS, Bogota, Colombia*

The Aviation industry demands a constant 24-hour operation and one of the main operational concerns is the stressful physiological challenges that affect productivity, performance, and safety. The workers of this industry must work by shifts, have multiple time zone transitions and changing working schedules. Therefore, fatigue arises as a physiological problem becoming a risk factor for occupational safety. Additionally, fatigue is not easy to estimate because of its subjective perception, so it is difficult to measure. However, document No. 9966 from the International Civil Aviation Organization included in the Fatigue Risk Management System Manual– FRMS, suggests that fatigue report forms should be available for online completion based on some tests that have been scientifically validated and have been widely used in aviation. Considering the above, an application has been devised to get information from the crew members every time they use the application, and will give alerts when any indicator is outside the established ranges. This application will be demonstrated and shown to help crew members to recognize the status of their fatigue levels and provides recommendations on what they should do in response to this information. This way, fatigue levels will be easier to identify in all those groups who make the decision to use this application.
**Learning Objectives:**
1. Describe how technology can improve fatigue estimation.
2. Provide information about an application that will help with the recognition of fatigue.

### [291] COGNITIVE PROFILE, BASED ON THE COGSCREEN NEUROPSYCHOLOGICAL TEST, OF A GROUP OF APPLICANT PILOTS AT AN AVIATION SCHOOL IN BOGOTA COLOMBIA

M. Acosta-Barreto[1] and D. Puerta-Malca[2]
*[1]San Buenaventura University, Bogota, Colombia; [2]Aeroclub of Colombia, Bogota, Colombia*

**INTRODUCTION:** The aeromedical edition of the CogScreen neuropsychological battery has been used for the evaluation of aeronautical personnel, considering its advantages for the identification of cognitive skills needed to fly an aircraft, such as attention, cognitive flexibility, working memory and orientation among others, which are grouped in the Taylor factors. Its importance for the evaluation of aspiring commercial pilots lies in that it can determine, from the beginning, the strengths and weaknesses of selected candidates, in order to then potentiate the skills that exhibit low scores through our education system and psychological assistance. **METHOD:** The selected sample consisted of the first 104 candidates for the commercial and private pilot course that were admitted during 2013-2014, and who agreed to participate in the study. The aeromedical edition of the CogScreen neuropsychological battery, based on the Taylor factors (1 Attribute Identification; 2 Motor Coordination; 3 Visual Association Memory; 4 Speed/Working Memory and 5 Tracking) was applied to those subjects. A descriptive cross-sectional design was conducted using the statistical software IBM SPSS® V21 **RESULTS:** A total of 104 subjects were analyzed, including 89 men and 15 women. (Age range: 17-46, mean: 21.6 years). Expected according to the Cogscreen cut-off point, age norm (Major Carriers, all ages) were observed for most of the factors, except for Attribute Identification, which obtained T scores lower than 35, while Motor Coordination obtained the highest score:

59.64. **DISCUSSION:** In reference to Cogscreen cut-off point population, the evaluated subjects were found to have the basic flying skills, except for Attribute Identification, which had medium-low scores. This finding suggests that applicants could experience initial difficulties regarding the association of certain flying rules and their situational awareness. Based on these findings, we recommend that applicant's evaluation should be performed at the end of the educational program for student pilots, in order to evaluate the cognitive changes that they acquired during their learning of flying techniques.

**Learning Objectives:**

1. Understand the utility of the CogScreen test battery in assessing pilot applicants.

## WEDNESDAY, APRIL 27, 2016

***Wednesday, April 27*** ***8:30 AM***
***Avalon 1-3***

## S-50: PANEL: RESPIRATORY IMPACTS OF HIGH-PERFORMANCE FLIGHT

**Chair: Ryan Mayes**
*Upper Arlington, OH*

**PANEL OVERVIEW:** Recent U.S. Air Force investigations into the etiology of unexplained in-flight physiologic incidents have uncovered numerous gaps in aeromedical knowledge. This panel presents some of the work undertaken by the 711th Human Performance Wing (711 HPW) to better understand the respiratory effects of flight in high-performance aircraft (HPA). First, data will be presented from the High-Performance Aircraft Respiratory Study, an epidemiologic study that characterizes baseline rates and types of HPA-related respiratory symptoms. This will be followed by a companion study of exposures in breathing air; this effort uses physiologically based pharmacokinetic modeling to data collected in the High-Performance Aircraft Respiratory Study to estimate dose. Next, two presentations will cover the U.S. Air Force Test Pilot School and 711 HPW "Have Breathless" project, a limited investigation of the effects of elevated work of breathing in HPA flight. The study provided insight into the effects of breathing restriction during flight and had several unexpected findings that may drive future research. An update on 711 HPW aircrew-mounted respiratory sensor development will be provided, followed by a presentation of a laboratory study of the effects of aircrew flight equipment on work of breathing. This will be followed by an investigation of exhaled breath biomarkers for hypoxia under normobaric conditions. A second hypoxia study will present the effects of transient hypoxia on cognitive performance. A third hypoxia study will describe the effects of hyperoxia and hypoxic hypoxia on cognitive function. Finally, the presentations will conclude with the findings and recommendations of a 711 HPW review of the oxygen schedule for a specific aircraft and the presentation of a model of alveolar oxygen partial pressure following rapid decompression. The panel will conclude with a question-and-answer session with a diverse group of experts.

### [292] HIGH-PERFORMANCE AIRCRAFT RESPIRATORY STUDY

R.S. Mayes[2], K. West[3], D.K. Ott[2] and C.C. Grigsby[1]
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During the temporary stand-down of the F-22 fleet in 2011, the 711th Human Performance Wing (711 HPW) collected data from F-22 pilots that suggested frequent post-sortie respiratory symptoms, such as a cough. However, there were no baseline data on the occupational risk of post-flight respiratory symptoms among high-performance aircraft (HPA) pilots with which to interpret F-22 findings. To provide these baseline data and to assess the impact of aircrew flight equipment changes over time, 711 HPW conducted the High-Performance Aircraft Respiratory Study. Data were collected over 1 mo for five flying squadrons: one F-15E, F-16, and T-38 squadron each and two F-22 squadrons at different bases. Data collected consisted of (a) a retrospective questionnaire to assess each pilot's baseline experience with HPA-related respiratory symptoms, occupational and non-occupational exposures, and symptom history; (b) a prospective questionnaire after each sortie to assess the impact of operational exposures (Gz, altitude) on respiratory symptoms; and (c) environmental and breath sampling to assess the impact of ozone and exposure to irritants. Multiple analytic methods were used. As an occupational assessment, this study did not require Institutional Review Board approval. Pilots reported one or more respiratory symptoms on 13% of HPA sorties, most commonly cough or chest tightness. The operational F-22 squadron reported the highest symptom rate, although this rate was half that reported in previous F-22 studies. F-15E and F-16 rates were moderate, and T-38 rates were near zero. Interestingly, the F-22 training squadron reported very low rates. Symptom etiology was largely unclear and appears multifactorial. Longer duration sorties were associated with higher rates of symptoms, and higher Gz was associated with shortness of breath. Finally, individual susceptibility was an important predictor of future symptoms. Preliminary findings from the study were briefed to the Air Combat Command in early 2015. Initial analysis of exhaled breath data showed no definitive conclusions, but further analysis is ongoing. Further study with additional fighter squadrons has been proposed to address remaining knowledge gaps.

**Learning Objectives:**

1. Describe respiratory symptoms associated with high-performance flight.

### [293] SIMULATED RECONSTRUCTIONS OF HIGH PERFORMANCE AIRCRAFT PILOT EXPOSURES USING PHYSIOLOGICALLY BASED PHARMACOKINETIC MODELING

H. Pangburn[2], T. Covington[1], R.S. Mayes[3], C.C. Grigsby[4], D.K. Ott[3] and J.M. Gearhart[1]
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**INTRODUCTION:** Chemical irritants can pass through the on-board oxygen generation system in high-performance aircraft, but the level of and further identification of irritants have not been thoroughly evaluated. The 711th Human Performance Wing recently conducted a High-Performance Aircraft Respiratory Study (HPARS) to identify the etiology of reported coughing/respiratory pilot symptoms and mitigate a common health complaint in high- performance aircraft. HPARS sampling included exhaled breath before and after hundreds of sorties to identify volatile organic compounds (VOCs). Typically, VOCs absorbed into the body via inhalation often rapidly clear from the bloodstream shortly after cessation of exposure. Thus, it is challenging to accurately reconstruct the actual inhalation exposure concentration and blood levels within a pilot's circulatory system and potential toxic chemical levels at the most responsive tissue sites such as the lung respiratory tract or cognitive centers of the central nervous system. **METHODS:** The current study seeks to overcome these issues by using the HPARS human exhaled breath exposure samples. We have applied a physiological simulation tool, Physiologically Based Pharmacokinetic Modeling, to reconstruct pilot blood and tissue concentrations during each specific sortie. **RESULTS:** These reconstructions allowed us to determine possible exposure ranges experienced by pilots during flight (some in-flight concentrations modeled to have exceeded post-sortie exhaled breath samples as much as 1000x), compare modeled exposure to permissible exposure limits and threshold limit values (TLVs) (some in-flight concentrations modeled to have exceeded TLVs, dependent on dosing and timing of exposure), and compare modeled exposure to exposure levels and symptomology from the literature associated with various chemical species. **DISCUSSION:** This approach produced informed knowledge judgment as to the probabilities that any particular chemical could have both the potential to have achieved high enough in-flight exposure concentrations and have a known level of toxic potency to be of consequence.

**Learning Objectives:**

1. Better understand the basis of respiratory effects of possible in-flight exposures in high performance aircraft.